



Vibration, Shock, and Acoustics Testing from SPECTRAL DYNAMICS (SD)

The following article, authored and submitted by Spectral Dynamics, is featured in Current Awareness as part of Spectral Dynamics' commitment to SAVIAC's 77th Symposium. They are one of two featured commercial organizations for the upcoming symposium in Monterey, CA.

demiological, Engineering and legal aspects of HAVS. In Japan, much of the pioneering work in this field has been performed by Dr. Setsuo Maeda and his staff at the National Institute of Industrial Health (NIIH) in Kawasaki. Most recently, reports of work done by this group and by Dr. Ren Dong of NIOSH in the U.S., as well as many other Japanese practitioners were presented at the 13th Japan Group Meeting on Human Response to Vibration held in Osaka during August 3-5, 2005.

The laboratory at NIIH has been at the forefront of much of the testing technology and instrumentation verification involved in the latest HAVS research which is taking place. An example of this is the recently installed 3-axis vibration simulator installed in the NIIH laboratory. This system is shown in the photograph. 3-axis control of motion at the specially developed patient handle is performed by a Spectral Dynamics (SD) JAGUAR MIMO control system. (Note that a similar SD control system is in use at NIOSH in Morgantown, West Virginia by Dr. Ren Dong and his team.)



Fig. 1 - Patient grasping special Test Handle with embedded Force & G sensors

Spectral Dynamics, Inc. was founded in San Diego, California in 1961 and has been providing high quality instrumentation and systems, continuously, since then. With a wide range of Analysis and Control products, SD has always been at the forefront of innovation, thanks to our very heavy investment in Engineering. Currently, one of the most exciting areas for both SD and our customers is the application of multi-shaker, MIMO, testing which is playing an important role in many disciplines today. The traditional applications for MIMO testing have included aerospace, seismic and automotive, each for conditions where a Unit Under Test may be too large for a single shaker or where multiple axes and multiple degrees of freedom testing may be necessary. To this has now been added the need for testing the human response to vibration, specifically Hand Arm Vibration Syndrome.

Hand-Arm Vibration Syndrome (HAVS) was identified as early as 1918 in Bedford, Indiana in the U.S. Since then much research work has been done around the world in the areas of medical, epi-

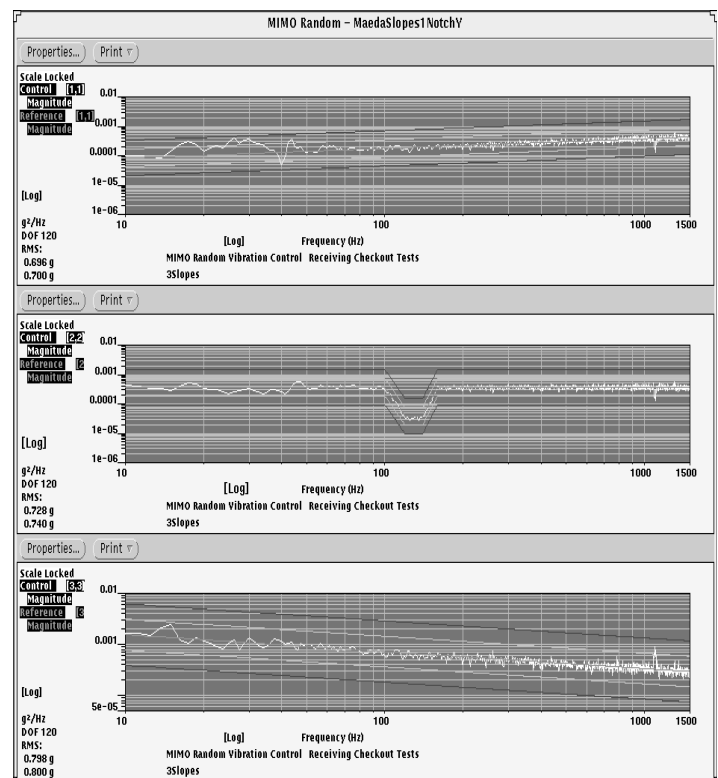


Fig. 2 - 3 different Control spectra including notched profile

Virtually any desired spectrum shape, within reason, can be specified and simulated with the 3-axis test system at NIIH. If certain, harmful, characteristics are present in a field condition, it is often feasible to measure these conditions and reproduce them in the laboratory. In the case of simultaneous 3-axis testing, care must be taken during field measurements to accurately obtain both Magnitude and relative Phase for all measured conditions using true simultaneous sampling with no unwanted channel Phase shifts induced.

Figure 2 shows an example of different spectrum shapes and different RMS levels for each axis being controlled at the same time. Since Adaptive Control is employed, the effects of the patient grasping the handle are typically overcome and Control returned to the nominal level and shape very quickly.

When performing controlled Multi-Shaker (MIMO) vibration testing, one of the most important steps is the determination of the System Impedance Matrix. The reason for this importance is the necessity to calculate the required Drives in Real-Time and to update these continually during the test. The Impedance Matrix gives an excellent indication of the complexity of the test system and can show whether or not the requested test parameters can actually be achieved! An example of the Impedance Magnitudes for the 3 major axes in the tests described above is given in figure 3.

With 3 shakers and 3 control points, the full Impedance Matrix is a 3 X 3 definition. In figure 3 we see the 3 major diagonal terms of this Matrix. [Note that in HAVS testing, the Z-axis is considered to be the axis of the patient's arm and the Vertical axis is called the Y-axis.] Figure 3 shows that at low frequencies, for this test setup, it will take nearly 5 Volts of system Drive to achieve 1 g of

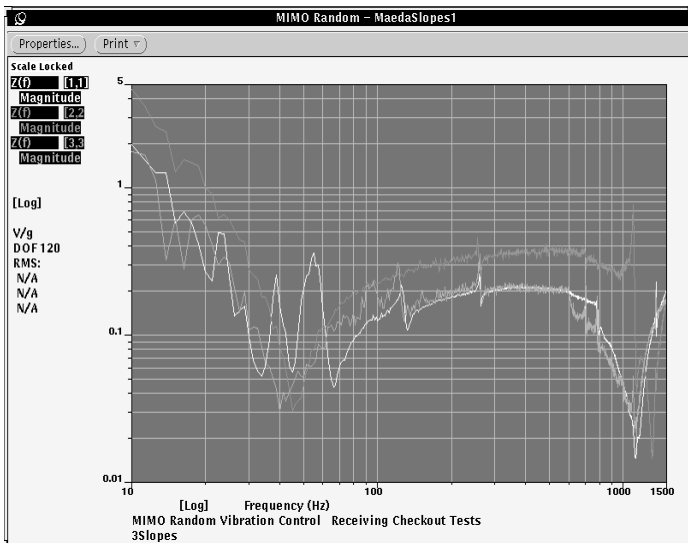


Fig. 3 - Impedance Function Magnitudes for the 3 slope X, Y, Z tests described

response acceleration in the Vertical (Y - 2,2) direction. It also shows that we can expect a sharp resonance at about 1,500 Hz in the same direction. This is typically also present in the resulting Drive signals, since the Impedance Function has a direct effect on the Drives due to:

$$\{DO(f)\} = \{Z(f)\}\{R(f)\}$$

The above equation says that the Drive signal to the shaker(s) is the product of the desired Reference spectrum and the Impedance function, all expressed in Matrix terms. For this test condition the resulting 3 shaker Drives in terms of Magnitude and relative Phase are shown in figure 4.

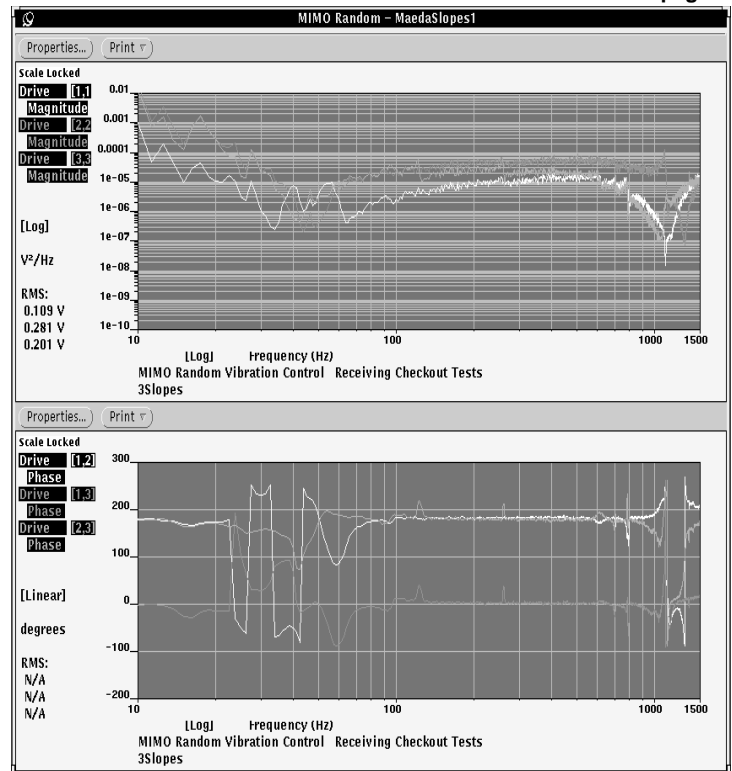


Fig. 4 - Drive Magnitudes and Phases required to achieve the desired Control

Note that Drive 2,2 in the upper trace of figure 4 also shows a peak near 1,200 Hz. Also, in order to achieve the desired "In-Phase" control conditions at the Grip Handle, the required Drives included a 180° Phase difference between Drive 1,3 and Drives 1,2 and 2,3. The Control system used here automatically calculates these Drive conditions from the defined and measured Spectral Density Matrix.

Summary:

Multi shaker (MIMO) control is finding it's way into many varied disciplines. From a testing perspective, MIMO offers advantages at many levels. Not only can MIMO testing be done with smaller shakers than requiring one "monster" shaker, but often, a user may find that several smaller shakers may already be available in the laboratory. Also, it is often the case that greatly reduced or almost no fixturing is required when using multiple, controlled exciters. This must be contrasted with the often tremendous costs associated with purchasing a special, large fixture required only for one special test. From a control standpoint, using multiple exciters permits far greater flexibility and accuracy of creating and controlling motion at several points on a structure.

Some of the MIMO advantages offer by Spectral Dynamics include:

- Real-Time Random, Swept Sine and Shock control
- Real-Time solution of the entire System Spectral Density Matrix (SDM)
- Updating of the SDM every control loop using true Adaptive Control
- Patented performance in Shock, Random and Sine
- Choice of Square or Rectangular Control
- Use of software Coordinate Transformations for even greater control flexibility

Many of these characteristics have been described in a series of MIMO papers authored by Spectral Dynamics Engineers over the past 5 years. Copies of these are available from Spectral Dynamics upon request. Additional information about SD is available at www.spectraldynamics.com.

(cont'd page 3)

(Cont. - Spectral Dynamics)

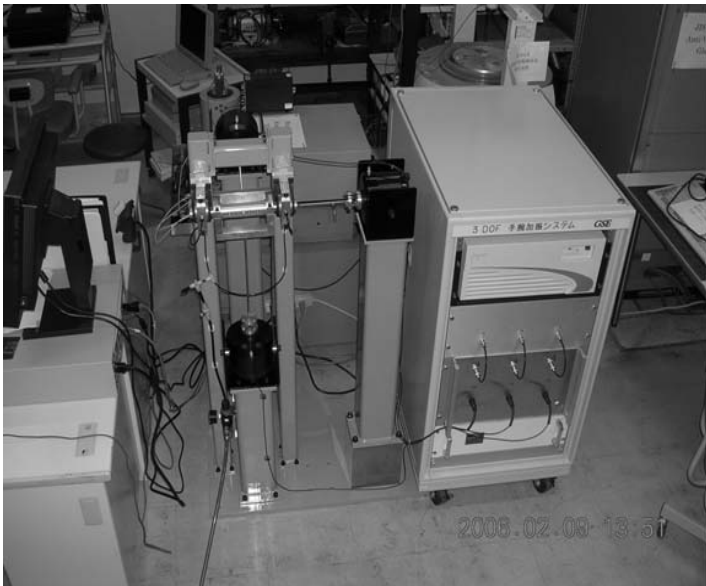


Fig. 5 - Overall view of HAVS testing and control system at NIIH in Kawasaki, Japan

FREE SHOCK AND VIBRATION SEMINAR

June 28, 2006 - Hyatt Regency Monterey, CA

**If interested in presenting, call Jeff Morris @
(434) 581-3204**

**If interested in attending, call Darnise Johnson @
(804) 282-5570.**

LAST CALL!

Papers from the 76th Symposium

Due to increased interest in submitting papers from last year's symposium, we are extending the deadline until April 21, 2006. If you have a paper from the 76th (or even the 75th), please send it to us.

Remember, if you need a release form or the formatting procedure for submitting the paper, e-mail Darnise and she will provide those to you.

darnise.johnson@saviac.org

76th Proceedings - Release Date

Based on the information above, we expect the proceedings from the 76th Symposium to be available in June 2006.

77th Proceedings - Expediting

In order to avoid a six to nine month lag in proceedings release, please make a dedicated effort to have your paper(s) and release form(s) for the 77th symposium in before November 15, 2006. Our goal is to have the proceedings available within three months of the symposium.

Don't Forget to Submit Your Abstract for the 77th Shock & Vibration Symposium

Go to

http://www.saviac.org/77th_Symposium/77th_symposium.htm

and follow the instructions

PIEZOELECTRIC DYNAMIC PRESSURE SENSORS

Explosion, Blast, & Shock Wave Pressure Probes

- Free-field & Underwater Blast
- Shock Wave Pressure
- Shock Tube Research
- Closed Bomb Testing
- Squib Lot Acceptance Testing
- Wave Velocity & Time-of-Arrival



Series 137 ICP® Free-Field Blast Pressure Pencil Probes



Series 132 ICP® Microsensors



Series 138 ICP® Underwater Blast Pressure Probes



Series 113B3X ICP® Pressure Probes

PCB PIEZOTRONICS™

PRESSURE DIVISION

Satisfaction Guaranteed or Your Money Refunded

Join SAVIAC's 2006 Corporate Supporter Program

*Show your Competitors, Employees, Colleagues, Current Clients, and Potential Customers
Your Commitment to the Continuing Success of this Community*

Corporate Supporter Benefits

Recognition

- o SAVIAC news releases
- o SAVIAC website
- o SAVIAC newsletters
- o S & V Symposium Opening Session
- o Corporate Sponsor Plaque

Corporate Image

- o Identified as a leader of the community

Financial

- o Solidify current customers
- o Recruit new customers
- o Significant savings over individual prices
- o Modest investment

Marketing

- o Communitywide exposure
- o Opportunity to be a Featured Company (for Platinum & Gold Levels)

Corporate Supporter Levels

Platinum Level - \$15,000

Two 8' x 10' Exhibit Booths, 7 Registrations, & up to 6 tutorials per registrant at 77th S&V Symposium / One 2007 Calendar Ad / 6 half page ads - *Current Awareness* Newsletter / SAVIAC Supporter Recognition / Compendium CD (5 lic) & 7 Proceedings CDs (savings of \$9,860 over ind. pricing)

Gold Level - \$10,000

One 8' x 10' Exhibit Booth, 5 Registrations, & up to 6 tutorials per registrant at 77th S&V Symposium / One 2007 Calendar Ad / 3 half page ads - *Current Awareness* Newsletter / SAVIAC Supporter Recognition / Compendium CD (1 lic) & 5 Proceedings CDs (savings of \$6,670 over ind. pricing)

Silver Level - \$6,000

One 8' x 10' Exhibit Booth, 3 Registrations, & up to 6 tutorials per registrant at 77th S&V Symposium / One 2007 Calendar Ad / 3 quarter page ads - *Current Awareness* Newsletter / SAVIAC Supporter Recognition / Compendium CD (1 lic) & 3 Proceedings CDs (savings of \$5,505 over ind. pricing)

Bronze Level - \$4,000

One 8' x 10' Exhibit Booth, 2 Registrations, & up to 4 tutorials per registrant at 77th S&V Symposium / 3 quarter page ads - *Current Awareness* Newsletter / SAVIAC Supporter Recognition / Compendium CD (1 lic) & 2 Proceedings CDs (savings of \$3,410 over ind. pricing)

S&V Seminar Sponsor Level - Sponsor the lunch or the notebooks for the Winter and Summer S&V Seminars, Recognition at the Seminar, SAVIAC Supporter Recognition (\$1000/notebooks, \$750/lunch per seminar)

Supporter Recognition includes:

Your company listing in the SAVIAC calendar which is distributed to over 2000 people in the community, Recognition at the Opening Session of the Shock & Vibration Symposium with the presentation of your plaque, Listing on the SAVIAC web page with a link to your web page membership in the SAVIAC Technical Advisory Group (TAG) which meets three times a year to discuss community needs and issues.

For more information on SAVIAC's Corporate Supporter Program or other SAVIAC opportunities, call Drew Perkins, SAVIAC Program Manager, at 804-282-5570 or e-mail drew.perkins@saviac.org.

INDUSTRY NEWS

Robust, Isolated Digital I/O Module for USB 2.0**Data Translation, Inc
Marlboro, MA**

Data Translation Inc. announces the DT9817-R, a data acquisition digital I/O relay output module for USB 2.0. This new isolated module provides high drive, and high current digital I/O capability. You can access images and further documents relating to this product and other new Data Translation products easily from our FTP site. The URL to the Data Translation FTP PR location site is; <http://ftp.datx.com/Public%20Relations/> Username-pr Password-!!Aple9! (Both the username and password are case sensitive.) Contact Lori Stanton at 508-481-3700 x1544 or Tim Ludy at 508-303-1274 for additional information

Strain Sensors Measure Quality on Resistance Welding Machines for Delivery of Zero Defect Product Components**PCB Piezotronics, Inc
Depew, NY**

New Series JM240 ICP® Ground Isolated Strain Sensors from the Force/Torque Division of PCB Piezotronics, Inc. (PCB®) use piezoelectric sensing elements to indirectly measure dynamic and quasi-static stress forces on resistance welding machinery structures. ICP® Strain Sensors feature sensitivity stability, repeatability, high resolution, and extremely long life. Mounted on a C-frame or actuator with a single screw keeps the sensor out of the current flow and high electrical noise environments do not affect the ground-isolated design. For additional information, contact the Force/Torque Division of PCB Piezotronics, Inc. toll-free at 888-684-0004 (in the U.S. and Canada) or 716-684-0001; e-mail: force@pcb.com; fax 716-684-8877; or visit PCB's web site at www.pcb.com.

New 4-Channel Solid-State Data Recorder**Scantek, Inc
Columbia, MD**

The RION DA-20 is a compact 4-channel data recorder that provides users a

lightweight and high quality instrument to record various types of electronic signals and waveform data for audio recording and sound and vibration on-site measurement. Transducers that can be used include constant current Electret condenser mics and single- and tri-axis accelerometers. The measurement data are stored on memory card (CF card) in WAV file and the stored data can be reproduced as analog signal or output to external signal analyzer. The CF card enables easy access to stored data download to PC, and the software DA-20 Viewer (supplied accessory) enables the time-history data display on PC or via WAV/CSV file output to PC. Optional software line-up is also available for waveform analysis. For further information: <http://www.rion.co.jp/asp/product/sound/ProC.asp?pos=15&div=1> (attached) Scantek, Inc., an ISO 17025 NIST accredited Calibration Laboratory, is a distributor for multiple sound and vibration lines, including Norsonic, RION, CESVA Acoustical Instrumentation, Castle Group, KCF Technologies, Metra Vibration Transducers, DataKustik, RTA Technologies, BSWA Transducers, EXTECH Instruments, and ROGA Instruments. Scantek is committed to providing quality sales, customer repair, service, and calibration of sound & vibration instrumentation. For more information, call (800) 224-3813 or visit www.scantekinc.com.

**New Model 377B01 Free Field 1/4" ICP™ Microphone
Vibration Division of PCB
Piezotronics, Inc.
Depew, NY,**

The Vibration Division of PCB Piezotronics, Inc. (PCB®) introduces Model 377B01 prepolarized, 1/4" Free Field response-type microphone which operates from ICP® sensor power. The distinguishing feature of this model is its enhanced frequency rating of 90 kHz (+/- 2 dB.) It has a sensitivity rating of 3 mV/Pa and a wide dynamic range (30 to 166 dB(A) re 20 µPa). This microphone has a 120 °C operating temperature range. This model is one of a full series of modern, pre-

polarized, condenser microphones and preamplifiers available from PCB. Powered by a 2 to 20 mA signal conditioner and standard coaxial cables, these modern designs allow for significant savings in power supply and cabling cost, greater ease-of-use and operate from the same power required for ICP® accelerometers. This provides the advantage of using microphones with ICP® accelerometers in the same test, with the same signal conditioning equipment, minimizing set-up time. For additional information, contact the Vibration Division of PCB Piezotronics, Inc., toll-free, at 888-684-0013; E-mail: vibration@pcb.com; or fax at 716-685-3886. For other PCB products, contact PCB directly at 716-684-0001, or visit our web site at www.pcb.

**Additional ATEX Approvals for Spark® Personal Noise Dosimeters
Larson Davis (a PCB Group Company)
Provo, UT,**

Larson Davis has received European ATEX approvals (II 2 G, EEx ib IIB T4) for its Spark® dosimeters. The approval extends to all of the dosimeters in this product family: 703, 703+, 704, 705, 705+, 706, 706RC, which allows them to be used in hazardous surface locations for Industrial Hygiene and worker safety applications. Larson Davis Spark® Dosimeters combine ease-of-use and strength in a miniature, lightweight package. With seven intrinsically safe models available, Spark® provides days of operation on just two AA batteries, and has a wind-screen that stays secured between calibrations. When used with Blaze® Noise Exposure Analysis software, personal noise dosimeter data can be converted into concise reports and full-color graphics. All Larson Davis products are accompanied by full technical support, as well as a guarantee of total customer satisfaction. Larson Davis provides a complete line of acoustic and vibration measurement systems, including dosimeters, sound level meters, preamplifiers and more. For more information, please contact Larson Davis toll-free at 888-258-3131, email sales@larsondavis.com, or visit www.larsondavis.com.

Conference & Short Course Announcements

Annual Reliability and Maintainability Symposium (RAMS) Call for Papers IEST

January 2007.

Orlando, FL

The Institute of Environmental Sciences and Technology (IEST) announces that the 53rd Annual Reliability & Maintainability (RAMS) Symposium call for papers and tutorials is due no later than April 17, 2006. The theme of the 2007 RAMS is "Reliability and Maintainability in the New Frontier." More information about topics that are relevant to the theme of the 2007 Symposium and procedures for submitting your abstract may be found on the RAMS website. Please go to <http://www.rams.org/call> to retrieve the "Call for Papers and Tutorials" for 2007. You may also download a PDF version to print and share with your colleagues. IEST is the sponsor of the Symposium. More information can be found at www.rams.org.

Vibration and Shock Test Control Techniques

TTI' (TechnologyTraining, Inc)

May 1-5, 2006

Las Vegas, NV

This course presents an application-oriented approach to digital computer control of random vibration and shock testing on shakers and analysis of vibration and shock data. Complex mathematical concepts are reduced to graphic form for intuitive understanding. Illustrative examples from the "real world" are used throughout. The course is presented as a series of highly-interactive lecture/discussion sessions. Problems for individual and group solution are interspersed throughout the course to act as training aids and to evaluate class progress. Special-interest discussions are encouraged outside of Instructor is Strether Smith, a long time SAVIAC affiliate and subject matter expert. For addi-

tional information: call 866-884-4338 (866-TTi-4edu) 805/715-2638 o FAX 805/715-2650 website [/www.tti.edu.com](http://www.tti.edu.com)

23rd Annual Aerospace Testing Seminar IEST

October 10-12, 2006

Manhattan Beach, CA

The Institute of Environmental Sciences and Technology () announces that the 23rd Annual Aerospace Testing Seminar provides a forum to communicate and exchange knowledge about the improvement and implementation of aerospace testing technology that will benefit current and future space programs. Engineers, managers, and leaders will be able to share their experiences, discover new methods and procedures, and learn how others are coping with designing and implementing cost-effective test programs. Nine sessions are planned. The prestigious Otto Hamberg Best Paper Award will once again be presented to the author(s) of a paper that embodies this year's theme and exhibits technical excellence in both manuscript and presentation. This year's theme is "New Dimensions." The ATS pre-seminar tutorial program will feature classroom-style presentations of interest to professionals at all levels of experience. For more information, contact Erwin Perl at 310.336.5371 or visit www.aero.org.

ESTECH, the 52nd Annual Technical Meeting and Exposition

May 7-10, 2006

Phoenix, AZ

ESTECH is an excellent opportunity for you to meet and do business with key people in the international community of environmental sciences. IEST is an ANSI-accredited standards-developing organization; Secretariat of ISO/TC 209 Cleanrooms and associated controlled environments; Administrator of the ANSI-accredited US

TAG to ISO/TC 209; and a founding member of the ANSI-accredited US TAG to ISO/TC 229 Nanotechnologies. For more information about ESTECH sponsor opportunities go to www.iest.org/marketing/esponsors.htm. You can also contact IEST at 847-255-1561 or marketing@iest.org.

Random Vibration and Shock Testing Training

ERI

August 22-24, 2006

Santa Barbara, CA

A short course on practical vibration and shock testing, measurement, analysis and calibration, also HALT, ESS and HASS. Many people conducting vibration and shock tests, ESS, HALT and HASS lack formal training in this specialized area of mechanical engineering. They do what they have shown, but often they don't understand WHY certain steps are necessary. Nothing comparable is offered by university engineering departments. Course details can be found at <http://www.equipment-reliability.com/sb1.htm>. To register, visit http://www.equipment-reliability.com/regist_form.htm. Phone: (805) 564-1260 FAX: (805) 966-7875

Climatic Test Techniques,

June 12-13, 2006 at

TTI' (TechnologyTraining, Inc)

Las Vegas, NV

Instructor, Dick Leatherman teaches an introduction to climatic testing with an overview of field test measurement and analysis. Test methods and conditions of commercial and military test specifications and standards are discussed. For schedules, general information and registration forms, go to TTI's website at: <http://www.tti.edu.com> For any other additional information please call: 866-884-4338 (866-TTi-4edu) or E-mail: Training_@ttiedu.com

Make sure your events get into the 2007 SAVIAC Calendar!

The 2007 SAVIAC Calendar is being compiled for distribution among the 77th Shock & Vibration Symposium attendees, as well as hundreds of other SAVIAC community members around the globe! Don't miss your opportunity to have your event placed in our calendar. Contact Drew Perkins with your event dates and details at drew.perkins@saviac.org.

77th Shock and Vibration Symposium Call For Papers

**October 29 - November 3, 2006
Hyatt Regency Monterey
Monterey, CA**

Planning for the 77th Shock and Vibration Symposium is underway, with the selection of the Naval Undersea Warfare Center as the Government Featured Organization and ABAQUS and Spectral Dynamics, Inc, as the Commercial Featured Organizations, and the Hyatt Regency Monterey as the location.

The Shock & Vibration Symposium is the oldest continuously held meeting dealing specifically with the structural dynamic behavior of air, sea, space, and ground vehicles and structures. The Symposium was established as a mechanism for the exchange of information among Government activities, private industry, and academia on current work and new developments. Presentations on work in progress are encouraged. Separate sessions are held for presentation of classified or limited-distribution material.

Presentations in the following subject areas are welcomed:

Two categories of presentations will be accepted: full papers, suitable for publication in the Symposium Proceedings; and short discussion topics, consisting of viewgraphs with no written paper. Full papers will have a 15 minute technical presentation time plus 5 minutes for questions, while short discussion topics will have a 10 minute presentation time with no question period.

901D Case Studies	Dynamic Testing	Product Announcement/Facility
Active Vibration Control	Environmental Databases	Description
Ballistic Shock	Finite Element Analysis	Pyrotechnic Shock
Biodynamics	Fluid-Structure Interaction	Shock Characterization
Blast Design	Ground Shock	Shock Hardening
Combined Environments	Seismic Shock	Shock Qualification by Extension
Computational Structural Dynamics	Impact/Penetration Mechanics	Shock Test/Equipment Failure Modes
COTS	Instrumentation	Simulation Methods
Crash Dynamics	Isolation Systems	Specifications and Standards
Damage Identification	Large Structures	System Identification
Damping	Live Fire Testing	Test Criteria
Data Analysis	Machinery Diagnostics	Test Tailoring
Dynamic Analysis Methods	Machinery Vibration	Underwater Shock Testing
Dynamic Measurement	Material Dynamic Properties	Vibroacoustics
Dynamic Scale Modeling	Modal Analysis and Testing	

Presentations will be accepted on the basis of their abstracts, which must be submitted by June 3, 2006. You are encouraged to submit online at www.saviac.org, click on 77th S&V Symposium Abstract Submittal. The Program Committee will review the abstracts during the June Program Committee meeting and authors will be notified of acceptance by July 14, 2006. The full paper presentations must meet the following standards: They must be previously unpublished and unrepresented, must be appropriate to community interests and must not be overtly commercial, except for papers in the Product/Facility session. Standards for short discussion topics are similar except that they may include previously presented or published material.

The Proceedings will be published on CD-ROM

The paper due-date is October 6, 2006

Questions should be directed to Drew Perkins, 804.282.5570 or drew.perkins@saviac.org



SAVIAC / HI-TEST Laboratories Inc.
8100 Three Chopt Road Suite 110
Richmond, VA 23229
RETURN SERVICE REQUESTED

In the April 2006 Current Awareness Newsletter

***Vibration, Shock and Acoustics Testing from
SPECTRAL DYNAMICS (SD)***

***Final Call for 75th and 76th Papers
77th S&V Corporate Supporter Program
Industry News
Conference & Short Course Announcements
Call for Papers for 77th Symposium - Monterey, CA***

The Current Awareness newsletter is published by the Shock and Vibration Information Analysis Center, which is operated by HI-TEST Laboratories, Inc., under contract to the U.S. Army Engineer Research and Development Center.

Program Manager
Drew Perkins
(804) 282-5570
drew.perkins@saviac.org

Administrative Services Mgr.
Darnise C. Johnson
(804) 282-5570
darnise.johnson@saviac.org

Manager of Technical Services
Henry Pusey
(540) 678-8678
mfpt@adelphia.net

SAVIAC/HI-TEST Laboratories Inc.
8100 Three Chopt Road
Suite 110
Richmond, VA 23239
(804) 282-5557 (fax)

SAVIAC Director
Dr. Charles Robert Welch
US Army Engineer Research and Development
Center
Vicksburg, MS 39180
saviac@wes.army.mil