SAVE
SHOCK & VIBRATION EXCHANGE

Tutorials & Training

September 19 - 23, 2021
Orlando, Florida

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TRAINING TYPES & COSTS

TUTORIALS

DESCRIPTION:
THREE HOUR COLLEGE LEVEL COURSES (UNLESS OTHERWISE DESIGNATED) ON A SPECIFIC TOPIC. AVAILABLE TUTORIALS ARE LISTED HEREIN WITH A BRIEF DESCRIPTION OF THE MATERIAL TO BE COVERED.

WHAT'S INCLUDED?
REGISTERED ATTENDEES WILL RECEIVE A SET OF NOTES AND A CERTIFICATE OF COMPLETION. SOME STATES MAY AWARD CEUs/PDHs BASED ON THIS CERTIFICATE OF COMPLETION. ALL NOTES PROVIDED ARE PROPRIETARY TO THE PRESENTER. PERMISSION FOR DUPLICATION OR DISPERSION MUST BE ACQUIRED BY THE PRESENTER.

COST:
EACH THREE HOUR COURSE COSTS $195 OR ONE COURSE PER AVAILABLE TIME SLOT IS INCLUDED IN THE TRAINING PACKAGE. ATTENDEE MUST PRE-REGISTER TO ENSURE AVAILABILITY OF SPACE AND NOTES.

TRAININGS

DESCRIPTION:
COURSES RANGE IN DURATION FROM 45 MINUTES TO 120 MINUTES. ENTRY LEVEL PROFESSIONAL COURSES ON A SPECIFIC TOPIC. AVAILABLE TRAININGS ARE LISTED HEREIN WITH A BRIEF DESCRIPTION OF THE MATERIAL TO BE COVERED.

WHAT'S INCLUDED?
NO CERTIFICATE OF COMPLETION IS AWARDED FOR THESE COURSES. AVAILABILITY OF NOTES FOR EACH TOPIC DEPENDS ON INSTRUCTOR AVAILABILITY. ALL NOTES PROVIDED ARE PROPRIETARY TO THE PRESENTER. PERMISSION FOR DUPLICATION OR DISPERSION MUST BE ACQUIRED BY THE PRESENTER.

COST:
TRAININGS ARE PROVIDED TO PAID SYMPOSIUM ATTENDEES AT NO ADDITIONAL FEE. FOR ATTENDEES NOT ATTENDING THE TECHNICAL PROGRAM FOR THE 91ST SHOCK AND VIBRATION SYMPOSIUM, THE TRAINING PACKAGE MUST BE SELECTED AND PAID IN ADVANCE OF TRAINING ATTENDANCE. THERE IS, HOWEVER, NO NEED TO REGISTER IN ADVANCE FOR EACH SELECTED TRAINING TOPIC.

HOW TO REGISTER

TO REGISTER IN CONJUNCTION WITH THE 91ST SHOCK AND VIBRATION SYMPOSIUM, PLEASE VISIT WWW.SAVECENTER.ORG/SYMPOSIUM AND FOLLOW THE LINKS FOR REGISTRATION.

TO REGISTER FOR THE TRAINING PACKAGE WITHOUT ATTENDANCE TO THE SHOCK AND VIBRATION SYMPOSIUM, PLEASE REGISTER USING THE LINK ON OUR HOMEPAGE.

SPECIAL 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 QUALIFICATION TESTING
Mr. Jeff Morris (H-TEST Laboratories)
Mr. Travis Kerr (H-TEST Laboratories)
Mr. Braden O'Meara (H-TEST Laboratories)

This training will cover the necessary background information and definitions relative to shock qualification per MIL-DTL-901E and is intended for engineers and product developers who are unfamiliar with the U.S. Navy's shock qualification process by test. Shock test requirements for all four test categories (lightweight, medium weight, heavyweight, and medium weight deck simulating) will be discussed to include the limitations of each method. Subjects covered include pre-test planning, procedure preparation, fixture selection and design, test set-up, test operations, instrumentation interpretation, and reporting. Some aspects of shock machine (LWSM, MWSM, and DSSM) and floating shock platform (FSP, IFSP, and LFSP) construction and operation will be covered so that the end user is familiar with how the machine or platform is utilized to meet the shock test requirements. Although specific guidelines are not included in MIL-DTL-901E, a brief summary of alternate test vehicles/machines will be introduced since the phrase appears more than 20 times in the detailed specification and may be approved as an appropriate qualification method when the limitations of the primary test methods are exhausted. In addition to this tutorial, separate training sessions for each test method will be held at various time during the conference for those that are interested in just a specific area.

Please note that current U.S. Navy shock policy will not be discussed in this session. The appropriate technical authority should be contacted with respect to questions concerning the interpretation of U.S. Navy shock policy.

TUTORIAL SESSION 1
8:00 - 11:00AM

THE MEASUREMENT & UTILIZATION OF VALID SHOCK AND VIBRATION DATA
Dr. Patrick Walter (TCU / PCB Piezotronics)

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

AIR BLAST AND CRATERING: AN INTRODUCTION TO THE ABC'S OF EXPLOSION EFFECTS IN AIR AND ON LAND
Mr. Denis Rickman (USACE ERDC)

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

ANALYSIS FOR A MEDIUM WEIGHT SHOCK TEST
Mr. Josh Gorfain (Applied Physical Sciences)
Mr. Jeff Morris (HI-TEST Laboratories)

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

TUTORIAL SESSION 1
8:00 - 11:00AM
(CONTINUED)

PREPARING SPECIFICATIONS FOR MULTI AXES MULTI SHAKER VIBRATION TESTING - STATIONARY & NON STATIONARY CONDITIONS
Mr. Zeev Sherf (Consultant)

Part 1 Stationary Conditions . The use and application of the Multi Axes Multi Shaker Vibration Testing Technology that was included in MIL STD 810 G (Method 527) is expanding slowly but constantly. Its implementation requires the handling of several tasks. The assembling of the Vibration System from a set of shakers that simultaneously excite in several directions, the attachment of the tested item to the shakers using and appropriate set of hydro spherical bearings' the operation of an appropriate control system(hardware and software) that will control the simultaneous excitation work of the shakers and last but not least a methodology for the preparation of appropriate multi axes vibration testing specifications. These specifications must enable the generation of a laboratory dynamic regime equivalent to the field regime. Equivalence meaning the same regime or the same effects(fatigue damage, energy content). While the preparation of vibration testing specifications for single or dual shaker single axis tests is clear, the generation of multi shaker , of multi axis vibration testing specifications requires the clarification of several aspects. The acquisition of field data, the analysis of the data and building of the SDM (Spectral Density Matrix). The definition of the envelope SDM as the Functional Testing Matrix and the application of energy accumulation consideration in definition of the life testing conditions. In the presentation all the above mentioned aspects will be discussed.

Part 2 Non Stationary Conditions. The application of the Multi Axes Multi Shaker Vibration Testing Technology , the use of which is expanding in the last years, requires the establishment of a methodology for the generation of testing specifications. It is the goal of this presentation to elucidate the elements of such a technology. The presentation will use simulated data. At the beginning the generation methods of the data will be presented. Following analysis methods of the non stationary data both in the frequency and in the time domain will be demonstrated. Next the definition of testing conditions to simulate the non stationary field regime are discussed and applied on the simulated data. Both methods in the time and the frequency domain are presented. Use of energy considerations in the definition of testing conditions that simulate repetitive non stationary regimes time histories are presented. Some non linearity issues that affect the specifications' preparation are

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

MULTIPLE-INPUT MULTIPLE-OUTPUT CONTROL FOR ACOUSTICS AND VIBRATION ENVIRONMENTAL TESTING: THEORY & PRACTICE
Mr. Umberto Musella (Siemens Industry Software)
Mr. Mariano Blanco (Siemens Industry Software)

Environmental tests are performed to prove that a system and all the sub-components will withstand the harshness of a predicted environment during the operational life. These tests aim to replicate with a high degree of fidelity the structural responses of a Unit Under Test (UUT) in the in-service conditions. As far as dynamic tests are concerned, the replication of the environmental conditions is only effective if the UUT's dynamics is also faithfully represented in the lab. The common practice of Single-Input-Single-Output (SISO) control tests has known limitations and drawbacks. The most critical aspect is that SISO tests may lead to unacceptable UUT time to failure overestimation and different failure modes. On top of more practical aspects that make difficult (or even impossible) to perform SISO tests (e.g. testing large items), this is the main reason why Multi-Input-Multi-Output (MIMO) tests are nowadays the "go for" in the environmental testing community for both vibration and acoustics testing. Even though the benefits of MIMO testing are clear and widely accepted by the environmental engineering community ever since 1958, this practice experienced a very slow growth. Initially this was due to the available technology in terms of excitation mechanisms and computational power for the data acquisition hardware and vibration controllers. Just recently, the increased complexity, size and cost of the article to be tested increased the concern about replicating as close as possible the environments to be tested. The high degree of expertise needed to perform these tests and decades of SISO controlled excitation built meanwhile a legacy of standards that currently represents the main reference for the environmental test engineers. For this reasons nowadays MIMO tests are still considered a pioneering testing methodology. The objective of this course is to give a detailed insight on MIMO control for reproducing a more realistic vibration and acoustic environments. An introduction to the topic will provide the theoretical background needed to understand MIMO control tests. Two parts (acoustics and vibrations) will follow, that focus, at the light of the acquired background, on industrial application cases and research topics in the field.

TUTORIAL SESSION 2
NOON - 3:00PM
(CONTINUED)

UNDEX PHENOMENA AND UNDERWATER BULK CHARGE WEAPON EFFECTS
NOTE: LIMITED DISTRIBUTION D (SECURITY PAPERWORK REQUIRED)
Mr. Greg Harris (Consultant)

This training will provide an overview of underwater explosion (UNDEX) shock wave and bubble phenomena, including the effects of nearby boundaries such as the water surface and solid surfaces. This talk provides special emphasis on UNDEX bubble dynamics, bubble pulse loading, and bubble jetting phenomena. The procedures used to characterize the UNDEX shock and bubble output of explosives will be discussed. An overview of UNDEX effects on naval structures and submerged infrastructure will be given.

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

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.

ENVIRONMENTAL SIMULATION AND TESTING TASKS TO BE FULFILLED DURING A PROJECT IN THE ACHIEVEMENT OF A PRODUCT'S DYNAMIC ENVIRONMENTAL ROBUSTNESS
Mr. Zeev Sherf (Consultant)

A project is a system, the input of which is the requirement for a new product and the output of which is the respective product. The project operates through three subsystems respectively: the design, manufacturing and the testing and evaluation. This presentation relates to the testing and evaluation subsystem, trying to elucidate the tasks to be performed in the evaluation of a product's dynamic environmental robustness. The main two tasks are the characterization and the simulation. In the frame of the characterization task, features of the field regime are identified to be replicated in the laboratory simulation of the field environment, as a basis to a realistic laboratory testing. The laboratory environment is "tailored" , meaning that it represents the specific loads, of a specific system on a specific platform and a specific interaction between the system and the loading environment. The main and best data source in the tailoring process are field measurements. The acquisition of high quality data requires the control skilled application of vibration and shock measurement technologies. Appropriate data analysis methods must be applied for the identification of the data's characteristic features. These methods shall be used for the analysis of the in the laboratory simulated data also. The results for the field and laboratory data shall be compared as a mean for the equivalence between the field and laboratory evaluation.(Method 525 of MIL STD 810G). If measured data are not available, data supplied by standards (Method 514 of MIL STD 810G or other relevant sources.) can be used. These are empirical models that can be easily programmed and used. From the measured data testing laboratory conditions must be defined that make possible the testing of the functional capability of the product as well its life long capability and survivability. Appropriate methods for the derivation of the testing conditions must be applied. An additional task to be performed is the assembling of the vibration simulation setup (single or multi axes and shaker setup) and the choosing of the appropriate control system. In summary the tasks to be performed during a project for the achievement of the product's environmental robustness are presented. Methods for their implementation are discussed.

TUTORIAL SESSION 3
4:00 - 7:00PM
(CONTINUED)

HOW MODAL ANALYSIS CAN BRING INSIGHT INTO VIBRATION TESTING

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

In this tutorial, a base mounted payload within a system undergoes a vibration environment. The apparently complex motion is “dissected” into a relatively small number of fixed base modes as well as its six rigid body modes. These modes give significant insight into the dynamic strain experienced by the payload. The complex field motion can be represented with a linear combination of these modes. Next, the motion is considered when the payload is mounted to a shaker table. The capability to reproduce the system response on a six degree-of-freedom shaker is demonstrated. Also, the response as typically controlled on a single degree-of-freedom shaker is demonstrated. Using an understanding of the fixed based modal response, and improved control can be demonstrated. The approach is first demonstrated with simple finite element beam models. A final example is demonstrated using real hardware in a system environment, and then mounted on a six degree-of-freedom shaker controlling to the system environment.

EFFECTIVE SOLUTIONS FOR SHOCK AND VIBRATION CONTROL

Mr. Alan Klembczyk (Taylor Devices)
Dr. J. Edward Alexander (Consultant)

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

TUTORIAL SESSION 4
8:00 - 11:00AM

SOME MODERN FRAMEWORKS FOR SHOCK MODELING
Dr. Tom Paez (Thomas Paez Consulting)

Accurate specification of mechanical shock tests has long been a fundamental goal of environment analysts. The de-facto standard for shock test specification, today, is the method of shock response spectra (SRS), first developed in 1932. The method has its shortcomings. Although it is possible to specify tests that somewhat accurately reflect field environments, practical implementations tend to yield over-tests that do not accurately resemble the field environments they are meant to represent. Yet many alternatives to the method of SRS are available. This presentation discusses four data-based alternatives for modeling oscillatory shocks, alternatives for which tolerance limit-based test time histories can be specified. These are: (1) The Karhunen-Loeve Expansion; (2) Continuous Wavelet Transform; (3) The Priestley Model for Nonstationary Random Processes; and (4) Least Favorable Response. The methods are all data-based; they permit the use of small or large ensembles for the specification of tolerance limit-based, test time histories. Some are more mathematically complex than the others, but software can be written that permits the simple specification of test time histories. This presentation develops the methods in as much detail as possible during a limited-duration exposition. Examples of the use of the four methods will be presented. MATLAB programs for the implementation of the four methods will be distributed to those who wish to have them.

AN OVERVIEW OF THE MIL-STD-461G ELECTROMAGNETIC INTERFERENCE CONTROL REQUIREMENTS FOR SUBSYSTEMS AND EQUIPMENT DEPLOYED ON SURFACE SHIPS AND SUBMARINES
Mr. Jeff Viel (National Technical Systems - NTS)

This college level tutorial addresses the essentials of the MIL-STD-461G standard including a brief history of the standard, test applicability, hardware configuration setup requirements, test procedures development and Test methodologies including basic formulas and calculations. This tutorial discusses some of the most common product compliance issues encountered during EMI testing, and provides insight into practical mitigation and design techniques. It is suited for students, technicians, engineers, and project managers, and anyone seeking a thoughtful understanding of these requirements, and guidance on practical application of test limits levels and ranges.

A PRIMER ON VIBRATION TESTING AND DATA ANALYSIS
Dr. Luke Martin (NSWC Dahlgren)

This tutorial will give an introduction to vibration testing and will be concept focused. The tutorial will begin with an understanding of a typical laboratory vibration test setup, followed by a deeper dive of the fundamental components. Specifically, a typical single degree of freedom vibration test will be decomposed into its pieces: amplifier, shaker, slip table, test item, vibration controller, and reference profiles. Once the components of the control loop are understood, the tutorial will focus on data analysis required by both the vibration controller to conduct a test and by a user who wishes to use measured field data to develop a tailored vibration test profile. Along the way concepts that will be covered are: electrodynamic shakers, servo-hydraulic shakers, single degree of freedom testing, multiple degree of freedom testing, control vs measurement transducers, Miner's Rule, sinusoidal testing, random testing, mixed mode testing, MIL-STD-167, MIL-STD- 810, need for tailored vibration data, and digital signal processing used for data analysis

TUTORIAL SESSION 5
3:30 - 6:30PM

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

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.

QUANTITATVE METHODS FOR HIGH-G ELECTRONICS SURVIVABILITY
NOTE: LIMITED DISTRIBUTION D (SECURITY PAPERWORK REQUIRED)
Mr. Curtis Mckinion (Air Force Research Laboratory)
Dr. Matthew Neidigk (Air Force Research Laboratory)

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

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

THE SEA (STATISTICAL ENERGY ANALYSIS METHOD) - A METHOD FOR THE DYNAMIC ANALYSIS OF A MECHANICAL SYSTEM EXPOSED TO RANDOM EXCITATION

Mr. Zeev Sherf (Consultant)

With the advancement of the space and aeronautic industry, the need of dynamic behavior evaluation of mechanical systems in the high frequency domain (above the fundamental structural frequencies) increased significantly. The classical analysis methods didn't answered to these needs. The modes are very dense and much more of them must be considered High frequency modes (of shorter length scale) are more sensitive to small unavoidable structural changes, so that, the by the classical method predicted responses lack reliability. Even if a reliable prediction is achieved , in the high frequency range , the computer generated data is so vast, that is difficult to handle the results. Under these limitations the proposed method was to adopt a statistical attitude according to which the question to answer is: "What is the average dynamic response (in terms of the mean square value), while the averaging is over time and over space?". The SEA (Statistical Energy Analysis) methodology was created. According to R. Lyon this is a branch of the dynamic systems' research. Statistical – stresses the fact that the studied system belongs to a population of systems of known distribution of the dynamic parameters. Energy- the parameter of main interest in the dynamic analysis is Energy. Mechanical parameters as: displacement, pressure, acceleration and force are evaluated from the Energy. Analysis – stresses the fact that SEA is a frame of research and not a particular technique

According to the SEA the behavior of structural elements is characterized by averages from the start of the analysis, instead of a detailed analysis, followed by calculation of averages. The dynamic analysis is in terms of energy flow between the subsystems of a mechanical system, for a certain frequency band, or the spatial distribution of the vibratory energy in the structure. The SEA method doesn't solve the motion equations. It analyses the energy distribution in the system and relates it to average response parameters. In the SEA analysis process the systems is divided into subsystems that interact each with another. By applying the SEA method the mean square response of the subsystems is evaluated. The parameters required in the calculation can be identified partly by calculations and partly experimentally. In the tutorial the principles of the SEA Method will be described. The building of the dynamical structure's system of energy flow equations will be exemplified. Analytical and measurement methods to be applied in the determination of the elements required in the building of the system of equations are presented. The application of the SEA method in the dynamic analysis of a system exposed to acoustic excitation is exemplified. Numerical tools used in the application of the method are discussed. Several summarizing remarks conclude the presentation.

TRAINING TOPICS HAVE NOT YET BEEN ANNOUNCED.

TITLES AND ABSTRACTS FOR THESE TRAININGS ARE DUE TO SAVE BY MAY 30 FOR INCLUSION IN OUR FORMAL PROGRAM.

SAMPLE TOPICS FROM PREVIOUS YEARS INCLUDE:

- INTRODUCTION TO UERDTOOLS
- STRUCTURAL DYNAMICS WITH OCTAVE
- INTRODUCTION TO HEAVYWEIGHT SHOCK TESTING
- INTRODUCTION TO MEDIUM WEIGHT AND LIGHTWEIGHT SHOCK TESTING
- COUPLING ABAQUS/EXPLICIT WITH XFLOW USING THE ABAQUS CO-SIMULATION ENGINE
- DDAM-COUPLED OPTIMIZATION METHODS
- SHOCK RESPONSE SPECTRUM PRIMER
- MANUFACTURING PROCESS EFFECTS ON THE PERFORMANCE OF FASTENERS IN SERVICE
- TYPE I VIBRATION QUALIFICATION
- UNDEX MODELING
- SIMULATION DRIVEN DESIGN AND OPTIMIZATION OF HULL FOR BLAST RESISTANT VEHICLES
- MESHLESS SIMULATION DRIVEN DESIGN APPLIED TO SHIPBUILDING INDUSTRY
- STRUCTURAL DYNAMICS WITH OCTAVE (AN OPEN-SOURCE ALTERNATIVE TO MATLAB)
- UNDEX PHENOMENA AND UNDERWATER BULK CHARGE WEAPON EFFECTS
- SENSOR AND SIGNAL CONDITIONING CONSIDERATIONS FOR PYROSHOCK MEASUREMENTS
- DEVELOPING EXODUS II AND SIERRA SD/ SM FORMAT MODELS

QUESTIONS?

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