SAVE
SHOCK & VIBRATION
EXCHANGE

92nd Shock & Vibration Symposium

September 18 - 22, 2022

Denver, Colorado

www.savecenter.org

Welcome

WELCOME TO DENVER AND THE 92ND 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 the **Shock and Vibration Exchange**.

Thank You

IN ADDITION TO OUR EVENT HOSTS, WE WOULD LIKE TO RECOGNIZE OUR 92ND SHOCK AND VIBRATION SYMPOSIUM COMMITTEE*:

Mr. Jeff Averett, US Army ERDC
Mr. Jim Breault, Lansmont Corporation
Mr. Sloan Burns, NSWC Dahlgren
Mr. Justin Caruana, Cardinal Engineering
Mr. Matthew Davis, HII-NNS
Mr. Sal Detruit, NTS
Mr. Bill Gregory, Applied Physical Sciences
Ms. Rebecca Grisso, NSWC Carderock**
Mr. Adam Hapij, Thornton Tomasetti
Mr. Roger Ilamni, NSWC Indian Head
Dr. Bryan Joyce, NSWC Dahlgren
Mr. Alan Klembczyk, Taylor Devices
Mr. Russ Kupferer, IDA
Mr. Kenneth Lussky, BAE Systems
Dr. Luke Martin, NSWC Dahlgren
Ms. Melissa Maze, PCB Piezotronics
Mr. Barton McPheeters, Gibbs & Cox
Dr. Russel Miller, IDA
Mr. Drew Perkins, SAVE/HI-TEST
Dr. John Pott, Sandia National Laboratories
Mr. Jenner Sequeira, PCB Piezotronics
Mr. Jeff Scheuren, Marinette Marine
Ms. Ashley Shumaker, SAVE/HI-TEST
Mr. Ernest Staubs, AFRL
Mr. Jon Stergiou, NSWC Carderock**
Ms. Caroline Wiley, NSWC Indian Head
Ms. Lauren Yancey, HI-TEST Laboratories

**TAG members in attendance at summer meeting for 92ND S&V program review (held at NSWC Carderock)*
***NSWC Carderock hosts*

Thank You

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Schedule at a Glance

(WITH DAILY OUTLINE AND HOURS)

DAY/DATE	PROGRAM FEATURE TYPE	TIME	PAGE
SUNDAY (09/18)	REGISTRATION (TOWER COURT A)	8:00AM - 5:00PM	
	BUSINESS CENTER (TOWER COURT ALCOVE)	9:00AM - 5:00PM	
	EXTENDED TUTORIAL SESSION	10:00AM - 4:00PM	PG. 7
MONDAY (09/19)	REGISTRATION (TOWER COURT A)	7:00AM - 6:00PM	
	TUTORIALS	8:00AM - 7:00PM	PG. 8-13
	BUSINESS CENTER (TOWER COURT ALCOVE)	7:00AM - 6:00PM	
	EXHIBIT HALL SETUP (GRAND BALLROOM)	NOON - 6:00PM	
	WELCOME RECEPTION (GRAND BALLROOM)	6:30PM - 8:30PM	PG. 14
TUESDAY (09/20)	REGISTRATION (TOWER COURT A)	7:00AM - 6:00PM	
	EXHIBIT HALL OPEN (EXECUTIVE BALLROOM)	7:00AM - 5:00PM	
	BUSINESS CENTER (TOWER COURT ALCOVE)	7:00AM - 6:00PM	
	TUTORIALS	8:00AM - 11:00AM	PG. 16-17
	GENERAL SESSION I & EXHIBITORS LUNCHEON	11:00AM - 1:00PM	PG. 18
	TECHNICAL PAPER SESSIONS & TRAINING	1:00PM - 6:10PM	PG. 20-23
WEDNESDAY (09/21)	REGISTRATION (TOWER COURT A)	7:00AM - 6:00PM	
	BUSINESS CENTER (TOWER COURT ALCOVE)	7:00AM - 6:00PM	
	TECHNICAL PAPER SESSIONS & TRAININGS	8:00AM - NOON	PG. 24-27
	EXHIBIT HALL OPEN (GRAND BALLROOM)	9:00AM - 4:00PM	
	GENERAL SESSION II & AWARDS LUNCHEON	NOON - 1:30PM	PG. 28
	TECHNICAL PAPER SESSIONS & TRAININGS	1:30PM - 3:30PM	PG 30-31
	TUTORIALS	3:30PM - 6:30PM	PG. 32
	SPECIAL INDUSTRY PANEL	4:15PM - 5:15PM	PG. 33
	EXHIBIT HALL DISMANTLE	4:15PM - 6:00PM	
	COMMERCIALLY SPONSORED SOCIAL EVENT	7:30PM - 9:30PM	PG. 34-35
THURSDAY (09/22)	REGISTRATION (TOWER COURT A)	7:00AM - NOON	
	BUSINESS CENTER (TOWER COURT ALCOVE)	7:00AM - NOON	
	TECHNICAL PAPER SESSIONS & TRAININGS	8:00AM - 12:05PM	PG. 36-39
	S&V TAG COMMITTEE MEETING (WINDOWS)	1:00PM - 2:00PM	PG. 39
	EXHIBIT HALL LAYOUT & VENDOR DESCRIPTIONS		PG. 40-47
	HOTEL MEETING SPACE FLOOR PLANS		PG. 48-51

Food & Beverage Events

(ALL SYMPOSIUM ATTENDEES ARE WELCOME TO ATTEND EVENTS LISTED BELOW)

MONDAY (09/19)	**WELCOME RECEPTION** (GRAND BALLROOM / EXHIBIT HALL) *BEVERAGES & HEAVY HORS D'OEUVRES* **GUESTS OF SYMPOSIUM ATTENDEES ARE WELCOME.*	6:30PM - 8:30PM
TUESDAY (09/20)	**CONTINENTAL BREAKFAST** (GRAND BALLROOM / EXHIBIT HALL)	7:00AM - 8:00AM
	GENERAL SESSION 1: ELIAS KLEIN KEYNOTE LECTURE & EXHIBITORS LUNCHEON (GRAND BALLROOM / EXHIBIT HALL)	11:00AM - 1:00PM
	ICE CREAM SOCIAL (GRAND BALLROOM / EXHIBIT HALL)	3:00PM - 3:40PM
WEDNESDAY (09/21)	**CONTINENTAL BREAKFAST** (GRAND BALLROOM / EXHIBIT HALL)	7:00AM - 8:00AM
	GENERAL SESSION 2: AWARDS LUNCHEON AND PRESENTATION (GRAND BALLROOM / EXHIBIT HALL)	NOON - 1:30PM
	ICE CREAM SOCIAL (GRAND BALLROOM / EXHIBIT HALL)	3:30PM - 4:15PM
	SYMPOSIUM SOCIAL/DINNER **AT OFF-SITE LOCATION (LUCKY STRIKE)** **COMMERCIALLY SPONSORED BY HI-TEST LABORATORIES, NATIONAL TECHNICAL SYSTEMS, AND SPECTRAL DYNAMICS** **GUESTS OF SYMPOSIUM ATTENDEES ARE ALSO WELCOME.*	7:30PM - 9:30PM
THURSDAY (09/22)	**CONTINENTAL BREAKFAST** (GRAND BALLROOM / EXHIBIT HALL)	7:00AM - 8:00AM

KEEP A LOOK OUT FOR THIS QR CODE IN THE PROGRAM AND IN PRESENTATION ROOMS!

SCAN THE QR CODE TO NOMINATE ANY PRESENTATION YOU FEEL DESERVING OF OUR ANNUAL

***HENRY C. PUSEY BEST PAPER AWARD*.**

FULL AWARD CRITERIA AND NOMINATION FORM AVAILABLE BY SCANNING THE QR CODE ABOVE.

SUNDAY
SEPTEMBER 18

EXTENDED TUTORIAL SESSION
10:00AM - 4:00PM

OPTIONAL FIVE-HOUR COURSE WITH ONE-HOUR LUNCH BREAK. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

MIL-DTL-901E SHOCK TRAINING
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

WINDOWS

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

MONDAY
SEPTEMBER 19

TUTORIAL SESSION I
8:00 - 11:00AM

OPTIONAL THREE HOUR COURSES. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

MIL-DTL-901E SHOCK QUALIFICATION TESTING
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

WINDOWS

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

DDAM 101
Mr. George D. (Jerry) Hill (SERCO)

TOWER D

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

INTRODUCTION TO DESIGNING SHOCK MOUNTED SYSTEMS USING SIMPLE SOFTWARE
Mr. Dave Callahan (HII - Newport News Shipbuilding)

TOWER B

This course will introduce a process for designing and assessing shock isolation systems with special emphasis on applications related to the design of shipboard equipment for shock loads produced by underwater explosions utilizing the analytical software tool “Shock Isolation Mount Prediction & Loading Estimates” (SIMPLE). This process is split into two parts: 1) initial analysis using classic Shock Response Spectrum (SRS) and 2) assessment, confirmation, iteration or comparison of isolation system designs using SIMPLE simulation methods. Attendees will learn how to building six Degree of Freedom (DOF) SIMPLE models of isolated systems, select shock mounts and modify mount properties, select shock inputs, evaluate the isolation system performance and iterate designs rapidly. This course is intended for anyone who desires validation and assurance that shock and vibration mounts are properly selected for equipment racks, consoles, cabinets and other structures using SIMPLE software. Examples of SIMPLE users are: engineers, program and project managers, equipment integrators, shock/vibration analysts, mount vendors and shock qualification reviewers/approvers.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 9]

INTRODUCTION TO PYROSHOCK TESTING
Dr. Vesta Bateman (Mechanical Shock Consulting)

TOWER C

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.

MONDAY
SEPTEMBER 19

TUTORIAL SESSION II
NOON - 3:00PM

OPTIONAL THREE HOUR COURSES. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

MIL-DTL-901E SHOCK QUALIFICATION TESTING EXTENSIONS

WINDOWS

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

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

AN INTRODUCTION TO ALIASING, FFT, FILTERING, SRS & MORE FOR FEA USERS AND TEST ENGINEERS

TOWER D

Dr. Ted Diehl (Bodie Technology)

Working with either physical test data and/or numerical simulations related to severe mechanical shock, impact, failure, etc. is extremely challenging. Some of the biggest challenges in this type of work are 1) properly collecting the initial raw data while avoiding aliasing [especially from numerical simulations], 2) utilizing robust methods to identify and separate the “noise & distortions” from the “true” frequency-rich content in the data, and 3) determining what portion of the “true” frequency-rich content is meaningful and what does it tell you. For a given problem, the initial appearance of raw time-domain data in this class of work may be vastly different between physical testing and data derived from transient simulation codes (LS-Dyna, Abaqus/Explicit, RADIOSS…). While the data might look different, the rules of DSP (Digital Signal Processing) are the same. Most importantly, understand and utilizing DSP properly is a critical requirement to success in BOTH types of approaches, especially to obtain correlation between physical tests and simulation of the same specific problem.

The 3-hour seminar provides guidance to both simulation analysts and test engineers on how to properly collect and process such data; ultimately uncovering significantly improved results. The course covers highlights of DSP theory in the language of Mechanical Engineering pertinent to simulation analysts and test engineers. This seminar introduces key aspects of working with transient data – specifically, clearly explaining time-domain and frequency domain analysis (DFS, FFT, PSD); data collection (sampling, up-sampling, decimation, and aliasing); filtering (lowpass, highpass, IIR, and FIR), how to avoid aliasing, calculating Shock Response Spectrum (Accel SRS & 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, and more). Simplified demonstrations are presented to solidify key DSP aspects, along with many relevant real-world examples. Both FEA users and experimentalists will benefit from this training.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 11]

EFFECTIVE SOLUTIONS FOR SHOCK AND VIBRATION CONTROL

TOWER C

Mr. Alan Klembczyk (Taylor Devices)
Mr. Ken Lussky (BAE Systems)

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

MONDAY
SEPTEMBER 19

TUTORIAL SESSION III
4:00 - 7:00PM

OPTIONAL THREE HOUR COURSES. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

MIL-DTL-901E SUBSIDIARY COMPONENT SHOCK TESTING & ALTERNATIVE TEST VEHICLES — WINDOWS

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

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

ANALYSIS FOR A MEDIUM WEIGHT SHOCK TEST — TOWER D

Mr. Josh Gorfain (Applied Physical Sciences)

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.

REMOVING THE BOUNDARY CONDITION HOBGOBLINS IN VIBRATION QUALIFICATION TESTING WITH MODAL TECHNIQUES — TOWER C

Mr. Troy Skousen (Sandia National Laboratories)
Mr. Randy Mayes (Consultant)

Mitigating the field-to-laboratory boundary condition impedance mismatch for base excitation testing by controlling the test article fixed base elastic modes through appropriate base inputs

Random vibration laboratory testing is used to qualify components to survive in-service responses to system environments. Using realistic research hardware and an analytical rocket system, we show that traditional single input (SDOF) base excitation laboratory test specifications generate large response uncertainties when compared with the field environment responses. A brief review is provided showing how vibration mode shapes are derived from test data. A model utilizing fixed base and rigid body modes of the component on its vibration test fixture is used to decompose the component field motion into a few insightful modal responses. It is used to develop 6DOF laboratory control that eliminates large uncertainties with a corresponding boost in qualification confidence. This model is used to develop a greatly improved SDOF base input test. The same approach can be applied to achieve much higher fidelity 3 DOF translation base input tests. The model can also be used to address unit-to-unit variability simply based on a laboratory random survey before the component qualification test is executed.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 13]

CAN METHODS FOR NUMERICAL TIME INTEGRATION IN COMMON USE BE REPLACED BY EQUIVALENT DIGITAL FILTERS?

TOWER B

Prof. Kjell Ahlin (Xielalin Consulting)

Equivalent digital filters have been derived for conventional explicit methods used in numerical time integration of forced responses in mechanical systems. The methods are Runge-Kutta, Newmark beta, HHT-alpha and matrix exponential. To simulate forced response, modal superposition is used. For each mode there is a corresponding second order digital filter. The filter coefficients are calculated from the used sampling frequency (or time step), the residues and poles for the Frequency Response Function in question, and the actual original model parameters, such as alpha, beta and gamma for HHT-alpha method.

As modal superposition is used, there is a natural way to limit the calculation to a certain frequency range by using a limited number of modes. In that way the problem with high frequency modes is eliminated. If only a limited number of inputs and responses are of interest, the filter method is much faster, giving the same result.

As the filter method is equivalent with the conventional method, the filter properties can easily be used to map the properties for the original method. In that way properties like stability range and accuracy, both in time and frequency domain, are easily calculated. This means that the accuracy for a certain simulation may be exactly calculated in beforehand without doing any simulation. In that way a needed fixed time step for a defined accuracy can be calculated, avoiding the need for methods with changing time steps, like ODE45. Comparison is made with a class of filters based on the convolution integral. It is shown that those filters may have better accuracy, putting the whole use of the conventional methods under question.

MONDAY

SEPTEMBER 19

Welcome Reception

HI-TEST Laboratories, Inc.

ALL SYMPOSIUM ATTENDEES AND GUESTS ARE INVITED TO ATTEND.

6:30 - 8:30PM
FOOD & DRINKS
GRAND BALLROOM/EXHIBIT HALL

End Monday Events

CONTINENTAL BREAKFAST

7:00 - 8:00AM
GRAND BALLROOM/EXHIBIT HALL

AFTER BREAKFAST, ENJOY THE OPPORTUNITY TO NETWORK WITH OTHER ATTENDEES AND INTERACT WITH EXHIBITORS.

TUESDAY
SEPTEMBER 20

TUTORIAL SESSION IV
8:00 - 11:00AM

OPTIONAL THREE HOUR COURSES. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

CHANGES FROM MIL-S-901D TO MIL-DTL-901E EXPLAINED
Mr. Kurt Hartsough (NSWC Philadelphia)

WINDOWS

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

MIL-DTL-901E ENGINEERING TOPICS
Mr. Domenic Urzillo (NSWC Carderock)

TOWER C

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

INTRODUCTION TO UNDERWATER EXPLOSION PHENOMENA WITH BASIC APPLICATIONS TO STRUCTURES
Mr. Fred Costanzo (Consultant)

TOWER D

This tutorial is divided into two major parts. The first segment consists of 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. The second segment involves basic applications of UNDEX-induced dynamic shock wave loadings to the estimation of both local and global responses of simple floating and submerged structures. Three primary well-documented methodologies are presented, including the Taylor Flat Plate analogy for estimating the responses of both air-backed and water-backed plates, the Peak Translational Velocity method for estimating the response of submerged cylindrical bodies, and the application of the conservation of momentum principle for estimating the vertical kickoff velocity of floating structures (Spar Buoy approach). Derivations of the governing equations associated with each of these solution strategies are briefly presented, along with a description of the appropriate ranges of applicability. Applications of each of these methodologies will be illustrated using simple examples. Finally, some case studies are presented that illustrate the power of applied numerical methods in the form of finite differences to obtain approximate solutions to some classical nonlinear mechanics problems.

[SEE ADDITIONAL TOPICS FOR THIS SESSION ON PAGE 17]

COMMON ROADBLOCKS AND LESSONS LEARNED IN SHOCK QUALIFICATION (PRACTICAL GUIDANCE AND CASE STUDIES)

TERRACE

Mr. Patrick Minter (HII - Newport News Shipbuilding)

This course will focus on errors and missteps common to the shock qualification process and how they can be avoided by walking attendees through qualification efforts for several real-life examples. The instructor will provide details on the issues which were faced, the utilized testing/analysis methodologies, related 901 requirements, and lessons learned. The end-goal of the training is to provide attendees with a better practical understanding of shock qualification by test and extension. This course is aimed at those who are or will be responsible for shock qualifying naval equipment per 901 requirements. This course assumes the attendees have at least a base understanding of 901 methodologies and requirements. Therefore it is recommended (but not required) that attendees have sat through previous 901 trainings or at least have a base understanding of 901 requirements. There will also be a portion of the tutorial set aside for specific attendee questions and hypothetical scenarios.

AIR BLAST AND CRATERING: AN INTRODUCTION TO THE ABC'S OF EXPLOSION EFFECTS IN AIR AND ON LAND

TOWER B

Mr. Denis Rickman (USACE ERDC)

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

TUESDAY
SEPTEMBER 20

EXHIBITORS LUNCHEON
(GENERAL SESSION I)
WITH ELIAS KLEIN KEYNOTE LECTURE
11:00AM - 1:00PM

GRAND BALLROOM

11:00AM—11:10AM	**CALL TO ORDER** Mr. Drew Perkins, SAVE / HI-TEST Laboratories
11:10AM—11:15AM	**KEYNOTE LECTURE INTRODUCTION** Dr. Najib Abboud, Thornton Tomasetti
11:15AM—NOON	**ELIAS KLEIN KEYNOTE LECTURE** Dr. Raymond Daddazio, Thornton Tomasetti
NOON—1:00PM	**LUNCH** **FOLLOWED BY EXHIBITOR MEET & GREET**

INTRODUCING ELIAS KLEIN KEYNOTE LECTURER, DR. RAYMOND DADDAZIO

Thornton Tomasetti

As President of Thornton Tomasetti, **DR. RAY DADDAZIO** provides strategic and operational leadership across the firm's 50 offices and 1500 people. During his 40-year career, he has held various leadership roles, including that of president and CEO of Weidlinger Associates, which merged with Thornton Tomasetti in 2015.

Prior to his election as Weidlinger's president in 2006, Ray was director of the firm's Applied Science business unit. As such, he oversaw all of the firm's advanced analysis and R&D initiatives. Dr. Daddazio has made significant contributions to the structural engineering of buildings and the advancement of civil engineering, especially in the use of applied science and analytics to improve structural design and performance. His contributions span the critical areas of shock and vibration, extreme loadings on structures, blast effects, physical security, software development and threat and vulnerability assessments. He has authored more than 40 papers and articles on such topics as non-linear underwater shock analysis, low frequency structural acoustics, structural optimization and vibration control, and uncertainty quantification.

Dr. Daddazio is a member of American Society of Civil Engineers' Industry Leaders Council, the National Academy of Construction, a fellow of the Engineering Mechanics Institute, and is a director emeritus of the New York Building Congress. He received his Eng.Sc.D. from Columbia University, as well as his B.S. and M.S. in civil engineering.

EXHIBITORS LUNCHEON
(GENERAL SESSION I)
WITH ELIAS KLEIN KEYNOTE LECTURE
11:00AM - 1:00PM

TUESDAY
SEPTEMBER 20

Exhibitor Meet & Greet

ENJOY TIME TO PERUSE THE EXHIBIT HALL AND MEET ALL THE VENDORS.
DON'T FORGET TO GET STARTED ON YOUR PASSPORT PROGRAM ENTRY FORM!
PRIZES TO INCLUDE:

SAVE PROGRAM PRIZES	VENDOR DONATED PRIZES
$250 AMAZON GIFT CARD	YETI MERCHANDISE
HP CHROMEBOOK	VARIOUS GIFT CARDS
JBL FLIP BLUETOOTH SPEAKER	FLAT SCREEN TV
RING DOORBELL	LEGO AIRCRAFT CARRIER
AMAZON ECHO SHOW	EARBUDS & MISC. ELECTRONICS
AMAZFIT SMART WATCH	EXHIBITOR APPAREL & SWAG

DRAWING TO BE HELD DURING WEDNESDAY AFTERNOON BREAK IN THE EXHIBIT HALL!

Tuesday (September 20)

	SESSION 1: **CHARACTERIZATION OF MECHANICAL SHOCK** 1:00-1:20PM / LIMITED DIST. C 1:25-3:00PM / UNLIMITED DIST. A CHAIR(S): Dr. John Pott (Sandia National Labs) Dr. Bryan Joyce (NSWC Dahlgren)	*SESSION 2:* **VIBRATION TEST SPECIFICATIONS & ENVIRONMENTS** 1:00-2:35PM / UNLIMITED DIST. A **SHOCK ANALYSIS IMAGING** 2:40-3:00PM / UNLIMITED DIST. A CHAIR(S): Mr. Shawn Czerniak (Hutchinson) Dr. Peter Vo (Raytheon)	*SESSION 3:* **WEAPON EFFECTS MODELING** 1:00-3:00PM / LIMITED DIST. D CHAIR(S): Ms. Michelle LeBlanc (AFRL) Dr. Gregory Bessette (US Army ERDC)
	MAJESTIC BALLROOM	VAIL	TOWER COURT D
	(##) following each paper title indicates associated page number in the abstract book appendix.		
1:00	**Development of In-Structure Shock Test Motions for Shake Table Qualification of Critical Equipment** (1) *Mr. James Wilcoski (US Army ERDC)*	**Program Development Approaches for MIL-STD-167-1A Based External Vibration Testing (3)** *Mr. Neil McRae (Thornton Tomasetti)*	**Comparison of Damage Detection Results for Fine and Coarse Mark 84 Finite Element Models Using PENCURV/ EPIC Program (5)** *Mr. Logan Rice, Dr. Mark Adley, Mr. David Lichlyter, & Mr. Ernesto Cruz (US Army ERDC)*
1:25	**Analyzing Shock Response of Simple Structures to Investigate Relationships between Shock Spectrum and Physical Response Parameters (1)** *Mr. Jason Sammut & Dr. Matthew Lear (Penn State Applied Research Laboratory)*	**Aspects of Laboratory Vibration Test Specification Development (3)** *Dr. Ronald Merritt (SAALEX Solutions)*	**Modeling of Blast-Enhancing, Low-Density Reactive Materials (6)** *Mr. Gustavo Emmanuelli & Dr. Gregory Bessette (US Army ERDC), Dr. Alan Ohrt & Dr. Kyle Overdeep (USAF/AFRL/RWMW)*
1:50	**The Relationship between Pseudo Displacement and Shock Severity (2)** *Dr. Bryan Joyce, Mr. Sloan Burns, & Mr. Vincent Mihota (NSWC Dahlgren)*	**Use of the Damage Potential Spectrum as a Comparison Descriptor for Multiple-Degree-of-Freedom Random Vibration Specifications (4)** *Dr. Michael Hale (Trideum Corp), Mr. William Barber (US Army Redstone), Mr. Jesse Porter (Hill Technical Solutions)*	**Modeling Enhanced Blast from Low-Density Reactive Materials in the BlastX Fast-Running Model (6)** *Dr. Greg Bessette & Mr. Gustavo Emmanuelli (US Army ERDC), Dr. Al Hort, Mr. Brian Taylor, Mr. Kyle Overdeep, & Mr. Suhiti Peiris (AFRL)*
2:15	**Shock Response Calculation - An Overview (2)** *Prof. Kjell Ahlin (Xielalin Consulting)*	**Dual Rigidly Coupled MDOF Vibration System (4)** *Mr. Matthew Forman, Dr. Luke Martin, Mr. Shawn Schneider, Dr. Bryan Joyce, & Mr. Robert Ponder (NSWC Dahlgren)*	**Endgame Framework and Shock Effects Application Development (7)** *Ms. Michelle LeBlanc (AFRL)*
2:40	**An Experimental Comparison of Force Reconstruction Techniques (2)** *Mr. Jacob Lewton, Dr. Curtis Masmussen, & Dr. Massimo Ruzzene (Univ. of Colorado), Mr. Jonathan Hower & Dr. Washington DeLima (Kansas City National Sec. Campus)*	**Schlieren Techniques for Shock Analysis with High-Speed Imaging (5)** *Mr. Wayne Carlson (Vision Research)*	**Evaluation of Tactical Ballistic Missiles (TBM) Airblast Surrogates (7)** *Ms. Shelby Buckley, Ms. Jessica Fulk, Mr. John Hoemann, & Dr. Genevieve Pezzola (US Army ERDC)*

3:00 - 3:40

Ice Cream Social

GRAND BALLROOM (EXHIBIT HALL)

	SESSION 4: **DYSMAS I** 1:00-3:00PM / LIMITED DIST. D CHAIR(S): MS. REBECCA GRISSO (NSWC CARDEROCK) MR. ROGER ILAMNI (NSWC INDIAN HEAD)	*VENDOR SESSION A:* **EXHIBITOR PRESENTATIONS INCLUDING CASE STUDIES, NEW DEVELOPMENTS, TESTING & PRODUCTS** 1:00-3:00PM / UNLIMITED DIST. A CHAIR(S): MR. BOB METZ (PCB PIEZOTRONICS) MR. BLUEJAY ROBINSON (CORRELATED SOLUTIONS)	*TRAINING I:* **DEVELOPING EXODUS II AND SIERRA SD/SM FORMAT MODELS** 1:00-2:00PM / UNLIMITED DIST. A **AN INTRODUCTION TO FEA ANALYSIS** 2:00-3:00PM / UNLIMITED DIST. A 
	WINDOWS	TERRACE	COLUMBINE
	(##) FOLLOWING EACH PAPER TITLE INDICATES ASSOCIATED PAGE NUMBER IN THE ABSTRACT BOOK APPENDIX.		
1:00	**MEASUREMENT RESULTS FROM UNDEX SHOCK WAVE PROPAGATION TESTS IN THE SEA BOTTOM (7)** *Mr. Roger Ilamni & Mr. Brad Klenow (NSWC Indian Head), Mr. Tobias Timm, Mr. Swen Metzler (WTD-71), Mr. Greg Harris (ATR)*	**USING DIC TO MEASURE THE SHAPE OF SOUND AND VIBRATION (9)** *Mr. Bluejay Robinson (Correlated Solutions)*	**DEVELOPING EXODUS II AND SIERRA SD/SM FORMAT MODELS (10)** *Mr. Kory Soukup (Altair Engineering)* 1:00 - 2:00PM
1:25	**CHARACTERIZATION OF SEA BOTTOM MATERIAL AND DYSMAS CONSTITUTIVE MODEL DEVELOPMENT (8)** *Dr. Tom McGrath & Dr. Jeff St. Clair (NSWC Indian Head), Mr. Norman Herzig (Nord-metall), Mr. Swen Metzler (WTD-71)*	**IEPE SHOCK SENSORS FOR HIGH-G MEASUREMENTS (9)** *Mr. Kevin Westhora (Dytran Instruments)*	
1:50	**DYSMAS SIMULATION OF RECENT UNDEX SHOCK WAVE PROPAGATION TESTS IN THE SEA BOTTOM USING DEVELOPED SEA BOTTOM MODEL (8)** *Mr. Brad Klenow & Dr. Tom McGrath (NSWC Indian Head)*	**ADVANTAGES OF A SOLID ARMATURE SHAKER (10)** *Mr. Graham Carmichael (ETS Solution)*	**AN INTRODUCTION TO FEA ANALYSIS (11)** *Mr. Bart McPheeters (Gibbs & Cox)* 2:00 - 3:00PM
2:15	**MULTI-CYCLE BUBBLE UNDEX SIMULATIONS USING DYSMAS BUBBLE ENERGY LOSS CAPABILITY (8)** *Mr. Martin Heuvers (WTD–71 Engineer and Scientist Exchange Program), Dr. Tom McGrath (NSWC Indian Head), Mr. Greg Harris (ATR)*	**LIVE REMOTE VIBRATION MONITORING (10)** *Mr. Ed Okorn (Scantek, Inc.)*	
2:40	**NEAR-FIELD UNDEX RESPONSE OF SHIP GRILLAGES (FVEY) (8)** *Dr. Ken Nahshon & Mr. Andrew Glass (NSWC Carderock)*	**PROPER STRAIN RELIEF TO AVOID CABLE DAMAGE (10)** *Mr. Bob Metz (PCB Piezotronics)*	

3:00 - 3:40

PCB PIEZOTRONICS AN AMPHENOL COMPANY

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Ice Cream Social

GRAND BALLROOM (EXHIBIT HALL)

SPECTRAL DYNAMICS

	SESSION 5: **SHOCK & VIBRATION ISOLATION** 3:45-5:20PM / UNLIMITED DIST. A **SHOCK & VIBRATION HUMAN EFFECTS** 5:25-5:45PM / UNLIMITED DIST. A CHAIR(S): MR. ALAN KLEMBCZYK (TAYLOR DEVICES) MR. ROBERT SHARP (HUTCHINSON)	*SESSION 6:* **MECHANICAL SHOCK: NUMERICAL APPLICATIONS** 3:45-4:55PM / UNLIMITED DIST. A **NAVY SHOCK QUALIFICATION** 5:00-6:10PM / LIMITED DIST. D CHAIR(S): DR. JOHN POTT (SANDIA NATIONAL LABS) DR. PETER VO (RAYTHEON)	*SESSION 7:* **WEAPON EFFECTS TESTING** 3:45-4:55PM / LIMITED DIST. D 5:00-6:10PM / LIMITED DIST. C CHAIR(S): MR. JEFF AVERETT (US ARMY ERDC) MR. ERNIE STAUBS (AFRL)
	VAIL	MAJESTIC BALLROOM	TOWER COURT D
3:45	**COMPARING THE PERFORMANCE OF WIRE ROPE ISOLATORS AND ELASTOMER MOUNTS UNDER CHANGING TEMPERATURES (11)** *Mr. Liron Fridman (Vibro/Dynamics)*	**MECHANICAL SHOCK ANALYSIS AND TESTING FOR SEISMO-GEODETIC ICE PENETRATOR (13)** *Mr. Michael Brown, Mr. Alex Miller, Mr. Aaron Makikalli, Prof. Jeff Hoffman, Dr. Pedro Elosegui, Mr. Cesar Miza, Mr. Christopher Eckert, & Mr. Chester Ruszczy (MIT)*	**OVERVIEW OF JOINT WEAPON EFFECTS RESEARCH (15)** *Mr. Ernest Staubs (AFRL), Dr. Holger Sohn (German Ministry of Defense), Mr. Jason Angel (US Army CCDC/AFRL)*
4:10	**ROBUST ISOLATION FOR VIBRATION ABATING (RIVA): A TECHNOLOGY TO INCREASE LASER BEAM STABILITY (11)** *Dr. James Rall & Mr. David Frank (ShockTech RED)*	**OPTIMIZING MOUNTING TECHNIQUES FOR PCB COMPONENTS SUBJECT TO HIGH-G TESTING (13)** *Mr. Richard Clayson, Mr. Josh Dye, & Mr. Shane Curtis (Sandia National Labs)*	**SECONDARY DEBRIS IMPULSE MEASUREMENTS FROM FAILING CMU AND RC WALLS (15)** *Dr. George Lloyd, Dr. Tom Paez, and Mr. Jake Allyn (ACTA, Inc.)*
4:35	**THE UNDERWATER BUBBLE EFFECT ON ON-BOARD EQUIPMENT SUSPENSIONS ON SURFACE VESSELS AND SUBMARINES (12)** *Mr. Jean-Michel Courzereaux & Mr. Ali Shehadeh (Vibro/Dynamics)*	**PRESSURE TESTING ENCLOSURE PROJECTILE IMPACT ANALYSIS (14)** *Mr. Jonathan McConnell (UCF), Mr. Andrew Hicks (LSU), Dr. Kimberly Haulenbeek, Dr. Neal Hubbard, & Dr. Thomas Ivanoff (Sandia National Labs)*	**AN ANALYSIS OF THE GROUND CRATER PRODUCED ON THE SHIELD 2019 TEST (16)** *Mr. Denis Rickman, Dr. Kyle Crosby, & Mr. Daniel Vaughan (US Army ERDC)*
5:00	**LIQUID CRYSTAL ELASTOMERS (LCES): A NEXT-GENERATION DISSIPATIVE, RATE DEPENDENT, AND DIRECTIONAL MATERIAL FOR IMPACT PROTECTION AND VIBRATION ISOLATION (12)** *Dr. Chris Yakacki (Impressio)*	**FAST STATISTICAL MODELS OF SHOCK PROPAGATION AT MID AND HIGH FREQUENCIES (14)** *Mr. Ed Heyd (3DS SIMULIA)*	**THE GHOST OF THE NEGATIVE PHASE: AN INTRODUCTION TO BLAST-INDUCED CONDENSATION CLOUDS (16)** *Mr. Denis Rickman & Dr. Kyle Crosby (US Army ERDC)*
5:25	**A REVIEW OF SHOCK DYNAMICS EXPERIENCED BY A PARARESCUEMEN (PJ) DURING A MILITARY TETHERED TANDEM BUNDLE (MTTB) JUMP (12)** *Dr. James Rall & Mr. David Frank (ShockTech RED)*	**SHOCK QUALIFICATION METHODOLOGIES AND CHALLENGES FOR SUBMARINE PAYLOADS (14)** *Ms. Teresa Gangi (NUWC Newport)*	**GROUND SHOCK PREDICTIONS FOR BURIED CONVENTIONAL MUNITIONS (17)** *Dr. Jeffrey Honig & Mr. Matt Barsotti (Protection Eng. Consultants), Mr. Frank Holiman (Applied Research Associates), Dr. Young Sohn (DTRA)*
5:50		**BLOCK V VIRGINIA CLASS SHOCK ENVIRONMENT SELECTION FOR TOMAHAWK ALL-UP-ROUND (AUR) QUALIFICATION (15)** *Mr. Michael Warnock, Mr. Kevin Behan, & Ms. Stacy Canepari (NUWC Newport)*	**A GREEN'S FUNCTION METHODOLOGY FOR HIGHER-FIDELITY SURROGATE MODELS (17)** *Dr. George Lloyd, Dr. Tom Paez, & Mr. Jake Allyn (ACTA, Inc.)*

	SESSION 8: **DYSMAS II** 3:45-6:10PM / LIMITED DIST. D CHAIR(S): MS. CAROLINE WILEY (NSWC INDIAN HEAD) DR. EMILY GUZAS (NUWC NEWPORT)	*VENDOR SESSION B:* **EXHIBITOR PRESENTATIONS INCLUDING CASE STUDIES, NEW DEVELOPMENTS, TESTING & PRODUCTS** 3:45-6:10PM / UNLIMITED DIST. A CHAIR(S): DR. TED DIEHL (BODIE TECHNOLOGY) MR. JAMES BREAULT (LANSMONT CORP)	*TRAINING II:* **NONLINEAR MECHANICAL SYSTEMS-IDENTIFICATION AND SIMULATION USING MATLAB** 3:45-5:45PM 
	WINDOWS	TERRACE	COLUMBINE
3:45	**DYSMAS COUPLING UPDATES IN SUPPORT OF COMPLEX, ERODING GEOMETRIES (18)** *Mr. Alan Luton, Mr. Horacio Nochetto, & Dr. Jeff St. Clair (NSWC Indian Head)*	**THE IMPORTANCE OF USING PROPER DSP WHEN CORRELATING PHYSICAL TESTS AND NUMERICAL SIMULATIONS (20)** *Dr. Ted Diehl (Bodie Technology)*	**NONLINEAR MECHANICAL SYSTEMS - IDENTIFICATION AND SIMULATION USING MATLAB (22)** *Prof. Kjell Ahlin (Xielalin Consulting)* 3:45 - 5:45PM
4:10	**CALIBRATING AND VALIDATING DYSMAS MATERIAL MODELS VIA OPTIMIZATION (18)** *Dr. Frank Vangessel (NSWC Indian Head)*	**MEMS GAS DAMPED SENSORS REPLACING STRAIN GAGE FLUID DAMPED SENSORS (21)** *Ms. Jennifer MacDonell (Endevco)*	
4:35	**FLUID-STRUCTURE INTERACTION OF COLLAPSING VOLUMES IN CONFINED ENVIRONMENTS (19)** *Mr. Craig Tilton (NUWC Newport)*	**SIRIUS XHS FOR HIGH BANDWIDTH RECORDING (SAMPLE RATE – 15 MS/s) (21)** *Mr. John Hiatt (DEWESoft)*	
5:00	**IMPLOSION OF PAYLOADS WITHIN CONFINED ENVIRONMENTS (19)** *Dr. Joseph Ambrico (NUWC Newport)*	**'SEEING IS BELIEVING' IN DYNAMIC EVENTS (21)** *Dr. Josh Loukus (REL, Inc.)*	
5:25	**SIMULATED HYDROSTATIC IMPLOSION OF A CYLINDER WITHIN A CLOSED BOX (20)** *Dr. Emily Guzas (NUWC Newport)*	**THE INFLUENCE OF HIGH DAMPING CABLE WIRE ROPE ISOLATORS ON NAVAL APPLICATIONS (21)** *Mr. Ali Shehadeh (Vibro/Dynamics)*	
5:50	**SIMULATING THE UNDERWATER SHOCK RESPONSE OF SOFT BIOMIMETIC STRUCTURES (20)** *Dr. Emily Guzas (NUWC Newport)*	**THE QUEST FOR A DIGITAL TWIN (22)** *Mr. Ray Deldin (Altair Engineering)*	

End Tuesday Events

Wednesday (September 21)

CONTINENTAL BREAKFAST WITH THE EXHIBITORS
GRAND BALLROOM | 7:00-8:00AM

	SESSION 9: **PYROSHOCK** 8:00-9:10AM / UNLIMITED DIST. A CHAIR(S): Dr. Carl Sisemore (ShockMec Eng.)	*SESSION 10:* **UNDEX SHOCK TEST SIMULATION** 8:00-9:10AM / UNLIMITED DIST. A CHAIR(S): Mr. James Breault (Lansmont Corp)	*SESSION 11:* **BLAST & BALLISTICS MEASUREMENT** 8:00-8:45AM / LIMITED DIST. D CHAIR(S): Mr. Matt Davis (HII-NNS)
	MAJESTIC BALLROOM	VAIL	WINDOWS
8:00	**Feasibility of Using Lightweight gas Guns for High-G Resonant Plate Shock Testing (22)** *Dr. Carl Sisemore (ShockMec Engineering)*	**DP_VITS/Mechanical Shock for UNDEX Laboratory Simulation, Part I (24)** *Mr. Kevin Gilman (Lansmont Corp.)*	**Interior Ballistics Hardening for Sensor Package Development (25)** *Mr. Ryan Hanc, Mr. Russell Jones, Mr. Adrian Sanchez, Mr. Arhum Mirza, Mr. Ervin Beloni, & Mr. Alfred Rotundo (US Army CCDC)*
8:25	**Shock Model and Test Correlation for Structural Response Prediction (23)** *Mr. Sean Pham & Dr. Ali Kolaini (NASA Jet Propulsion Laboratory)*	**On-Site Acceptance Testing of New Vertical Shock Testing Systems at WTD 71 (24)** *Mr. Alexander von Bluecher (Bundeswehr - WTD 71)*	**Strain Gage Response of Large Caliber Stub Bases (25)** *Mr. Russell Jones, Mr. Ryan Hanc, Mr. Brian Peterson, Mr. Adrian Sanchez, & Mr. Arhum Mirza (US Army DEVCOM)*
8:50	**Guidelines for Reducing Uncertainty in Shock Analysis and Testing (23)** *Mr. Monty Kennedy (MK Engineering), Dr. Jason Blough (Michigan Tech. Univ)*		

9:10 - 10:00

Coffee BREAK WITH THE EXHIBITORS

GRAND BALLROOM (EXHIBIT HALL)

CONTINENTAL BREAKFAST WITH THE EXHIBITORS
GRAND BALLROOM | 7:00-8:00AM

	SESSION 12: **BLAST EFFECTS ON CONCRETE MATERIALS** 8:00-8:45AM / LIMITED DIST. D 8:50-9:10AM / LIMITED DIST. C CHAIR(S): MR. DENIS RICKMAN (US ARMY ERDC) MR. DANIEL VAUGHAN (US ARMY ERDC)	*VENDOR SESSION C:* **EXHIBITOR PRESENTATIONS INCLUDING CASE STUDIES, NEW DEVELOPMENTS, TESTING & PRODUCTS** 8:00-9:10AM / UNLIMITED DIST. A CHAIR(S): MR. ALAN KLEMBCZYK (TAYLOR DEVICES) MR. MIKE POSLUSNY (GIBBS & COX)	*TRAINING III:* **AN INTRODUCTION TO DYNAMIC ANALYSIS** 8:00-9:00AM / UNLIMITED DIST. A 
	TOWER COURT D	TERRACE	COLUMBINE
8:00	**A FUNCTIONAL ASSESSMENT OF THE REPAIR OF CONCRETE ELEMENTS (26)** *Ms. Katelyn Polk, Mr. Stephen Turner, Mr. Cameron Thomas, Dr. Jay Ehrgott, & Mr. Denis Rickman (US Army ERDC)*	**HIGH SPEED IMAGING WITH SENSOR DATA IN SMALL SPACES (28)** *Mr. Bill Spinelli (Photron)*	**AN INTRODUCTION TO DYNAMIC ANALYSIS (28)** *Mr. Bart McPheeters (Gibbs & Cox)* 8:00 - 9:00AM
8:25	**HIGH PERFORMANCE CONCRETE SHOTCRETE RAPID REPAIR AND ENHANCEMENT OF CONCRETE BARRIERS (27)** *Mr. Stephen Turner, Ms. Katelyn Polk, Mr. Cameron Thomas, Mr. Chris Moore, Dr. Jay Ehrgott, & Mr. Denis Rickman (US Army ERDC)*	**SHOCK & VIBRATION TEST RESULTS FOR A NEW, HIGH CAPACITY PUMPKIN MOUNT (28)** *Mr. Alan Klembczyk (Taylor Devices)*	
8:50	**COMPARATIVE STUDY OF UHPC AND HSC ONE-WAY SLABS SUBJECTED TO FAR-FIELD BLAST LOADS (27)** *Mr. Bowen Woodson, Dr. Bradley Foust, Mr. Micael Edwards, Dr. Serdar Astarlioglu, & Dr. Carol Johnson (US Army ERDC)*	**GIBBS & COX SURVIVABILITY CAPABILITIES (28)** *Mr. Michael Poslusny (Gibbs & Cox)*	

9:10 - 10:00

GRAND BALLROOM (EXHIBIT HALL)

	SESSION 13: **MODELING & VALIDATION OF RESONANT PLATE** 10:00-NOON / UNLIMITED DIST. A CHAIR(S): Dr. Vit Babuska (Sandia National Labs) Mr. David Soine (Sandia National Labs)	*SESSION 14:* **INSTRUMENTATION: PERFORMANCE VALIDATION** 10:00-11:10AM / UNLIMITED DIST. A **ACOUSTICS** 11:15AM-NOON / UNLIMITED DIST. A CHAIR(S): Mr. Bob Metz (PCB Piezotronics) Mr. Robert Sharp (Hutchinson)	*SESSION 15:* **UNDEX SIMULATIONS** 10:00-NOON / LIMITED DIST. D CHAIR(S): Ms. Rebecca Grisso (NSWC Carderock) Mr. Adam Hapij (Thornton Tomasetti)
	MAJESTIC BALLROOM	VAIL	WINDOWS
10:00	**A Simplified Finite Element Model for Design of a Resonant Plate (29)** *Dr. Vit Babuska, Ms. Angela Patterson, Mr. David Soine, & Mr. Daniel Lee (Sandia National Labs)*	**Testing of Vibration Immunity of MEMS Sensors with Excitation up to the MHz Range (32)** *Mr. Michael Mende (SPEKTRA GmbH)*	**Generation of UNDEX Loads at the Fluid-Structure Interface Using Machine Learning (35)** *Dr. Nicholas Reynolds, Mr. Ari Bard, & Mr. Eric Miller (NSWC Carderock)*
10:25	**Dead Ends and Challenges in Simplified Finite Element Modeling of a Resonant Plate (30)** *Dr. Vit Babuska, Ms. Angela Patterson, Mr. David Soine, & Mr. Daniel Lee (Sandia National Labs)*	**Applications of PDV in LFT&E (32)** *Mr. Brandon Hepner (US Army Aberdeen Test Center)*	**Shot Selection Methodology For Studies Involving Numerous Analyses (35)** *Dr. Nicholas Reynolds & Mr. T.W. Shaw (NSWC Carderock), Mr. Ryan Anderson & Mr. Adam Hapij (Thornton Tomasetti)*
10:50	**Validation of a Finite Element Model of a Resonate Plate in the Shock Domain (30)** *Dr. Vit Babuska, Ms. Angela Patterson, Mr. David Soine, & Mr. Daniel Lee (Sandia National Labs)*	**Validation Testing of Manufacturing Change to Legacy Accelerometer (33)** *Mr. Julian Richards & Mr. Brandon Hepner (US Army Aberdeen Test Center)*	**Taylor Flat Plate Analysis Verification with ABAQUS Explicit and Navy Enhanced Sierra Mechanics (35)** *Mr. Matt Davis & Mr. Chris Joseph (HII-NNS)*
11:15	**Resonant Plate Shock Test and Data Validation Challenges (31)** *Mr. David Soine, Mr. Forrest Arnold, Mr. Florentino Arias, Mr. Kevin Brebber, & Mr. Dillon Neeley (Sandia National Labs)*	**Multiple-Input Multiple-Output Acoustic Testing of Turboprop Fuselage Structures (33)** *Dr. Mattia Dal Borgo, Umberto Musella, Dr. Mariano Alvarez Blanco & Dr. Bart Peeters (Siemens), Luigi Staibano, Pasquale dell'Aversana, & Raffaele Bianco (Lead Tech), Dr. Bert Pluymers (KU Leuven), Salvatore Nocerino & Biagio De Maio (Leonardo Aircraft)*	**Design of a Mitigation Measure for Naval Infrastructure Exposed to Underwater Unexploded Ordnance (UXO) (36)** *Dr. Eric Hansen, Mr. John Mould, Mr. Adam Hapij, Mr. Ross Cussen, & Mr. Jason Young (Thornton Tomasetti), Mr. Jamie Anderson (Cape Env. Management), Ms. Kimberly Markillie (NAVFAC Pacific)*
11:40	**Evaluation of the RC Filter Cable Model with PR Accelerometer Resonant Response (32)** *Mr. Forrest Arnold, Mr. David Soine, Mr. Florentino Arias, Mr. Kevin Brenner, & Mr. Dillon Neeley (Sandia National Labs)*	**Full-Field Monitoring During Multiple-Input Multiple-Output Environmental Acoustic Tests (34)** *Dr. Alberto Garcia de Miguel, Dr. Mariano Alvarez Blanco, Dr. Onur Atak, Mr. Jan Blockx, Mr. Werner Brughmans, & Dr. Umberto Musella (Siemens)*	**Acoustic Fluid Study of the Submersible Box Test Series (36)** *Mr. Timothy McGee (NAVSEA), Lauren Evoy (NSWC Carderock/Univ. of Maryland)*

Tip

DON'T FORGET TO VISIT THE EXHIBIT HALL AND COMPLETE YOUR "PASSPORT" FOR A CHANCE TO WIN GIFT CARDS, GADGETS, & MORE!

	SESSION 16: **BLAST: CRATERING EFFECTS AND TOOL DEVELOPMENT** 10:00-11:35AM / LIMITED DIST. D CHAIR(S): MR. JOSH PAYNE (US ARMY ERDC) MR. DENIS RICKMAN (US ARMY ERDC)	*SESSION 17:* **COMPUTATIONAL BLAST AND FRAGMENTATION** 10:00AM-NOON / LIMITED DIST. D CHAIR(S): DR. T. NEIL WILLIAMS (US ARMY ERDC) MR. WILLIAM FURR (US ARMY ERDC)	*VENDOR SESSION D:* **EXHIBITOR PRESENTATIONS INCLUDING CASE STUDIES, NEW DEVELOPMENTS, TESTING & PRODUCTS** 10:00AM-NOON / UNLIMITED DIST. A CHAIR(S): MR. JAMES BREAULT (LANSMONT CORP) MR. GARY MARRACCINI (SPECTRAL DYNAMICS)
	COLUMBINE	TOWER COURT D	TERRACE
10:00	**AN OVERVIEW OF THE EFFECT OF WEAPON CASING ON GROUND CRATERING (36)** *Mr. Josh Payne, Mr. Daniel Vaughan, Mr. William Pratt, Mr. Denis Rickman, & Dr. Jay Ehrgott (US Army ERDC)*	**GENERATING FRAGMENT DISTRIBUTIONS USING ZAPOTEC FOR A GENERIC PIPE BOMB (38)** *Dr. T. Neil Williams, Mr. William Furr, Mr. Christopher Shackelford, Dr. Greg Bessette, & Dr. Jay Ehrgott (US Army ERDC)*	**VIDEO-BASED MOTION ANALYSIS (40)** *Mr. Eric Frederick (Xcitex)*
10:25	**EVALUATION OF CURRENT FORENSIC ASSESSMENT CAPABILITIES FOR CRATERS FROM ABOVEGROUND DETONATIONS (37)** *Mr. William Pratt, Mr. Daniel Vaughan, Mr. Josh Payne, Mr. Denis Rickman, & Dr. Jay Ehrgott (US Army ERDC)*	**ZONAL FRAGMENT DISTRIBUTION PREDICTIONS WITH THE GRADY-KIPP MODEL (39)** *Mr. William Furr, Dr. T. Neil Williams, Dr. Greg Bessette, & Dr. Jay Ehrgott (US Army ERDC)*	**THE REST OF THE STORY: VIBRATION CONTROLLERS AND ELECTRO-DYNAMIC VIBRATION TEST SYSTEMS (41)** *Mr. Steve Wood (Spectral Dynamics)*
10:50	**DEVELOPMENT OF CRATER PREDICTION EQUATIONS FOR ABOVEGROUND DETONATIONS OF INDIRECT-FIRE MUNITIONS (37)** *Mr. Daniel Vaughan, Mr. Josh Payne, Mr. William Pratt, & Dr. Jay Ehrgott (US Army ERDC)*	**BREACH AREA PREDICTIONS WITH AN INSTANTIATED FRAGMENT ENVIRONMENT (39)** *Mr. Christopher Shackelford, Mr. William Furr, Dr. T. Neil Williams, & Dr. Jay Ehrgott (US Army ERDC)*	**COMPARING STEEL AND ALUMINUM PLATES FOR RESONANT PLATE SHOCK TESTING (41)** *Dr. Carl Sisemore (ShockMec Engineering)*
11:15	**UPDATE ON FINITE ELEMENT/EMPIRICAL MODEL FOR RUNWAY CRATER PREDICTIONS AND GROUND SHOCK FROM BURIED HIGH-EXPLOSIVE DETONATIONS (38)** *Mr. Ernesto Cruz, Mr. Mark Adley, Mr. Logan Rice, Mr. Daniel Rios, Mr. Steve Akers, & Dr. Jay Ehrgott (US Army ERDC), Ms. Dorothy Boswell (ARA)*	**MODELING M107 155MM SURROGATE ROUNDS IN CTH (40)** *Mr. Zoran Nadzakovic & Dr. Greg Bessette (US Army ERDC)*	**ACQUIRE, ANALYZE, AND ACT: SHOCK AND VIBRATION SOLUTIONS FROM enDAQ AND HUTCHINSON (41)** *Mr. Chris Ludlow (Mide) & Mr. Neil Donovan (Hutchinson)*
11:40		**CHARACTERIZATION OF SIMPLIFIED SURROGATE MUNITION (40)** *Mr. Austin Hopkins, Mr. Marcus Barksdale, & Dr. Bradley Foust (US Army ERDC)*	**MECHANICAL SHOCK TESTING METHODS (41)** *Mr. Roger Rutz (Experior Laboratories)*

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WEDNESDAY

SEPTEMBER 21

AWARDS LUNCHEON (GENERAL SESSION II) NOON - 1:30PM

GRAND BALLROOM

NOON—12:05PM **CALL TO ORDER**
Mr. Drew Perkins (SAVE / HI-TEST Laboratories)

12:05PM—12:15PM **HENRY PUSEY BEST PAPER AWARD**
PRESENTED TO: Mr. Randall Mayes

12:15PM—12:25PM **LIFETIME ACHIEVEMENT AWARD**
PRESENTED BY: Mr. Scott Walton
PRESENTED TO: Dr. Vesta Bateman

Henry Pusey Best Paper Award Winner

"DERIVING BEST SDOF SHAKER INPUTS FROM 6 DOF BASE INPUT PAYLOAD MODELS"
By: Mr. Randall Mayes, Consultant

Paper Abstract:
We assume here that sufficient field vibration measurement data have been gathered on the base mounted payload. Given that, we show how a 6 DOF base input payload model can reproduce the field response on the payload. This is performed through a sum of the rigid body modes and a relatively small number of fixed base payload modes. Since most qualification testing is done on SDOF vibration machines, we utilize the payload model to determine the best input for the SDOF test as well as the associated uncertainty in matching the field data. The required portions of the 6 DOF payload model can be directly extracted from random surveys of the payload on either 6 DOF or SDOF machines. The structural strain damage potential can be quantified in the potential energy of each fixed base mode which provides significant mechanical insight.

Lifetime Achievement Award Winner Biography

DR. VESTA BATEMAN is a mechanical shock specialist who retired from Sandia National Laboratories after 27 years of service. She was the Facility Leader for the Mechanical Shock Laboratory at Sandia National Laboratories where she was responsible for a wide spectrum of mechanical shock testing including drop table, Hopkinson bar, horizontal pneumatic actuator, rocket rail, live pyroshock, and pyroshock simulation shock tests. She has developed a unique shock isolator for a high shock, high frequency accelerometer as well as the test techniques and data analyses required to evaluate accelerometers and isolated accelerometers. These technologies have been transferred to industry through Cooperative Research and Development Agreements (CRADA's).

Dr. Bateman also developed high frequency Hopkinson bar testing with bars made of beryllium and a technique for reconstruction of dynamic forces from accelerometer measurements to assess material crush characteristics. A paper by Dr. Bateman and her co-authors won the 1992 Henry Pusey Best Paper Award at the Shock and Vibration Symposium. She was awarded the IEST Edward O. Szymkowiak Award in 2003 for her leadership in Pyroshock Testing. She is the author of two chapters in Harris' Shock and Vibration Handbook, the ISO Secondary Shock Calibration Standard, and the IEST Pyroshock Testing Recommended Practice as well as over 100 journal and conference papers and reports. She also authored SVM-20 titled "*Pyroshock and Pseudo-Velocity*" for the Shock and Vibration Exchange. Dr. Bateman has a Ph.D from the University of Arizona and taught for four years at Virginia Tech at the beginning of her career.

Exhibitor Passport Program

HOW IT WORKS:

- Each Symposium attendee is given a "Passport" with a listing of participating exhibitors.
- Participating exhibitors are provided a custom stamp/sticker.
- As the attendees visit the participating exhibitors, exhibitors "stamp" the passport of the attendee.
- Attendees who collect the stamp of at least 24 participating vendors are entered into the drawing.
- Prizes range from gift cards to gadgets to new exhibitor products!
- *Drawing to be held during the Wednesday afternoon break (3:30 - 4:15pm).*

Thank You to the exhibitors participating in the Passport Program:

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Wednesday (September 21)

	SESSION 18: **UNDEX I** 1:30-3:30PM / UNLIMITED DIST. A CHAIR(S): Mr. Brian Lang (NSWC Carderock) Dr. Vasant Joshi (NSWC Indian Head)	*SESSION 19:* **TEST METHODS AND DATA VALIDATION** 1:30-3:30PM / UNLIMITED DIST. A CHAIR(S): Mr. Bob Metz (PCB Piezotronics) Mr. Jerome Cap (Sandia National Labs)	*SESSION 20:* **SCALED PROJECTILE PENETRATION AND PERFORATION TESTING** 1:30-3:30PM / LIMITED DIST. D CHAIR(S): Dr. Kyle Crosby (US Army ERDC) Mr. Reid Bond (US Army ERDC)
	MAJESTIC BALLROOM	VAIL	TOWER COURT D
1:30	**The Effects on Non-Contact Underwater Explosions on Naval Composite Structures: Design Numerical Analyses and Experimental Validation (42)** *Mr. Francesco Mannacio, Mr. C Rizzo & Mr. M. Gaiotti (Univ. of Genova), Mr. F. Di Marzo & Mr. M. Venturini (Italian Navy)*	**Calibration of Digital Accelerometers and Angular Rate Sensors (44)** *Mr. Michael Mende (SPEKTRA GmbH)*	**Projectile Nose-Shape Effects on Steel Plate Perforation with On-Board Accelerometers, Post-Test Photogrammetry, and Residual Velocity Measurements (46)** *Dr. Zane Roberts, Mr. Reid Bond, Dr. Kyle Crosby, & Dr. Jay Ehrgott (US Army ERDC)*
1:55	**Shape Evaluator - A Novel Metric for Assessing Simulation Performance for Spectral Quantities (42)** *Mr. Brian Lang (NSWC Carderock)*	**A Study of the Effects of the Digital Noise Floor on Flight Data Measured Using a Uniform Resolution Analog to Digital Converter (44)** *Mr. Jerome Cap, Ms. Melissa C' de Baca, & Ms. Angela Montoya (Sandia National Labs)*	**Characterizing Metal Target Response to Projectile Nose Shape and Impact Velocity Utilizing Photogrammetry (47)** *Mr. Logan Callahan, Dr. Zane Roberts, Mr. Reid Bond, Dr. Kyle Crosby, & Dr. Jay Ehrgott (US Army ERDC)*
2:20	**Verification of ABAQUS Import Methods for Determination of Permanent Set for Nonlinear Transient Problems (43)** *Mr. Matt Davis (HII-NNS)*	**Hampel Filtering of PSDs to Remove Spurious Sine tones in Random Vibration Data (45)** *Dr. Vit Babuska & Mr. James Woodall (Sandia National Labs)*	**Modeling and Simulation of the Ballistic Behavior of Steel Projectiles with Different Nose Shapes Against Steel Targets (48)** *Mr. David Lichlyter, Dr. T. Neil Williams, Dr. Kyle Crosby, & Dr. Jay Ehrgott (US Army ERDC)*
2:45	**Fast Pre-Design Assessment of Underwater Explosion Using Boundary Element Method (43)** *Mr. Kory Soukup (Altair Engineering)*	**Impact Dynamics Workflow for Seismo-Geodetic Ice Penetrator (SGIP) (45)** *Alex Miller, Michael Brown, Aaron Makikalli, Daniel Poe, Christopher Eckert, Dr. Chester Ruszczyk, Dr. Pedro Elosegui, & Prof. Jefferey Hoffman (MIT)*	**Penetration Experiments with 1018 Steel Targets and Ogive-Nose Steel Projectiles at Striking Velocities up to 4500 ft/s (48)** *Dr. Kyle Crosby, Mr. Reid Bond, Dr. Zane Roberts, Mr. Logan Callahan, & Dr. Jay Ehrgott (US Army ERDC)*
3:10	**JASSO: A Year of testing and Development (43)** *Mr. Alex Whatley, Mr. Gavin Colliar, Mr. Phillip Thompson, Mr. Nick Misselbrook, & Mr. Brian Ferguson (Thornton Tomasetti)*	**Multiple Shakers To Generate Large Force Needed for Massive DUT's and High Acceleration (46)** *Mr. Deepak Jariwala (Spectral Dynamics)*	**Perforation Testing and Simulation of Half-Scale Artillery Surrogates with Instrumentation Packages (49)** *Mr. Reid Bond, Dr. Zane Roberts, Dr. Kyle Crosby, & Dr. Jay Ehrgott (US Army ERDC)*

3:30 - 4:15

Ice Cream Social & Passport Program Drawing

GRAND BALLROOM (EXHIBIT HALL)

	SESSION 21: **MECHANICAL SHOCK TESTING & ANALYSIS** 1:30-2:15PM / LIMITED DIST. D 2:20-3:05PM / LIMITED DIST. C CHAIR(S): MR. JUSTIN CARUANA (CARDINAL ENG.) DR. RUSSEL MILLER (IDA)	*SESSION 22:* **COMPUTATIONAL & EXPERIMENTAL METHODS FOR ORDNANCE TECHNOLOGY** 1:30-2:15PM / LIMITED DIST. D 2:20-3:05PM / LIMITED DIST. A CHAIR(S): DR. JACOB DODSON (AFRL) MR. SHANE CURTIS (SANDIA NATIONAL LABS)	*VENDOR SESSION E:* **EXHIBITOR PRESENTATIONS INCLUDING CASE STUDIES, NEW DEVELOPMENTS, TESTING & PRODUCTS** 1:30-3:30PM / UNLIMITED DIST. A CHAIR(S): MR. TRAVIS KERR (HI-TEST LABORATORIES) MR. ROB SHARP (HUTCHINSON)
	WINDOWS	COLUMBINE	TERRACE
1:30	**MECHANICAL PROPERTY EVALUATION OF SILICON FOR HIGH G MICRO-ELECTROMECHANICAL SYSTEMS (MEMS) (49)** *Dr. Vasant Joshi, Dr. Salil Mohan, Mr. Colin Qualters, Mr. Efrem Perry, Mr. Sean Tidwell, & Mr. Chris Cao (NSWC Indian Head)*	**HIGH SPEED FUZE AND EXPLOSIVE SYSTEM DESIGN (51)** *Dr. Jacob Dodson (AFRL)*	**PYROSHOCK EVENT CAPTURE – RECENT ADVANCES IN HIGH FIDELITY BROADBAND MEASUREMENTS (52)** *Mr. Rob Eaton & Mr. Mark Remelman (MECALC)*
1:55	**CHAIN KEEPER ASSEMBLY: A CASE STUDY ON TAKING INTO ACCOUNT SHIP STRUCTURE FOR DDAM FEA VS. DDAM WITH FIXED BASE (50)** *Mr. Adarsha Sapkota (HII-NNS)*	**EXPERIMENTAL EVALUATION OF THE DYNAMIC RESPONSE OF STRUCTURAL INTERPENETRATING LATTICE AS SENSOR (51)** *Dr. Adriane Moura, Dr. Alain Beliveau, & Mr. Zachary Jowers (ARA), Mr. Michael Davies & Dr. Jacob Dodson (AFRL)*	**STATE-SPACE MODEL CREATION IN SIMCENTER TESTLAB (52)** *Mr. Chris Sensor (Siemens Digital Industries Software)*
2:20	**SEATED HUMAN INJURY CRITERIA FOR VERTICAL SHOCK (50)** *Dr. Russel Miller & Mr. John Przybysz (Institute for Defense Analyses)*	**IMPACT DETECTION USING A NOVEL RF SENSOR FOR SMART FUZING APPLICATIONS (51)** *Mr. Philip Randall, Mr. Daniel Gutierrez, Mr. Alex Chen, Mr. Ian Sobering, Mr. Shane Curtis, & Mr. John Borchardt (Sandia National Labs)*	**MARINE MACHINERY ASSOCIATION (53)** *Mr. John Rhatigan (Marine Machinery Association)*
2:45	**DIGITAL TRANSFORMATION OF THE SHOCK QUALIFICATION PROCESS (50)** *Mr. Justin Caruana, Mr. Michael Ros, Mr. Barry Mapen, Ms. Amanda Capasso, Mr. Steve Adams, Mr. Keith Kanoun, Mr. Doug Algera, & Ms. Annaliese Nardi (Cardinal Engineering)*	**TOWARDS ONLINE STRUCTURAL STATE-ESTIMATION WITH SUB-MILLISECOND LATENCY (52)** *Mr. Austin Downey (Univ. of South Carolina), Mr. Jason Bakos, Mr. David Andrews, Mr. Miaoqing Huang, Dr. Adriane Moura (ARA), Dr. Jacob Dodson (AFRL)*	**ADVANCED TECHNOLOGIES FOR VIBRATION TESTING OF LARGE, HIGH VALUE, TEST ARTICLES (53)** *Mr. Thomas Reilly (NVT Group)*
3:10			**DSF MASS RATIO AND HEAVYWEIGHT SHOCK TESTING (53)** *Mr. Travis Kerr (HI-TEST Laboratories)*

3:30 - 4:15

Ice Cream Social & Passport Program Drawing

GRAND BALLROOM (EXHIBIT HALL)

WEDNESDAY
SEPTEMBER 21

TUTORIAL SESSION V
3:30 - 6:30PM

OPTIONAL THREE HOUR COURSES. ATTENDEES WILL RECEIVE A CERTIFICATE OF COMPLETION AND MAY RECEIVE CEUs/PDHs (VARIES BY STATE). ADDITIONAL FEES APPLY TO ATTEND.

SHOCK TEST FAILURE MODES
Mr. Kurt Hartsough (NSWC Philadelphia)
Mr. Domenic Urzillo (NSWC Carderock)

WINDOWS

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

INTRODUCTION TO WEAPONS EFFECTS AND SHIP COMBAT SURVIVABILITY ANALYSIS
Mr. Jan Czaban (Zenginworks Limited)

TOWER B

This short course provides a practical understanding of naval ship combat survivability and methods to assess the effects of various weapons. The introduction will review terminology, concepts and current practice involved in setting, achieving and verifying survivability requirements. Naval threats and weapon types will be reviewed and methods for predicting their resultant loads and damage mechanisms explained. Primary weapons effects will include attacks from underwater explosions, above water explosions, internal blast, fragments and ballistic projectiles. Sample problems will be provided to demonstrate how to estimate the extent of damage sustained by ship structures and how to apply and interpret damage using standard terms of capability degradation. Methods for hardening ship systems and structures will be reviewed with an introduction provided to explain dynamic load effects tolerance, armour systems and simplified pass/fail global design assessment techniques. The course material will be entirely based on public domain sources and includes a comprehensive list of references and applicable military standards.

SOME METHODS FOR ANALYZING NONLINEAR RANDOM VIBRATION
Dr. Tom Paez (Thomas Paez Consulting)

TOWER C

All physical systems reflect nonlinear behavior, and most of those systems experience random vibration environments during their lives. Under some commonly observed circumstances, the level of nonlinearity in structural response is small, and a physical system can be modeled and analyzed as though it were linear. But there are also times when nonlinear behaviors must be understood and modeled. This tutorial starts with a brief review of linear random vibration. The idea of spectral density is developed on an intuitive level. Input-output relations for random vibration of linear structures are developed, culminating in the Fundamental Relation of Random Vibration. Next, some general ideas of nonlinear random vibration are presented. The reason why nonlinear random vibration yields non-Gaussian responses to Gaussian excitations is explained. Means for determining whether, and to some extent how much, nonlinearity is reflected in structural response are considered. The information obtained here can serve to determine whether or not nonlinearity must be modeled. Finally, a few methods for modeling nonlinear random vibration are developed. These include at least one “local linear” method where random vibration responses at various levels and with various distributions of frequency content serve to model and predict structural responses to arbitrary excitations. In addition, a fully nonlinear approach to modeling nonlinear random vibration behavior of a system is presented. An electronic copy of the presentation slides will be available to all tutorial participants, as well as MATLAB code to reproduce the examples in the presentation.

FUNDAMENTALS OF CLASSIC SHOCK AND SRS SHAKER TESTING
Mr. Chris Sensor (Siemens)
Mr. Bob Metz (PCB Piezotronics)

TOWER D

This tutorial will cover the fundamental concepts of shaker shock testing, from field data acquisition to Classic Shock and Shock Response Spectrum (SRS) wavelet synthesis in a vibration controller. The tutorial will cover shock data acquisition and analysis, classic shock pulses, SRS concepts, SRS and Pseudo Velocity Shock Spectrum (PVSS) data analysis, Fatigue Damage Spectrum, a review of Classic Shock and SRS test methods in MIL-STD-810H (including the “new” method of Te and TE), shock test tailoring and SRS wavelet synthesis for shaker SRS testing. A segment covering specialty shock sensors and instrumentation will also be presented. Subjects will be accompanied by live demos of data acquisition and shaker tests, with opportunities for hands on participation by attendees.

FROM THE TRENCHES: PAST, PRESENT & FUTURE PERSPECTIVES ON SURVIVABILITY TESTING

MAJESTIC BALLROOM

Moderator: *Mr. John Rhatigan (Marine Machinery Association)*

Panelists: *Mr. Jerry Hill (SERCO)*
Mr. Austin Alvarez (Consultant/Electric Boat Ret.)

This panel will provide a discussion of the role the shock & vibration community plays in not only the design and construction of the US Navy's Fleet, but also the importance of this work to the safety and security of our service men and women onboard those ships. The moderator and participants will discuss unique perspectives on the role of shock trials, including those from the designer, builder and end-user point of views.

Each of the panel participants, along with the moderator, will provide unique career and/or service-based perspectives on the panel topic, including growth and challenges in the industry. Afterwards, the moderator will provide the opportunity for questions from the audience.

Audience participants are encouraged to engage with the panel participants for an open industry discussion.

Wednesday Evening Social Event at

LUCKY STRIKE
Entertainment

7:30PM - 9:30PM

A FIVE MINUTE WALK; LOCATED ON THE THIRD FLOOR OF THE 16TH STREET MALL

All symposium attendees & guests are invited!
Dinner, Beverages, & Entertainment
Bring your conference badge for entry.

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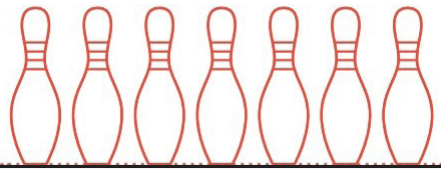

CONTINENTAL BREAKFAST
GRAND BALLROOM | 7:00-8:00AM

	SESSION 23: **SHOCK PULSE SHAPING & MITIGATION** 8:00-9:10AM / UNLIMITED DIST. A **PROTECTIVE STRUCTURES** 9:15-9:35AM / UNLIMITED DIST. A CHAIR(S): Mr. Randall Goodnight (NSWC Carderock)	*SESSION 24:* **VIBRATION TEST METHODS & STRUCTURAL RESPONSE I** 8:00-10:00AM / UNLIMITED DIST. A CHAIR(S): Dr. Bryan Joyce (NSWC Dahlgren) Mr. Bart McPheeters (Gibbs & Cox)	*SESSION 25:* **SCALED AIRBLAST** 8:00-8:45AM / UNLIMITED DIST. A **STRUCTURAL RESPONSE: NUMERICAL METHODS** 9:15-10:00AM / LIMITED DIST. D CHAIR(S): Mr. John Hoemann (US Army ERDC) Mr. Michael Miraglia (NSWC Carderock)
	MAJESTIC BALLROOM	VAIL	TOWER COURT D
8:00	**Reusable Energy Abatement Pad (REAP): A Replacement to Honeycomb for Aidrop Training (53)** *Dr. James Rall & Mr. David Frank (ShockTech RED)*	**Towards Multi-Axis Vibration Test Methodology (55)** *Mr. Barak Deutscher, Mr. Zachi Katzir, Mr. Gal Rubinstein, & Mr. Yuval Dekel (RAFAEL)*	**Considerations for Scaled Airblast Experiments (58)** *Mr. John Hoemann, Dr. Genevieve Pezzola, Mr. David Senior, Mr. Kyle Moss, & Mr. Thomas Carriveau (US Army ERDC), Dr. James Davidson (Auburn University)*
8:25	**Micro-Beaded Encapsulants for Electronics Packaging (54)** *Dr. Jeff Hill & Mr. Josh Stanfield (Brigham Young University), Mr. Alex Chen & Mr. Cayden Boll (Sandia National Labs)*	**Multiple-Input Multiple-Output Random Control of Strain Responses: A New Possibility to Enhance the Replication of Operational Environments (56)** *Mr. Umberto Musella, Dr. Mattia Dal Borgo, Dr. Alberto Garcia De Miguel, Dr. Raphael Hallez, & Dr. Bart Peeters (Siemens)*	**Efficient Hydrocode Modeling of Air Blast Propagation at Large Scaled Ranges (58)** *Ms. Kellan Sullivan, Dr. Genevieve Pezzola, Dr. Jesse Sherburn, & Dr. Catherine Stephens (US Army ERDC), Dr. Hussam Mahmoud (Colorado State)*
8:50	**Experimental Investigation of Impact Pulse Shaping in Elastic Metamaterials (54)** *Mr. Greg Dorgant & Dr. Michael Leamy (Georgia Institute of Technology), Dr. William Johnson (Savannah River National Lab), Dr. Washington DeLima (Kansas City National Security Campus)*	**Replication of MIMO Random Vibration Environments: Latest Software and Hardware Developments (56)** *Mr. Umberto Musella, Dr. Mattia Dal Borgo, Mr. Joris Janssens, Dr. Raphael Hallez, & Dr. Bart Peeters (Siemens), Ms. Lydia Bemol & Mr. Francois Decobert (SEREME)*	
9:15	**Ballistic Effects on 3D Printed Concrete (55)** *Mr. Ryan Salter, Mr. John Lindquist, & Mr. Michael Newberry (Battelle/AFCEC), Mr. Kevin Wise (AFCEC)*	**Improved Vibration Testing with a New Approach to Optimal Vibration Control and Analysis and a Modern Inductive Powered Vibration Shaker (57)** *Mr. Stewart Slykhous (Spectral Dynamics)*	**Verification of Applying Modal Projection Methods to Transient Data as an Analysis Filter (59)** *Mr. Jeff Cipolla (Raytheon), Mr. Matthew Davis (HII-NNS)*
9:40		**Development and Testing of Thick Shock Resistant GFRP-Steel Adhesive Bond (57)** *Mr. Sander Dragt (TNO), Ms. J. Schipperen, Mr. C. Verhaeghe, & Ms. A. Ruitenberg (Damen Naval), Mr. J. Vaders (Defense Materiel Organisation)*	**Features of Sierra/SD for Shock and Vibration Applications (59)** *Mr. Michael Miraglia (NSWC Carderock)*

CONTINENTAL BREAKFAST
GRAND BALLROOM | 7:00-8:00AM

	SESSION 26: **NUMERICAL APPLICATION FOR STRUCTURES** 8:00-8:45AM / LIMITED DIST. D 8:50-9:10AM / LIMITED DIST. C CHAIR(S): MR. DAVID ALFANO (US ARMY DEVCOM) DR. KEN NAHSHON (NSWC CARDEROCK)	*TRAINING IV:* **INTRODUCTION TO HEAVYWEIGHT SHOCK TESTING** 8:00-10:00AM / UNLIMITED DIST. A 	*TRAINING V:* **SHOCK RESPONSE SPECTRUM PRIMER** 8:00-10:00AM / UNLIMITED DIST. A 
	WINDOWS	COLUMBINE	TERRACE
8:00	**AUTOMATED DAMAGE ASSESSMENT OF T-STIFFENERS USING MACHINE LEARNING (59)** *Dr. Nicholas Reynolds (NSWC Carderock)*	**INTRODUCTION TO HEAVYWEIGHT SHOCK TESTING (61)** *Mr. Travis Kerr* *(HI-TEST Laboratories)* 8:00-10:00AM	**SHOCK RESPONSE SPECTRUM PRIMER (61)** *Dr. Carl Sisemore* *(ShockMec Engineering LLC)* 8:00-10:00AM
8:25	**DYNAMIC STRAIN EFFECTS IN PRESSURE VESSELS (60)** *Dr. Andrew Littlefield, Mr. David Alfano, & Dr. Michael Macri (US Army DEVCOM), Dr. Xin-Lin Gao (Southern Methodist Univ)*		
8:50	**GROUND SHOCK RESPONSE PREDICTIONS FOR BURIED CONVENTIONAL MUNITIONS (60)** *Dr. Jeffrey Honig & Dr. George Kantrales (Protection Engineering Consultants), Dr. Alexander Mieloszyk (ARA), Dr. Yong Sohn (DTRA)*		
9:15			
9:40			

Thursday (September 22)

	SESSION 27: **UNDEX II** 10:00-11:10AM / UNLIMITED DIST. A **VIBRATION: SPECTRAL DENSITIES** 11:15-NOON / UNLIMITED DIST. A CHAIR(S): Mr. Kevin Behan (NUWC Newport) Mr. Timothy McGee (NSWC Carderock)	*SESSION 28:* **NUMERICAL METHODS FOR VIBRATION** 10:00-10:45AM / UNLIMITED DIST. A **STRUCTURAL RESPONSE: NUMERICAL APPLICATIONS** 10:50-NOON / UNLIMITED DIST. A CHAIR(S): Mr. Bart McPheeters (Gibbs & Cox) Mr. Brian Lang (NSWC Carderock)	*SESSION 29:* **IMPACT & PENETRATION EFFECTS** 10:00-11:10AM / LIMITED DIST. D CHAIR(S): Mr. Ernest Staubs (AFRL) Ms. Michelle LeBlanc (AFRL)
	VAIL	MAJESTIC BALLROOM	TOWER COURT D
10:00	**Characterization of a PETN-Based Explosive Underwater Bubble Collapse Studies (61)** *Dr. Julian Lee, Mr. L. Gagne, & Mr. CR Marshall (Defence R&D Canada)*	**Coordinate Transformation of Vibration Autospectral Density (ASD) (65)** *Dr. Arup Maji (Sandia National Laboratories)*	**Modeling the Ballistic Limit of Fragment Simulating Projectiles Impacting A36 Mild Steel Spaced Armor Configurations (67)** *Mr. Daniel Rios-Estremera & Dr. Jesse Sherburn (US Army ERDC), Dr. Matthew Priddy (MSU)*
10:25	**The Phase Change and Thermal Effect on the Bubble Dynamics: First, Second, and Third Bubble Pulsations (62)** *Mr. Seonghak Kim, Mr. Kyungjun Choi, & Prof. Chongam Kim (Seoul National University)*	**Comparison of Power Flow through Interface Mode Sets (65)** *Mr. Jon Young & Dr. Kyle Myers (Penn State Applied Research Laboratory)*	**Joint US/GE Penetration Experiments against High-Strength Fiber Reinforced Concrete (68)** *Mr. Mark Green (GmRA), Ms. Keri Bailey (US Army ERDC), Mr. Ernie Staubs (AFRL), Mr. Thorsten Sarrach (WTD-91), Mr. Martin Bucksch (TMS), Dr. Danny Frew (DSR), Dr. Bradley Martin (AFLCMC)*
10:50	**Computations on the Entire Stage of Underwater Explosions: Single and Double Detonations (63)** *Mr. Kyungjun Choi & Prof. Chongam Kim (Seoul National University)*	**Truly Curved Contact in Higher-Order Lumped-Mass Explicit Methods for High-Rate Applications (66)** *Dr. Kent Danielson (US Army ERDC)*	**Fast-Running Model Framework for Concrete Penetration using Virtual Data (68)** *Mr. Jean Santiago Padilla, Mr. David Failla, & Mr. Daniel Rios-Estremera (US Army ERDC)*
11:15	**Spectral Densities: Statistics and Probability in the Frequency Domain, Part I (64)** *Mr. Neil Loychik (Los Alamos National Laboratory)*	**A Method to Expand Sparse Set Acceleration Data to Full Set Strain Data (66)** *Mr. Jonathan Hower & Mr. Raymond Joshua (Honeywell FM&T)*	
11:40	**Spectral Densities: Statistics and Probability in the Frequency Domain, Part II (64)** *Mr. Neil Loychik (Los Alamos National Laboratory)*	**Simplified Finite Element Model Generation for Exodus II and Sierra SD/SM (67)** *Mr. Kory Soukup (Altair Engineering)*	

1:00 - 2:00

SAVE TECHNICAL ADVISORY GROUP (TAG) MEETING

WINDOWS

The annual meeting of the members of the SAVE Technical Advisory Group (TAG) will convene to review the 92nd Shock & Vibration Symposium and discuss plans for 2023.

	SESSION 30: **RESPONSE OF CONNECTIONS UNDER SHOCK LOADS** 10:00AM-NOON / LIMITED DIST. D CHAIR(S): MR. MATT DAVIS (HII-NNS)	*TRAINING VI:* **INTRODUCTION TO UERDTOOLS** 10:00AM - NOON / LIMITED DIST. C	*TRAINING VII:* **INTRODUCTION TO MEDIUM WEIGHT SHOCK TESTING** 10:00AM - NOON / UNLIMITED DIST. A
	WINDOWS	COLUMBINE	TERRACE
10:00	**FIXTURE DESIGN FOR THE LIGHTWEIGHT SHOCK MACHINE TESTING OF BACKGOUGED AND NONBACKGOUGED WELDS (68)** *Mr. Matt Davis, Mr. Steve Elder, & Mr. Kevin Arden (HII-NNS)*	**INTRODUCTION TO UERDTOOLS (70)** *Mr. Brian Lang (NSWC Carderock)* 10:00AM - NOON	**INTRODUCTION TO MEDIUM WEIGHT SHOCK TESTING) (70)** *Mr. Jeff Morris (HI-TEST Laboratories)* 10:00AM - NOON
10:25	**LIGHTWEIGHT SHOCK MACHINE TESTING OF BACKGOUGED AND NONBACKGOUGED WELDS (69)** *Mr. Matt Davis, Mr. Steve Elder, & Mr. Kevin Arden (HII-NNS)*		
10:50	**COMPARATIVE QUASI-STATIC AND DYNAMIC SHOCK BOLTED JOINT TESTING: PART I - TESTING AND HIGH-LEVEL CONCLUSIONS (69)** *Mr. Randall Goodnight, Mr. Thomas Bruno, Mr. Jacob Mason, & Ms. Anna Bethel (NSWC Carderock)*		
11:15	**COMPARATIVE QUASI-STATIC AND DYNAMIC SHOCK BOLTED JOINT TESTING: PART II - DATA AND FINITE ELEMENT ANALYSES (69)** *Ms. Rebecca Grisso, Mr. Tam Nguyen, & Mr. Ryan Hegarty (NSWC Carderock)*		
11:40	**SUPPORTING PIPE FOUNDATION FLANGE SHOCK ANALYSIS TOOL FOR SIMULTANEOUS LARGE QUANTITY FLANGE ANALYSIS (70)** *Mr. Mackenzie Wilson & Mr. Chris Campbell (HII-NNS)*		

1:00 - 2:00

SAVE TECHNICAL ADVISORY GROUP (TAG) MEETING

WINDOWS

The annual meeting of the members of the SAVE Technical Advisory Group (TAG) will convene to review the 92nd Shock & Vibration Symposium and discuss plans for 2023.

Exhibitor list

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Additional Exhibiting Companies

Advanced Test Equipment Rentals (F5)
Altair Engineering (F2)
Correlated Solutions (103)
Crystal Instruments (G2)
Data Physics/Team Corp. (G14)
DEWESoft (206)
Dynamic Systems & Research (F6)
Dytran Instruments (202)
ETS Solution (G16)
Experior Laboratories (G6)
HBK (F9)
Hi-Techniques (303)
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SPEKTRA (304)
Vibration Research Corporation (G3)
Vision Research (F13)
Weiss Technik Testing Services (F11)
Xcitex (G10)

Ancillary Sponsorship Recognition

Lanyard Sponsor

Crystal Instruments (G2)

Notepad & Pen Sponsor

E-Labs (105)

WiFi Sponsor in Exhibit Hall

Hi-Techniques (303)

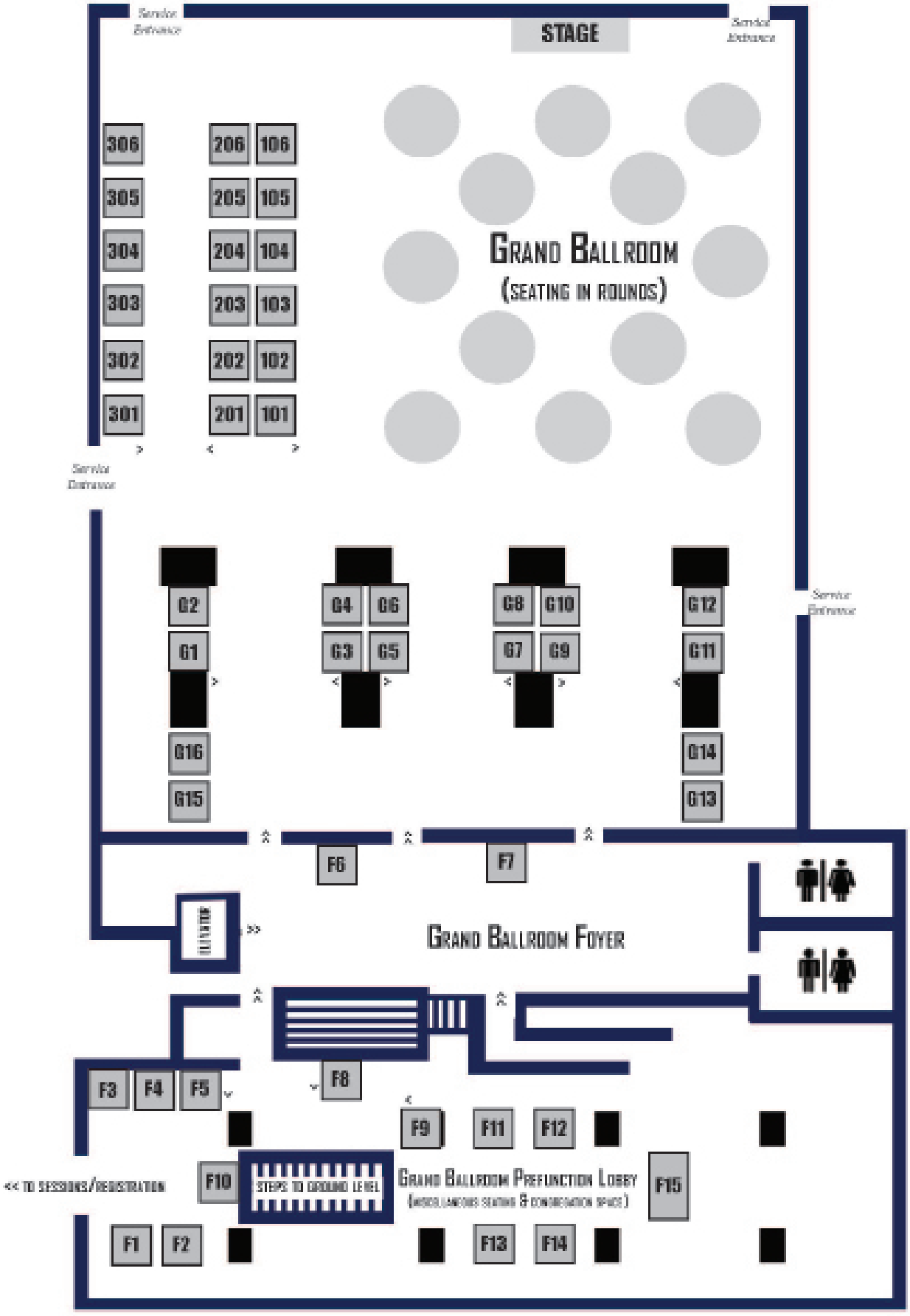
Charging Station Sponsor

Experior Laboratories (G6)
Data Physics/Team Corp. (G14)

Ice Cream Social Sponsors

E-Labs (105)
ITT Enidine (201)
PCB Piezotronics (104)
Spectral Dynamics (305/306)

Exhibit Hall layout



Exhibitor Descriptions

ADVANCED TEST EQUIPMENT RENTALS primary focus is providing a complete rental solution of measurement and test equipment to industries such as Aerospace, Defense, Communications, EMC, and more. Our wide inventory, custom solutions, flexible terms, and quality support differentiates us from competitors as a complete solution for all test and measurement needs. Our inventory covers most electronic test applications and we are always expanding to remain the leading rental provider.

ALTAIR is a global leader in computational science and artificial intelligence (AI) that provides software and cloud solutions in simulation, high-performance computing (HPC), data analytics, and AI. Altair enables organizations across all industries to compete more effectively and drive smarter decisions in an increasingly connected world – all while creating a greener, more sustainable future.

BODIE TECHNOLOGY provides engineers with excellent software, training, and consulting resources to help analyze complex nonlinear mechanics problems, especially those involving problematic or noisy transient data. Bodie offers guidance on how to tackle a nonlinear mechanics problem, including best practices for utilizing FEA and physical testing methods.

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.

CORRELATED SOLUTIONS, INC. develops and manufactures turn-key Digital Image Correlation (DIC) measurement systems for non-contact full-field analysis of shape, motion, deformation, strain, and vibration applications. The VIC-3D HS FFT system is capable of measuring ODS's with frequencies up to 50 kHz with nanometer resolution and has a large dynamic range. Visit the booth to see new windowing function options and how they can be used to see distinct amplitude peaks in the frequency domain.

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.

DATA PHYSICS has been pioneering high-performance vibration testing and signal analysis in the aerospace, defense and automotive industries since 1984. We design and manufacture a range of air and water-cooled electrodynamic shakers, vibration controllers, and dynamic signal analyzers. The modern 900 Series analyzer and controller enables simultaneous dynamic signal analysis and shaker vibration control, leveraging a compact hardware form factor with exceptional dynamic range, phase accuracy, and intuitive software which auto-aggregates your data into an easily searchable relational database. Data Physics controllers lead the industry in multi-shaker vibration control, and our MIMO controllers are trusted to control the world's most advanced multi-shaker vibration tables including multi-shaker single axis, 3-DOF, 6-DOF, 6+DOF, over-actuated systems, IMMAT/modal control, and more. Our unique soft-shutdown technology – engineered to protect high-value test articles – proved to be an invaluable feature, critical to the successful testing of the recently launched James Webb Space Telescope.

DAYTON T. BROWN's tenured engineers provide experience in adapting our test equipment to meet the most challenging customer requirements. Our extensive test facility includes several shakers, anechoic EMI/EMC rooms, multiple chambers to perform a myriad of environmental tests and our newly expanded structural testing area with its 40ft ceiling. DTB is an A2LA and NVLAP accredited laboratory in accordance with ISO/IEC 17025 requirements and is ISO 9001:2008 and AS9100C registered.

Exhibitor Descriptions

DEWESOFT, a privately held company, is a World leading provider of data acquisition software and hardware serving all. The DEWESoft software and hardware synchronizes Analog, Digital, Video, GPS, CAN, ARINC 429/1553, PCM and Chapter 10 support. The instruments have wide temperate and shock ranges and are available in many configurations.

DYNAMIC SYSTEMS & RESEARCH is a small, research and development company with the mission to equip the DoD, DOE, their contractors, and multiple universities with superior technical solutions in both the laboratory and in the field. With over 90 years of collective experience, out team works alongside government agencies and contractors to solve problems and lead innovation in the fields of mechanical, electrical, and software engineering. DSR has developed the most advanced shock-hardened data acquisition and initiation systems in the world for a variety of applications and have also developed high-pressure and high-strain-rate test equipment along with interior and exterior ballistic solutions that help our customers meet their technical requirements.

Founded in 1980, **DYTRAN INSTRUMENTS, INC**. is a leading manufacturer and designer of piezoelectric and DC MEMS sensors. Dytran offers a complete range of impulse hammers, piezoelectric force and pressure sensors, electronics, cables, and accessories for dynamic measurements, with full in-house customization capabilities.

E-LABS is a full-service testing laboratory featuring state of the art facilities, knowledgeable personnel, and simulation services such as test planning and fixture design. We perform climatic and dynamic testing, offer full EMI and EMC testing, and conduct specialized testing such as explosive atmosphere, high pressure, and helium leak detection.

ENDEVCO provides a complete range of dynamic test and measurement sensor solutions, including piezoelectric, piezoresistive, MEMS, and variable capacitance accelerometers, as well as angular rate, shock, and 6 DoF sensors, miniature pressure sensors, signal conditioners, cables and accessories. Our brand is recognized for highly reliability products with a wide range of testing applications, including automotive design and crash testing, aircraft and space vehicle testing, weapons and munition testing, and general lab testing. Endevco is an assumed name of PCB Piezotronics of North Carolina, Inc., which is a wholly-owned subsidiary of PCB Piezotronics, Inc. More info www.endevco.com

ETS SOLUTION is a world leader in High performance shakers, designed to enable the better test. We are discussing our IPA series amp, designed to never fail a fuse, and our Extreme Acceleration Solid armature Y-connection "EASY" Ring, designed for up to 220 g sine and 180 g RMS Random

EXPERIOR LABORATORIES, INC is a Southern California based, third-party test laboratory providing independent design verification and qualification testing services to component and system manufacturers, military contractors, integrators and system providers within the Telecommunication, Military, Aerospace, Space, Industrial, Medical and many other industries. Recognized throughout the industry for superior customer service, consistent on-time delivery, project management by experts and end-to-end accountability, Experior Labs offers customers cost-effective, highly qualified testing services that add value to any organization, regardless of size.

GIBBS & COX is the largest independent naval architecture and marine engineering firm in the US. Our world class draftsmen, designers, naval architects, engineers and program managers solve challenges across the entire spectrum of today's marine industry, from concept development through production and in-service support. From icebreakers to sportfish yachts, naval combatants to deep ocean research vessels – and many in between – our breadth of services enables us to tailor best practices for the specific needs of each customer.

Exhibitor Descriptions

From high-force electrodynamic shakers to palm-sized modal and measurement exciters, **HBK** a range of vibration test solutions. With a large selection of power amplifiers and vibration controllers, as well as matching slip tables, head expanders and thermal barriers, we meet all your vibration testing needs.

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 in data acquisition.

HI-TEST LABORATORIES, INC. is an unparalleled facility that has provided engineering, testing, and evaluation services to government and industry since 1975. HI-TEST is the undisputed leader in MIL-DTL-901E shock testing, housing all approved platforms at one convenient location. From pre-test analysis to post-test report generation, we offer our analytical engineering tools and expertise alongside our testing and design capabilities to make your test run as smoothly and efficiently as possible.

HUNTINGTON INGALLS INDUSTRIES (HII) is America's largest military shipbuilder. HII specializes in providing shock and vibration qualification and support through recognized expertise in testing and advanced shock analysis. HII is also the creator of the patented Deck Simulating Shock Machine (DSSM), the newest Navy approved test method in MIL-DTL-901E.

HUTCHINSON Defense and Mobility products have proven performance in all major modern conflicts from the first Gulf War to the Balkans, Iraq, Afghanistan and Syria. Hutchinson is trusted worldwide by soldiers to ensure their mobility and protection in all terrains and combat situations. Hutchinson provides innovative products and proactive support that exceeds customers' expectations and meets the demands of tomorrow's lighter and more survivable vehicles.

IMPRESSIO.TECH is a manufacturer of novel ultra-dissipative materials created to improve human health and safety through innovative applications of LCE technology. The company's materials utilize liquid-crystal elastomers to create dissipative liner materials for protective equipment to overcome the existing challenges of energy absorption in current helmet foams, enabling users to reduce concussion and protect the head and has applications in sports, military, automotive and aerospace.

IST offers a full line of acceleration 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). Stop by and see our new EDR-5 recorder!

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

IX CAMERAS is a world-leading technology and product company specializing in the field of high-speed (slow motion) imaging. Based on proprietary innovative technologies, we design, build and sell cutting-edge ultra-fast cameras and software for a wide range of advanced scientific research applications. Our commitment to innovate and push the boundaries of high-speed video science is the reason we develop technically superior and easy-to-use products that our customers need to attain the highest scientific achievements and creativity. iX Cameras introduced the revolutionary i-SPEED Series, the fastest high-speed, high-resolution camera in the market.

Exhibitor Descriptions

LANSMONT CORPORATION pioneered the commercial application of shock testing. Since then, Lansmont has established itself as a credible global supplier of shock and vibration measurement and test solutions for the transportation, aerospace and defense and automobile industries. Lansmont has developed high-performance vertical and horizontal shock test systems used for programmable blast simulations, including payload capacities exceeding 1-ton. Lansmont's data acquisition systems have been upgraded to provide high-speed, simultaneous measurement of acceleration, strain, force, and temperature from one front-end hardware solution at speeds of up to 2.5Mhz.

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.

MECALC is announcing the release of its newest Module for shock data acquisition. This Module is the industry's first 5 MSa/s 24-bit digitizer for PyroShock with a flat frequency response to 2.1 MHz. Not all shock capture systems are the same. This Module includes Bridge/Signal Conditioning, Advanced Trigger options, and scales to over 1000 channels. Come by our booth to hear why this solution is unique in the market and how it can help you. MECALC provides advanced signal conditioning and data acquisition solutions. Our QuantusSeries platform is used globally at the world's leading manufacturers in Automotive, Aerospace, Space, and Defense
.

MIDE / ENDAQ is a Hutchinson Company with brands that include: enDAQ shock, vibration & environmental sensors & software; Piezo.com Offering high-value piezoelectric products and expert solutions; and Mide's HydroActive Seal Products. Midé is a leading provider of advanced engineering products and services. Midé is committed to providing customers with high-quality deliverables that are on-time, on budget, and meet their expectations through the use of a quality management system focused on continual improvement. Midé uses industry best practices in both execution and cost effectiveness.

For over a half-century, **NTS** has helped manage your toughest environmental test requirements. Leveraging our national network of laboratories, we are uniquely qualified to guide clients through MIL-Standard requirements. Our engineers are experts in shock and vibration, possessing extensive knowledge of ship design and dynamic structural analysis. Trusted by the U.S. government and top defense contractors, NTS offers the most sophisticated MIL-STD testing on the planet.

PCB manufactures vibration, pressure, force and strain, shock, and acoustic sensors used by design engineers and predictive maintenance professionals worldwide for test, measurement, monitoring, and control requirements. Our sensors support testing in aerospace and defense, automotive, transportation, civil engineering, and general R&D industries. Primary sensing technologies include piezoelectric (ICP®), piezoresistive, and capacitive MEMS. With a worldwide customer support team, 24-hour SensorLine, and a global distribution network, PCB is committed to Total Customer Satisfaction. PCB Piezotronics is a wholly-owned subsidiary of Amphenol Corporation.

PHOTRON has continually expanded their product line to aid in the advancement of photo optics and electronic technologies furthering research and development in the areas of digital imaging and slow motion analysis. Markets include microfluidics, military testing, aerospace engineering, automotive, broadcast, particle image velocimetry (PIV), digital image correlation (DIC), ballistics testing, and more.

PRECISION FILTERS, INC. is a global provider of instrumentation for test measurements. You can rely on a single source for signal conditioning and switching—a complete range of instrumentation—products optimized to work together to provide high performance at reasonable cost. PFI designs and manufactures precision solutions that include a family of analog signal conditioning, filtering and switching systems. The 28000 Signal Conditioning System provides a complete range of transducer conditioning with up to 256 channels per chassis. Precision's solid-state switch provides up to 256x256 cross-point switching and replaces tedious manual patch panels. The PF-1U provides 8 or 16 channels of high performance filter/amplifiers in a compact package with Ethernet control.

Exhibitor Descriptions

QUANTIFI PHOTONICS is a test and measurement company focusing on various photonics applications and serving a broad range of industries, from optical communication to photon doppler velocimetry (PDV). Our PDV solution combines the key optical components in an extremely compact instrument, helping end users streamline their PDV setups.

REL, INC. is a World Class Original Equipment Manufacturer for LED Lighting and High Strain Rate Testing Solutions. REL provides solutions that are used in world class research and development institutions worldwide for bleeding edge product development. LED spectral output with spectral intensities higher than thermobaric explosions and testing timescales measured in microseconds are common environments for tested, tough REL products. Call us to discuss your specific Dynamic Testing Challenge.

SCANTEK, INC. is the leader in vibration and sound measuring equipment sales, service, rental, and calibration. The Scantek Calibration Laboratory is accredited for microphones, calibrators, sound level meters, dosimeters, sound and vibration FFT, and real-time analyzers, preamplifiers and signal conditioners, accelerometers, velocity sensors, vibration meters, and vibration exciters. At Scantek, we understand how important correct sound reading and output needs to be in professional We provide each client with a caring experience and unparalleled support with their sound measuring equipment.

SHOCKMEC ENGINEERING is a small startup research and development company focused on shock testing and analysis. We have designed and produced our own resonant plate shock test system that is sized for convenient installation in almost any laboratory space. Resonant plate shock testing is intended to be representative of pyroshock and other similar high-energy, low-displacement shock events. Our company also performs shock design and analysis work as well as acoustics testing and design.

Simcenter is the **SIEMENS** software brand for addressing Predictive Engineering Analytics. The Simcenter portfolio consists of solutions that span 3D simulation, 1D simulation, and testing solutions. It is comprised of a number of well-known products such as Simcenter Test.Lab, NX Nastran, STAR-CCM+, Simcenter Imagine.Lab and Simcenter 3D. Simcenter Test Solutions specializes in testing for Acoustics, Structural Dynamics, Rotating Machinery, Durability/Fatigue and Vibration Control and are the market leader for high-end data acquisition and test results visualization and post processing.

Dassault Systems Simulia Corporation provides software applications. The Company offers products such as 3D experience platform, design, engineering, modeling, simulation, data and process management. Dassault Systems Simulia specializes in consulting, deployment, engineering, enablement, and simulia services.

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

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

SPEKTRA is strong of decades of experience in the development, manufacturing and retail of electronic measuring instrumentation. Our company also applies the in-house developed technologies to provide tailored special services for metrological and industrial applications. Such outstanding performance and capabilities have been the key to our success and have made it possible for SPEKTRA to reach a top position on a fast growing market.

Exhibitor Descriptions

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

TEAM CORPORATION continues to define the future of advanced, high-performance vibration test systems and solutions that advance the aerospace, defense and automotive industries. Pioneering the world of multi-axis test systems has led to the introduction of many state-of-the-art high frequency hydraulic and electrodynamic multi-axis test solutions, such as the CUBE and Tensor test systems. Utilizing advanced hydrostatic bearing technology that has been refined over the past 65 years, Team Corporation implements leading hydraulics engineering to solve unique problems that others cannot.

THORNTON TOMASETTI provides engineering design, investigation and analysis services to clients worldwide on projects of every size and complexity. We have 70 years of experience in research, testing and software development for the U.S. Navy and Department of Defense in the fields of blast, underwater shock, impact and vibration effects.

VIBRATION RESEARCH (VR) has been the innovator in vibration control, data acquisition, and dynamic signal analysis since 1995. VR builds reliable and user-friendly software and hardware. It is attentive to emerging technologies and changes to the industries it serves. Every software release, the customer can expect new and relevant features meticulously tested before they reach them. Testing labs worldwide trust VR for the industry's best testing systems and support that delivers unrivaled value. Visit the VR booth to discuss your testing and analysis requirements with industry experts.

VIBRO/DYNAMICS, a Socitec Group Company, is a leader and pioneer in the field of shock and vibration control solutions specializing in engineering services for the design, simulation and development of shock protected equipment. Vibro/Dynamics offers full lines of wire rope isolators, elastomer mounts, leaf springs, custom isolators and assemblies for protection of equipment against shock and vibration. Markets we serve include: Defense, Aerospace, Transportation, Energy and Construction. Resources we offer our customers include advanced simulation capabilities via SDNL1, SYMOS (proprietary n-DOF simulation software) and ANSYS®, SOLIDWORKS®, FEA and MATLAB®, supported by physical and simulated testing.

VISION RESEARCH designs and manufactures high-speed digital imaging systems that are used in military, industrial, academic, machine vision, and entertainment sectors. Phantom cameras allow you to analyze physical phenomena when it's too fast to see, and too important not toTM. Vision Research prides itself in the high resolution of its images, the power of its software, the reliability of its products and its high level of attentiveness and dedication to its customers. The company's innovative approach to high speed electronic "digital" imaging was recognized by the US Patent Office and was granted US Patent #5,625,412.

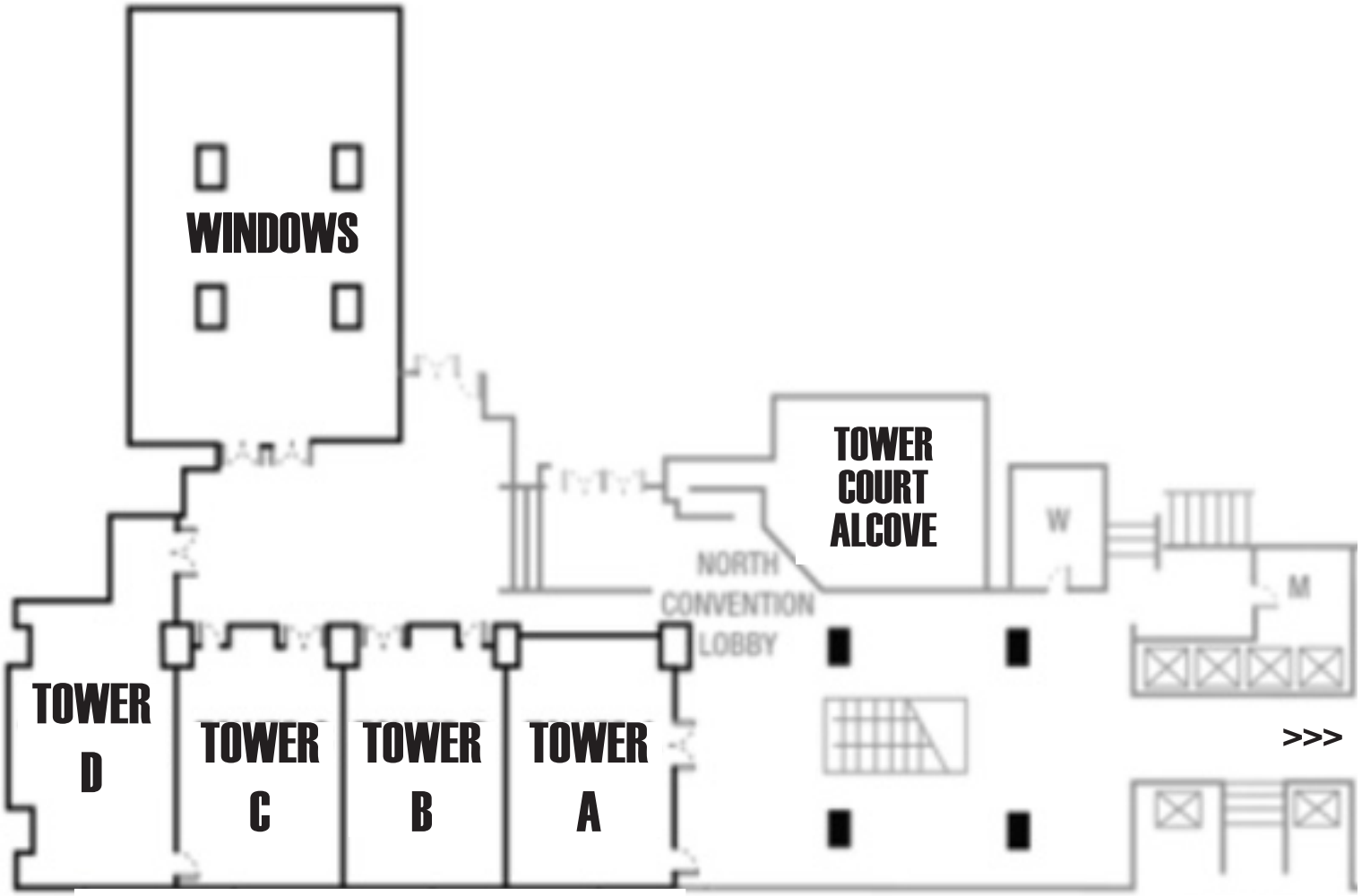
WEISS TECHNIK TESTING SERVICES (formerly CSZ Testing) is an A2LA Accredited test laboratory with extensive experience in a large array of testing applications. We provide a full range of environmental simulation testing services including temperature, humidity, and /or Vibration, HALT & HASS, shock, vibration, thermal shock, altitude, corrosion, salt spray and more. Serving you from two locations in Cincinnati, OH and Sterling Heights, MI. Visit www.wnatesting.com for more information.

XCITEX is an industry leader in video-based motion capture and motion analysis. Our engineers introduced the first synchronized high-speed video/data system -- MiDAS 1.0 -- in 1998 to take advantage of the first high-speed computer-based camera systems. We followed in 2005 with the introduction of ProAnalyst software that revolutionized the auto-tracking and motion analysis industry. The ProAnalyst line of software products has since expanded to include numerous innovative, award-winning editions for tracking various types of objects and for accurately tracking projectiles in flight.

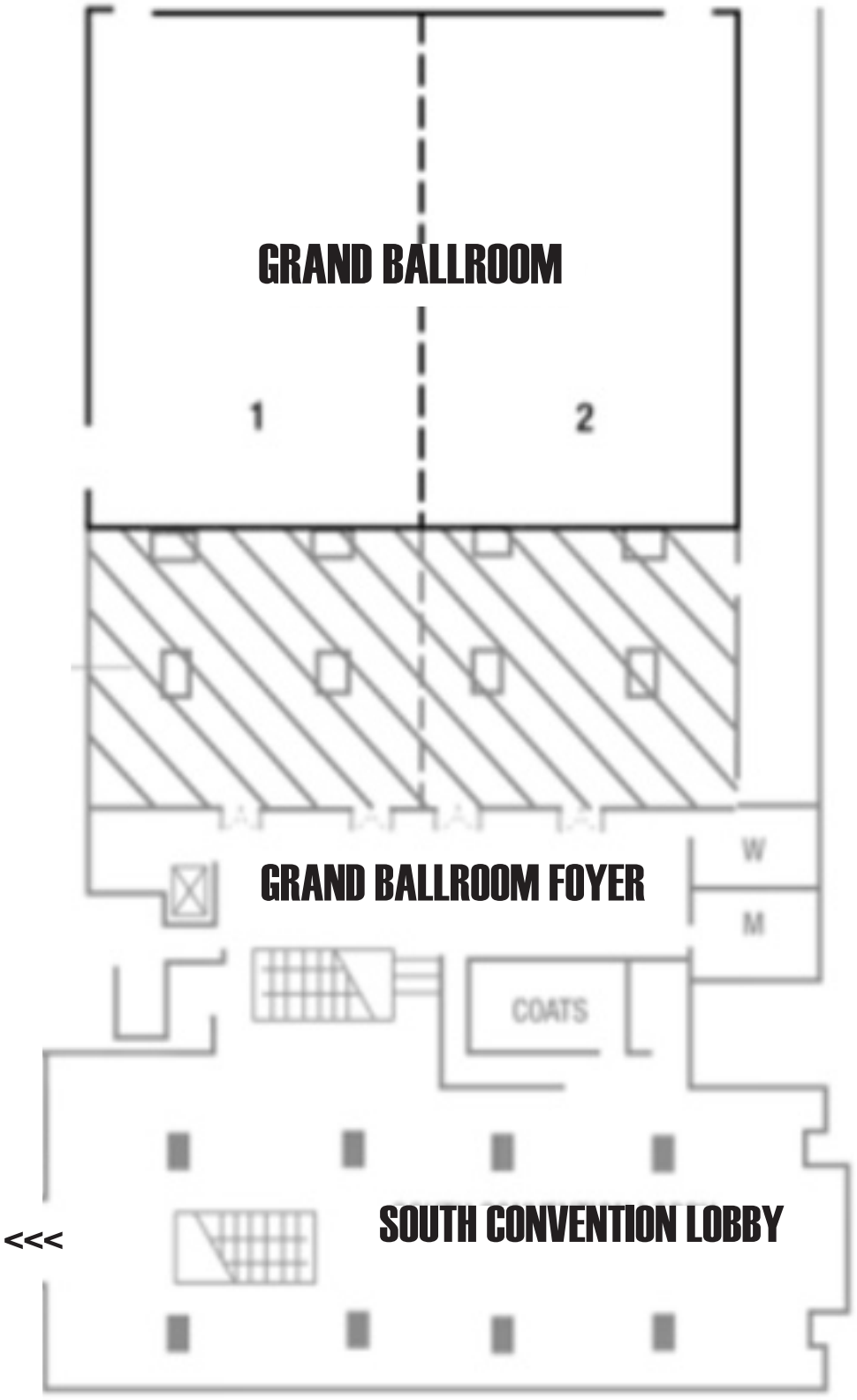
Sheraton Meeting Space layout

TOWER BUILDING - SECOND FLOOR

TOWER A:	SYMPOSIUM REGISTRATION & OPERATIONS
TOWER B:	SYMPOSIUM MEETING ROOM
TOWER C:	SYMPOSIUM MEETING ROOM
TOWER D:	SYMPOSIUM MEETING ROOM
WINDOWS:	SYMPOSIUM MEETING ROOM
GRAND BALLROOM:	EXHIBITS/GENERAL SESSION/MEALS



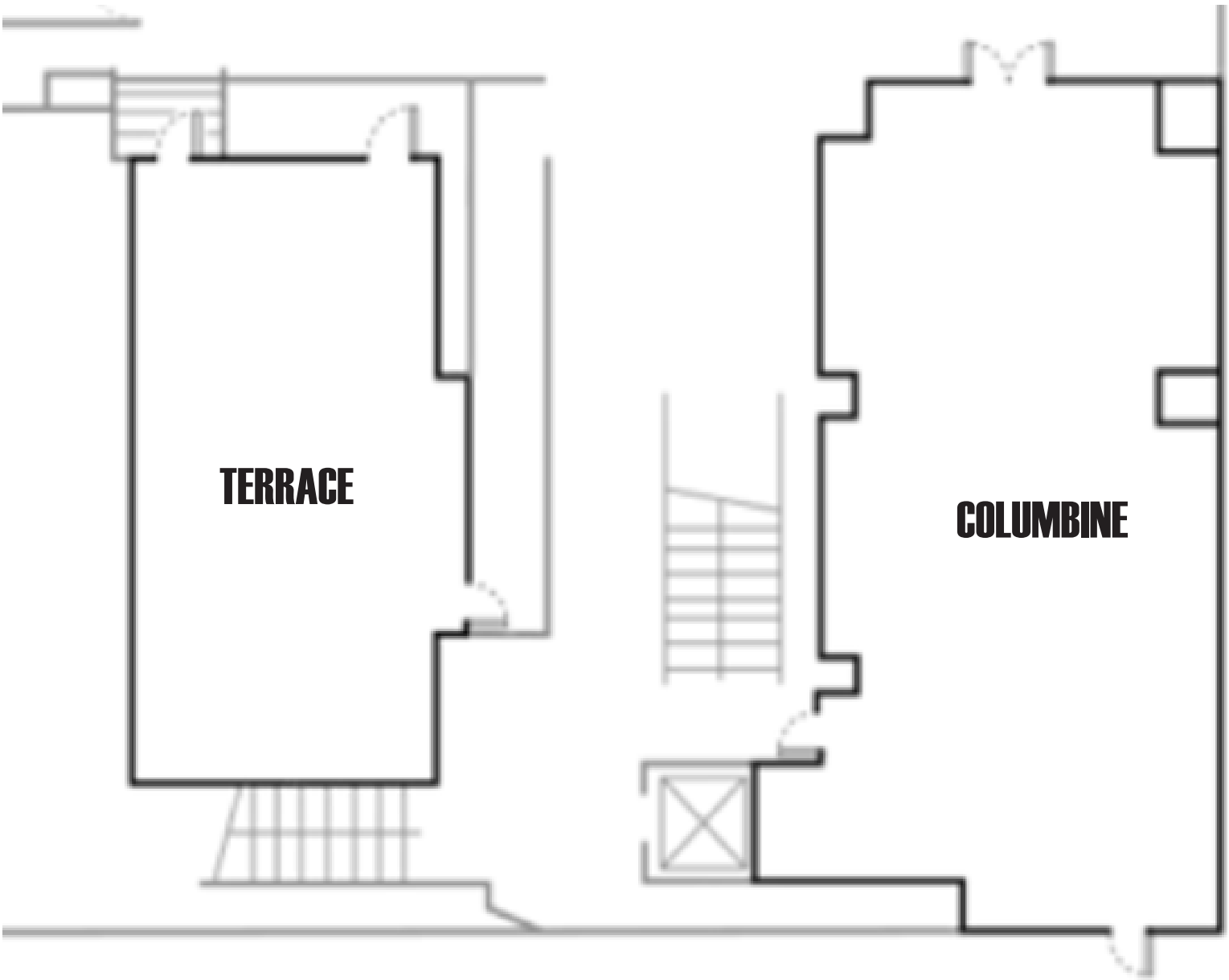
Sheraton Meeting Space layout



Sheraton Meeting Space layout

TOWER BUILDING - TERRACE LEVEL

COLUMBINE: SYMPOSIUM MEETING ROOM
TERRACE: SYMPOSIUM MEETING ROOM



Sheraton Meeting Space layout

TOWER BUILDING - MAJESTIC LEVEL

VAIL:	SYMPOSIUM MEETING ROOM
MAJESTIC BALLROOM:	SYMPOSIUM MEETING ROOM