Practical Considerations using Pressure, Force, Acceleration and Torque Instrumentation

Instructor: *Bill Zwolinski, Senior Applications Engineer Kistler Instrument Corp*

Course Length 4 hours

This tutorial will l explore the what's, why's and how's related to using Pressure, Force, Acceleration and Torque instrumentation and solve various application problems. The tutorial will cover the concepts of operation and technology review for Piezoelectric (PE), Integrated Electronics Piezoelectric (IEPE), Microelectromechanical Systems (MEMS) and Piezo-resistive (PR)/Strain Gage instrumentation. Practical considerations include the explanation of key performance specifications, selection criteria, installation, cabling and checkout. Several applications will be discussed to illustrate the concepts including military and aerospace. Active demos will be used to highlight various concepts as well as DAQ/signal conditioning.

A Primer on Scientific Test & Analysis Techniques (STAT)

Instructor: *Mark J. Kiemele, Ph.D., Air Academy Associates*

Course length 4 hours

With the increased emphasis that the Department of Defense is placing on the use of scientific principles in the test and evaluation environment, you may have heard of the term STAT (Scientific Test and Analysis Techniques). This 4-hour tutorial will provide an overview of some of the most important scientific test and analysis techniques that can and should be used in test and evaluation activities. This session is meant for executives, leaders, managers, and practitioners who need to know what STAT includes and what it can do for their organizations even if they themselves never design a test or evaluate its results. Design of Experiments (DOE) is most definitely a critical component of STAT, but this session will address other important tools as well. Methods for prioritizing requirements and translating them into measurable entities will be discussed, along with Measurement System Analysis (MSA). MSA should answer the question of whether we can trust the data that we are getting from the test. Transfer functions and their use in prediction and optimization will also be presented. After this session, leaders, managers, and practitioners will have a high-level understanding of a variety of methods that are implicit in STAT. No prior statistical prowess is needed to garner some key principles/take-aways from this session.

HD Transport, Timing and Compression

Instructor: *Paul Hightower, President and CEO, Instrumentation Technology Systems*

Course Length 4 hours

While many of the terms used in digital video are the same, the nature of digital video is quite different from analog video. As a first step in understanding what vertical sync, horizontal sync and resolution means in the digital video world this presentation will compare these terms side by side. This tutorial will describe the commonly used formats and their variations. It will be shown how resolution is 3-dimensional in digital video and that these dimensions are affected by

compression in several ways. Timing is another critical measurement in engineering test. In analog video time stamping at frame sync was customarily done at the destination. Time was consistent and delays due to transport were in microseconds. In digital video that may still be true when directly connected, but when transporting HD digital video more than 300 feet, the need to compress may be the only alternative. Compression introduces latencies that may be 70 milliseconds, but could just as easily be 10 seconds. The latency at any point in time varies. Reliable time stamping may only be possible at the source. These issues will be discussed along with possible solutions.

Troubleshooting Ethernet Data with Wireshark

Instructor: *Paul Ferrill, ATAC*

Course length 4 hours

The "Troubleshooting Ethernet Data with Wireshark" tutorial will use real-world aircraft data to demonstrate how to use the open source program Wireshark to both view data and troubleshoot problems. The class will include presentation and hands-on usage of Wireshark to look at data as if you were connected to the Ethernet network on an airplane and if you were connected to an IRIG 106 Chapter 10 recorder broadcasting data over UDP. We'll start out with a brief overview of Ethernet fundamentals and then get right on to using Wireshark.

The TENA and JMETC Solution for Distributed Test and Training

Instructor: *Gene Hudgins, TENA*

Course length 4 hours

Together, TENA and JMETC enable interoperability among ranges, facilities, and simulations in a timely and cost-efficient manner. TENA provides for real-time system interoperability, as well as interfacing existing range assets, C4ISR systems, and simulations; fostering reuse of range assets and future software systems. JMETC is a distributed, LVC capability which uses a hybrid network architecture; the JMETC Secret Network (JSN), based on the SDREN, is used for secret testing and the JMETC Multiple Independent Levels of Security (MILS) Network (JMN) is the T&E enterprise network solution for all classifications and cyber testing. JMETC provides readily available connectivity to the Services' distributed test and training capabilities and simulations, as well as industry resources.

This tutorial will address the current impact of TENA and JMETC on the Test and Training community; as well as its expected future benefits to the range community and the Warfighter.

Introduction to Python with Engineering Applications

Instructor: *Phillip Rogers, 812 TSS/ENT Edwards AFB*

Course length 4 hours

This tutorial is intended for flight test practitioners interested in using Python. Python is a general purpose interpreted programming language. Python emphasizes code readability and reuse. There are many add-on packages that make Python suitable for scientific computing, such as the SciPy packages. Also, Python can be used for "ad hoc" analysis and "what if" explorations.

Python supports object oriented design, dynamic variable typing, automatic memory management, and has an extensive and comprehensive set of application libraries.

Because Python is interpreted (like MATLAB) it is easily modified and run. This tutorial presents an introduction to Python that covers:

- Numbers, variables, basic operations
- Strings, lists, dictionaries, and related Python data structures
- Modules and functions
- Python packages: NumPy, MatPlotLib, SciPy, Pandas
- Reading / writing files

Engineering application of Python presented includes an example of analyzing an aircraft flight maneuver and determining particular data characteristics at certain events.

Real-World Design of Experiments, Modern Screening Design, and Modern Analysis Methods

Instructor: *Tom Donnelly, JMP Systems Engineer, SAS*

Course length 4 hours

<u>Part 1: Custom Design of Experiments (DOE) - Making Your Experimental Design Fit the Problem.</u>

This tutorial will present solutions to real-world Design of Experiment (DOE) problems. Nearly all of the solutions listed below cannot be achieved using classic textbook DOE. If textbook designs are your only resource, then experimenters will often change their problem to fit the available designs. It is highly recommended that experimenters instead make their design fit their real-world problem. This tutorial will show how to treat separately and in-combination, factors of the following types: continuous/quantitative, categorical/qualitative, discrete numeric, mixture, covariate, blocking, and hard-to-change. It will demonstrate how to constrain design regions and disallow certain factor level combinations. It will show how to augment or add onto existing experiments. By using both augmentation and constraints it will show how to repair a broken design. It will show how to design for special knowledge of the model. Algorithmic custom DOE is the most efficient way to develop accurate and useful models of real-world processes.

<u>Part 2: Using Definitive Screening Designs to Get More Information from Fewer Trials</u>

This tutorial is for testers interested in learning to use the new Definitive Screening Design (DSD) method of Design of Experiments. DSDs not only efficiently identify important factors but can

often support second-order predictive models. For the same number of factors three-level DSDs are often smaller than popularly used 2-level fractional-factorial (FF) designs yet yield more information especially about curvature for each factor. DSDs when first published in 2011 worked only with continuous factors. Subsequent publications in 2013 and 2015 added support for categorical factors with two levels and blocking factors. When the number of significant factors is small, a DSD can collapse into a 'one-shot' design capable of supporting a response-surface model with which to make accurate predictions. A case study will be shown in which a 10-factor process is optimized in just 24 trials. Checkpoint trials at the predicted optimum show the process yield increased substantially. In cases where too many factors are significant and the design can't collapse into a one-shot design, existing trials can economically be augmented to support a response-surface model in the important factors. Comparisons between augmented DSDs and augmented FF designs will show DSDs yield more information in fewer trials.

Part 3: Strategies for Analyzing Modern Screening Design of Experiments

The new Definitive Screening Designs (DSD) provide clean estimates of all main effects and squared effects for the design factors. This leads to saturated or nearly saturated models and the potential to falsely identify lower power squared terms as important. Effective strategies for analyzing these designs are reviewed to build a consensus model from the data. Plus, a newly developed (2015) method for robustly determining the most likely model will be featured. In this tutorial we examine several strategies for analyzing DOE data sets. We start with graphical exploration of the data using interactive distributions and scatterplots. With an idea of what factors are visually dominant we move on to conservative modeling approaches such as looking at first order effects before moving on to second order effects -including interactions - guided by "effect heredity" and "effect sparsity" principles. Finally aggressive strategies are used which include stepwise regression using several different stopping criteria to prevent over fitting and even fitting "All Possible Models." Actual vs. Prediction plots with checkpoints can be used to help choose models. The use of transformations to help make the data better match the assumption that they are normally distributed will also be demonstrated.

Measurement Quality Assurance Fundamentals (*Measurement Uncertainty, Measurement Decision Risk, and Calibration Intervals)*

Instructor: *Dr. Howard Castrup, Integrated Sciences Group*

Course Length 4 Hours

This tutorial provides an overview of the concepts and methods of the principal disciplines of analytical metrology: measurement uncertainty analysis, measurement decision risk analysis, and calibration interval analysis.

The topic of Measurement Uncertainty Analysis will cover the principal methodology of the ISO *Guide to the Expression of Uncertainty in Measurement* (the GUM), and will include methods that have been developed since the publication of the GUM, predominantly those documented in NCSLI Recommended Practice RP-12, *Determining and Reporting Measurement Uncertainty*.

The topic Measurement Decision Risk Analysis will consist primarily of a synopsis of the methodology documented in NCSLI Recommended Practice RP-18, *Estimation and Evaluation of Measurement Decision Risk* and other publications, with special mention of ANSI/NCSL Z540.3.

The topic Calibration Interval Analysis will provide an overview of the methodology of NCSLI Recommended Practice RP-1, *Establishment and Adjustment of Calibration Intervals* and NASA Reference Publication 1342, *Metrology — Calibration and Measurement Processes Guidelines*, for developing intervals of calibration for measuring and test equipment using attributes (pass/fail) data. Additional material will be presented on establishing intervals using variables data.