HELP US KICK OFF THE 50TH YEAR OF NCSLI.
We will be conducting a “50 year challenge” competition in 2011 to identify the top resources for making the case for metrology. Submissions may be in any media and must be suitable for public presentation. Three finalists will have an opportunity to present their “Case for Metrology” during our 2011 Workshop & Symposium.

THE GOAL OF THE AWARD
The goal of the award is to gather real-life examples that support the positive value of metrology and calibration practices.

DEADLINE
FEBRUARY 1, 2011

CASH PRIZES
First prize: $3,000
Second prize: $2,000
Third prize: $1,000

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The summer conference will soon be here. I’m looking forward to Providence and the chance to get back to the Northeast. The Board visited Providence in gorgeous weather in the fall of 2007 and a visit to Newport and Cape Cod on the weekend gave me a glimpse of the area. The touring part deserves some consideration, but here I hope to offer what I can about getting value from participation in NCSLI, its local meetings, and its committee meetings.

Getting more from resources beyond where you work to support your measurement science should lead to NCSLI. Speaking at a local meeting and presenting your aspect of metrology will help to get you hooked into NCSLI. National speakers and industry wide concerns are a part of the agenda, but the audience is looking for impact on subjects close to home as well.

Coordinating region meetings seemed a lonely task and fitting in at committee meetings seemed to expose one’s limited understanding of the subject matter. In fact both of these perspectives were true for me, but in the end not a problem. It isn’t trivial to network within a profession. It turns out metrology is unique in that its omnipresence offers more chances to share than other subjects in industry.

Learning to run a local NCSLI meeting, engaging the surprising variety of players and producing a successful agenda is well supported after a bit of investigation. This is mostly a task of enthusiasm and details. The details, although covered in the administrative guide, require some study. The enthusiasm flows from the people in the profession. Although my company seemed to have invented the shear weight of documentation, part and parcel to quality, the meaning of quality in industry is shared in the whole supply chain.

The individual able and willing to participate in NCSLI meetings finds great depth in the participants. The understanding of the metrology is right on the surface of these meetings, the hidden corners of the task don’t hide at NCSLI meetings. That being said the coordinator role picks a location and key speakers to shape a meeting using the local enthusiasm.

Getting the most out of NCSLI technical committees is about knowing what your company needs and recognizing where industry practices will help. NCSLI recommended practices lend themselves to be implemented at many levels. Understanding how your scale of operation can benefit is another challenge. Most of the benefits scale quite well. Not everyone can step forward, but when you’re involved you realize that the Navy, the NMI’s, the small calibration houses, big industry, and the equipment makers are all being heard and working together at NCSLI. Consumer risk and uncertainty, resolution and repeatability, that is to say the edges of training in our subject, are working around in the language of our standards. These have meaning to the contract, the sale and the overhead to the calibration procedure. By joining a committee or standards writing group you stay close to the words that impact your company. One significant value that we all have access to in NCSLI is the development of national and international standards that shape our industry. Once again, not everyone can step forward, but this activity is still very accessible. The Z540 Committee requires you to identify your experience and be then voted in, but this formality is in place to enable showing the balance of the committee.

Each summer the immediate past-president sets an agenda for the coordinators and committee chairs to meet at the annual Workshop & Symposium. The task is to bring forward the lessons and solutions that help us all at NCSLI. It offers a look at our leadership skills and the tools we are using for success in our meetings. If you are directly invited to this meeting (the meeting is otherwise open) it shows you have arrived in the world of NCSLI. The coordinators and committee chairs are serving the world of measurement as provided for in the workings of our remarkable organization.

See you in Providence.
The beautiful environs of Steinbeck’s “Cannery Row” created a backdrop for 27 attendees to the January 2010 NCSLI Board meeting in Monterey, California.

Many came early to visit the world renowned Monterey Bay Aquarium. The aquarium was founded in 1984 by Dave Packard as a retirement activity. He was the co-founder of Hewlett Packard and for years supplied the metrology world with leading edge test equipment.

Outgoing President Malcolm Smith passed the gavel to Derek Porter of Boeing, Seattle.

As always with the start of a new year, there are changes to the Board membership. New to the Board are Karen Semer with the US Air Force Metrology Program, Jim “Smitty” Smith from Boeing, and Jack Somppi from Fluke. Retiring from the Board are (myself) Dave Abell, Dave Agy and Carol Hockert. Roger Burton of Honeywell FM&IT assumes the job of Treasurer, Richard Ogg of Agilent takes the position of Secretary, Karen Semer, Jack Somppi and Jim Smith assume VP Division roles.

Our International visitors in Monterey included Andrew Wallard (BIPM Paris), Andy Henson (NPL/EURAMET United Kingdom) and Alan Steele (NRC-INMS Canada.) Andrew Wallard will be retiring from the BIPM this year turning the leadership over to Michael Kühne from PTB. This was Andrew’s last January meeting with NCSLI. He has hired Andy Henson from NPL to join the BIPM in March as the International Liaison Officer.

Belinda Collins from NIST reported that they have benefited from the U.S. stimulus funds. The American Recovery and Reinvestment Act provided NIST with about $550M to be spent by the end of fiscal year 2010. In addition to money received for construction and equipment, they have been awarding external grants. NIST recently gave out over $34M for research in measurement science, and announced grants totaling more than $123 million to 11 universities and a non profit research organization to provide cost-shared support for the construction of new scientific research facilities.

The Board made a historic change in the way it is managed and voted to extend the term of the President from one to two years. It has been one year since the founding of NCSLI in 1961.

This change takes effect in 2012. The motivation is that a single year is typically not long enough for a President to accomplish all of the programs they have envisioned. Several other non-profit organizations that were reviewed have presidential terms longer than a year.

Another new idea that was adopted by the Board is to experiment with a two day technical conference in late January. This would be offset from the annual Workshop & Symposium by six months and scheduled so as not to conflict with the Measurement Science Conference (MSC). The technical conference will be held on the east coast of the United States to service the large concentration of NCSLI members there, and provide a convenient venue for visitors from Europe.

The Conference Committee was asked to present a detailed proposal to the Board in July 2010. The first technical conference could be as soon as 2012. As one attendee summarized the idea, it’s like a “section meeting on steroids.”

As like most organizations, NCSLI is struggling to keep expenses down. Each member of the Board has a budget to follow and the budget for this year has been very conservative under President Porter’s direction. However, the Board agreed to allow the spending of some travel funds to support NCSLI’s activity in International affairs under the direction of VP Roxanne Robinson of A2LA. Although attendance was lower than usual during the 2009 San Antonio Conference, the team came in almost exactly on budget with tight expense controls. Similar conservative planning is ongoing for the upcoming Conference in Providence, RI.

Last, a personal note. After eighteen years with NCSLI and seven as your secretary, I will be finally retiring. I typed over 1000 pages total for 28 Board meetings in those seven years! I’m pleased that Richard Ogg of Agilent Technologies, my old company, has volunteered to assume the role. I’ll now turn my spare time to my favorite hobbies of ham radio (K6XG) and any music written before 1750. Wishing the best to all of you!

The Board always welcomes visitors at these meetings and the next one is scheduled for April 25 – 28, 2010 at the NCSLI Boulder, Colorado Business office.
Hexagon Metrology, Inc.

Hexagon Metrology is part of the Hexagon AB Group and includes leading metrology brands such as Brown & Sharpe, CimCore, CogniTens, DEA, Leica Geosystems (Metrology Division), Leitz, m&h, PC-DMIS, QUINDOS, ROMER, Sheffield and TESA. Hexagon Metrology brands represent an unrivaled global installed base of millions of CMMs, portable measuring systems and handheld instruments, and tens of thousands of metrology software licenses. Hexagon Metrology empowers its customers to fully control manufacturing processes that rely on dimensional precision, ensuring that products manufactured precisely conform to the original product design. The company offering of machines, systems and software is complemented by a wide range of product support, aftermarket and value-added services. More information can be found at HexagonMetrology.us.

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Email: wim.weekers@hexagonmetrology.com

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Email: keith.balasuriya@roche.com

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Email: mike.berry@patheon.com

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Email: chris@foxvalleymetrology.com

CONTACT NCSLI INTERNATIONAL AT 303.440.3339, OR VISIT US ONLINE AT WWW.NCSLI.ORG
Region/Section Meetings

April 29-30, 2010
1135 Michigan Section
Training Event
15000 Haggerty Road
Plymouth, MI 49170 United States
Contact: NCSLI Business Office
Phone: 303-440-3339
Email: info@ncsli.org
More Information

May 6, 2010
1132 Southern Ohio/Kentucky Section
The Place off the Square
50 North Second Street
Newark, Ohio 43055
Phone: 740-322-6455
Email: matthew.denslow@afmetcal.af.mil

May 13, 2010
1430 Northwestern Spring Meeting
Museum of Flight
Seattle, WA United States
Contact: Anthony Reed
Phone: 206-544-7976
Email: anthony.p.reed@boeing.com

Board of Directors Meetings

April 25-28, 2010
Boulder, Colorado
Homewood Suites
Hotel: 303-499-9922

July 25, 30-31, 2010
Providence Rhode Island
Westin Providence RI
Hotel: 800-627-7154

October 17-20, 2010
Stevenson Washington
Skamania Lodge
Hotel: 800-221-7117

International Events

April 19-23, 2010
CAFMET 20
International Metrology Conference
Contact: CAFMET Secretariat
http://www.ac-metrology.com
cafm2010@ac-metrology.com

June 13-18, 2010
CPEM 2010
Conference on Precision Electromagnetic Instruments
Contact: CPEM Secretariat
Tel: +82-42-472-7464
Email: secretariat@cpem2010.org

October 13-15, 2010
FLOMEKO 2010
Taipei, Taiwan
Contact: Dr. Jiunn-Haur Shaw
Jiunn-HaurShaw@itri.org.tw
Ms. Hui-Chung Ma
hcma@itri.org.tw
www.flomeko2010.itri.org.tw

Workshop & Symposium

July 25-29, 2010
NCSLI Workshop & Symposium
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www.ncsli.org

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Has been approved for United Way of Southeastern Pennsylvania’s Donor Choice Program, effective with the Fall 2009 Campaign.

The identification number is Code #48564.
The code will continue from year to year.

This is only for United Way of SE Pennsylvania. Remember our CFC code is 26683.

April 2010 : Metrologist 5
REAR ADMIRAL DAVID H. LEWIS, USN

Rear Admiral David H. Lewis is the Vice-Commander of the Naval Sea Systems Command (NAVSEA) located in the Washington Navy Yard in the District of Columbia. NAVSEA is the largest of the Navy’s five system commands and accounts for nearly one quarter of the Navy’s entire budget. With a workforce of 53,000 civilian, military and contract support personnel, NAVSEA engineers, builds, buys and maintains the Navy’s ships and submarines, their associated combat systems and their required support equipment. NAVSEA manages about 150 large acquisition programs and also manages foreign military sales cases that include billions of dollars in annual military sales to partner nations. The NAVSEA organization has 33 activities in 16 states. NAVSEA strives to be an efficient provider of defense resources for the nation and plays an important role in the Navy Enterprise. As a Provider Command, NAVSEA has the responsibility of directing the proper mix of manpower and resources to properly equip the Fleet to meet the demands of today and the future. This includes the need to keep metrology and calibration support advancing at a sufficient pace to support the critical and changing needs of the Navy. NAVSEA has the further responsibility of establishing, maintaining and enforcing technical authority in system design and operation for combat systems as well as for ships and submarines and support disciplines. This includes the technical authority for the Navy’s Metrology and Calibration Program. These technical standards use the organizations expertise to ensure that systems are engineered effectively, and that they operate safely and reliably. Rear Admiral Lewis will address the 21st Century Navy, and the realities and challenges faced at the start of the second decade of this century.
REGISTRATION RATES

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TUTORIAL RATES

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Workshop & Symposium Registration INCLUDES: Exhibitors Reception, Entrance into the Paper Sessions; Entrance into the Exhibit Hall; Lunches (Monday–Thursday); One Banquet Ticket; Workshop materials, including the Proceedings (CD-ROM only).

Workshop & Symposium Registration DOES NOT INCLUDE: The International Event; NCSLI Tutorials (see Tutorial Registration Form for fees); Guest Program Tours (see Guest Registration Form for fees); Hotel Registration, Airfare, Rental Car.

Exhibitors and Speakers Registrations include Workshop & Symposium privileges as noted above.

Exhibit Only registrations (booth workers) DO NOT include any Workshop & Symposium privileges except entrance to the Exhibit Hall and Exhibitor’s Reception. Tickets for lunches and Banquet may be purchased separately, if desired (Banquet: $85 per person; lunches: $35 each luncheon per person).

GUESTS

All Attendees and Guests who are attending any NCSLI International function must be registered, even if they are only participating in the Sunday evening reception. Badges are required.
Friday, July 23 | 8:00AM – 5:00PM

**Train the Trainer TT 1 - How to Design Effective Training Programs**
Jovie Masters

By the end of the workshop, the participant will be able to: Use a systematic method to easily design a training program. Design a training program to meet the learners’ needs. Use adult learning techniques to improve retention and reduce participant resistance. Write realistic training objectives that meet three conditions. Select the best learning experience to train learners. Pace methods to maintain high energy and active learning by the participants. Identify how much practice is needed to build a new skill. Develop effective training activities to instruct and assess learning.

Saturday, July 24 | 8:00AM – 5:00PM

**T1 - Running an Effective Laboratory - Measuring Performance**
Dr. Malcolm Smith, Jesse Morse

This “How To” tutorial will be of interest to owners, managers, and supervisors of calibration laboratories, both in-house and commercial. The tutorial will cover five areas where performance measurement is important in the running of a laboratory: (1) productivity, (2) quality, (3) finance, (4) service levels, and (5) customer satisfaction. The range of measures and associated tools that can be used to establish goals and monitor performance in each of these areas will be explained and discussed. Suggestions on how these tools might be used in practice will be reviewed. Examples of measurements needed for effective process improvement projects will also be given.

Tutorials:

**T3 - My Measurements are Traceable - Right? Demonstrating the Chain of Traceability**
Dana Leaman

This half-day tutorial examines the requirements to demonstrate the traceability chain for our measurement and test equipment. Topics will include the concept of traceability from several levels, including the International Bureau of Weights and Measures (BIPM), National Metrology Institutes, and Accreditation Bodies. Within those discussions, we will cover the Key Comparisons Data Base (Kcdb), accreditation and the associated scopes, how to demonstrate your traceability and the misconceptions associated with traceability. At the end of discussions, the participant will be able to use the concepts covered regarding traceability and apply them to the measurements made in their laboratories to determine their traceability chains.

**T4 - Oscilloscope Calibration Uncertainties**
Randy Van Wie, Ken Futronick

This half-day tutorial presents techniques for analyzing and expressing uncertainties in calibration (verification of calibration) of oscilloscopes. Measurement methods and associated uncertainties for the commonly measured oscilloscope characteristics (gain, timing and bandwidth) will be described. A variety of real-time oscilloscope types will be discussed, including analog and digital, 50 ohm and 1 megohm input, and ranging from low-cost to state-of-the-art. Expanded uncertainty will be developed according to ISO “GUM” (Guide to the Expression of Uncertainty in Measurement) guidelines.

**T5 - Measurement Uncertainty Made Easy**
Georgette Macdonald, Alan Steele

Why is it important to express the uncertainty in measurement? Quite simply, there is no traceability in measurements that lack statements of uncertainty at every link of the traceability chain. For this and other reasons, ISO/IEC 17025 requires calibration laboratories, in particular, to provide estimates of uncertainty of their measurements using accepted practices. The instructor will discuss the basics for preparing uncertainty estimates for typical uncomplicated measurement processes. This approach is consistent with the GUM but it dispenses, wherever possible, with the algebraic notations, statistical jargon, arithmetic modeling, and differential calculus operations found in the GUM that perhaps encumber a person who requires no more than a simple, conservative estimate of the uncertainty in the result of a simple measurement process. For these situations, it will be shown that the mathematics is quite straightforward and that the actual challenge, if any, to estimating uncertainty in measurement is in defining the factors that affect the measurement; namely, in understanding the metrology. Participants will receive an example Excel spreadsheet for making simplified uncertainty calculations. The tutorial will include a group exercise. Participants should bring stationary and a pocket calculator.

Saturday, July 24 | 1:00PM – 5:00PM

**T6 - CMMs in the Calibration Lab**
Jim Salsbury, Amosh Kumar

For the past 50 years, the use of coordinate measuring machines (CMMs) has continued to grow into new areas, and now we are seeing more and more CMMs being used in dimensional calibration labs. The original use of the CMM was for measuring large production workpieces where the CMM offered major savings in measurement time, ease of use, and flexibility. As CMMs have continued to get more and more accurate, we are seeing many CMMs being used for calibration purposes, not only for calibrating master workpieces and special gages, but also for the calibration of length gages, cylindrical masters, squares, and a variety of other traditional dimensional gages that have historically been checked using alternative methods. The purpose of this tutorial is to examine the use of the CMM in the calibration lab. The differences between CMM measurement methods and traditional methods will be discussed. The tutorial will cover using CMMs to measure manufactured workpieces, the inspection of special fixture gages, and the calibration of a variety of dimensional gages. The tutorial will also include a wide breadth of accuracy – ranging from part inspection on manual CMMs with uncertainty around 0.01” (0.25 mm) to high accuracy CMMs being used to measure length standards with an uncertainty under 10 millionths of an inch (0.25 micrometers). This tutorial will focus on techniques, understanding sources of errors, traceability, and the uncertainty of CMM measurements.

**T7 - Meeting ISO 17025 Accreditation Requirements through Properly Constructed Proficiency Tests**
Jeff Gust

In order to meet accreditation bodies requirements for laboratory accreditation, it is necessary for laboratories to participate in proficiency tests. A properly developed proficiency test provides objective evidence of laboratory competency. Whether internally developed or provided by a commercial proficiency test provider, most proficiency testing activities have been developed using the guidance of ISO 17025, Proficiency Testing by Interlaboratory Comparison. The Information Organization for Standardization (ISO) Committee on Conformance Assessment (CASCO) has improved ISO Guide 43-1 and 43-2 and elevated its status to a 17000 series standard. The new standard provides much more prescriptive requirements for the provision of proficiency tests and stands equivalent to other standards such as ISO 17025 and ISO 17020. This tutorial will cover: The historical development of ISO 17043, a detailed discussion of all the paragraphs of ISO 17043, examples of applications of ISO 17043.
T8 - Monte Carlo - Uncertainty Made Easy
Alan Steele, Rob Douglas, and Georgette Macdonald

A new era is dawning in uncertainty analysis. A new tool is emerging to bypass many of its difficulties that have troubled practical metrologists. The new tool can harness experience from the laboratory to help analyze the uncertainty of any practical measurement equation. Starting from the uncertainties claimed for input quantities (which can still be tough to evaluate), Monte Carlo simulation can simplify the rest.

The new Supplement-1 to the ISO-GUM gives formal recognition to building, exploring, and validating metrological uncertainty budgets using Monte Carlo methods. In this tutorial, you will use Monte Carlo simulation for uncertainty analysis, using Excel macros for this purpose. You will get an open-source Excel Toolkit that converts difficult uncertainty analysis into an easy Monte Carlo exercise that will feel much like doing a real experiment. You will learn the fundamentals of Monte Carlo uncertainty analysis, and how to enter your own measurement equation (or equations) into the Toolkit, using Excel’s version of Visual Basic. Some familiarity with uncertainty analysis, MS Excel and BASIC is essential to getting the most from this course, but students from all backgrounds and with all levels of experience are welcome and encouraged to attend. Attendees should bring their own laptop with Excel installed, including full permissions to access Excel’s Visual Basic programming environment. Excel from Office 2007 has a new user interface, and is not recommended for this Tutorial, since our demonstrations will be using earlier versions of Excel (all other versions, from Excel 97 on, are OK).

T9 - Fundamentals of Gas Flow Measurement
Robert B. DeRemer

The main thrust of the Fundamentals of Gas Flow Measurement tutorial will be the comparison of volumetric flow meters and mass flow meters used in gas flow measurement applications. Specific topics that will be covered will include principles of operation of various types of flow meters, factors that influence when to choose a mass flow meter or a volumetric flow meter, how to interpret performance specifications, how the various types of meters are calibrated, and an example of measurement uncertainty.

Sunday, July 25 | 8:00AM – 5:00PM

T10 - Collecting Objective Evidence: The Internal Audit Process in Preparation for the On-site Assessment
Barbara Belzer, Thomas Hettenhouser

This tutorial will be of interest to managers and staff of laboratories with new or mature quality systems. It will cover what constitutes objective evidence by stepping through the internal audit process, including skills that an auditor needs to have to be effective. The tutorial will emphasize the importance of records for all aspects of the management system including reference documents, method validation and their interdependency with metrological traceability and reporting results. Using the described internal audit process prior to an on-site assessment companies new to the accreditation process as well those with mature quality systems will be able to prepare better for an upcoming on-site assessment.

T11 - Statistical Analysis of Metrology Data for Laboratory Managers and Technicians
Dilip A. Shah

This full-day tutorial covers metrology data generation and statistical analysis techniques for laboratories that are either ISO 17025 accredited, are in the process of getting their ISO 17025 accreditation or for those laboratories that just want to apply sound data analysis techniques.

Learning objectives for this full day workshop include:
• Introduce metrology definitions per ISO Guide 99:2007 (VIM) for consistent application (conversing using metrology vocabulary for consistency).
• Develop methods and techniques for data generation.
• Introduce and apply basic statistics.
• Analyze data by appropriate statistical methods.
• Introduce Statistical Process Control (SPC) techniques and its application in calibration inter-laboratory analyses, trend analysis.
• Applying data for Measurement Uncertainty, Proficiency Testing and other ISO 17025 requirements (Clauses 5.3.2, 5.4.6, 5.5.2, 5.5.9, 5.5.10, 5.6.3.3, 5.7, 5.9).

The workshop is targeted for laboratory managers and technicians who are involved in test and calibration activities. Practical examples are demonstrated using a Microsoft Excel® spreadsheet. Participants are provided a copy of the spreadsheet template for their own use. Attendees may bring a laptop computer with Microsoft Excel® spreadsheet pre-loaded on it to the workshop. However, it is not a requirement. Attendees should plan on bringing a scientific calculator for hands-on problem solving exercises for comprehension.

Upon completion of the workshop, attendees shall be able to:
• Apply some of Microsoft Excel® spreadsheet’s functions and data analysis capabilities.
• Generate and analyze metrology data correctly for compliance and decision making.
• Analyse statistical techniques in data analysis.
• Apply their generated data for complying with ISO 17025 or other Quality Management Systems’ metrology requirements (measurement uncertainty, preventive actions, continuous improvement and other applications).

T12 - Strategic Planning – Preparing for the Unknown Future – Both Good and Bad
Carroll Brickenkamp, Sharrill Dittmann, Ernest Garner

This full-day tutorial will focus on scenario planning and implementation for the high technology business of metrology. Metrology, the science of measurements, is frequently perceived, valued, and characterized by metrologists as an end unto itself. This traditional and narrow view can become a barrier to the business side of metrology, impacting the productivity, profitability and competitiveness of users and clients of metrology organizations as well as the metrology as a whole. Eschewing the end product, instead, in these times of a tough economic climate, the process of planning and acting for the future will substantially improve the likelihood of having one.

The first part of the tutorial will explore the impact of rapidly changing technology on today’s metrology organization, present the basic principles of scenario planning as a tool that will help keep it competitive in the future and review a well-documented success in scenario planning and action. Using an interactive format, the second phase of the tutorial will look specifically at the application of scenario planning to metrology organizations (as designed by the attendees) using parameters selected by the participants. Applications to the participants’ own organizations will be explored.

Sunday, July 25 | 8:00AM – 12:00PM

T13 – Fundamentals of Temperature Calibration
Thomas Wandt

This presentation is a review of the fundamentals of temperature calibration. Topics include calibration equipment, calibration techniques, curve fitting issues, and the mathematics important to thermometry. Types of thermometers covered include platinum resistance thermometers, thermistors, thermocouples, and combined thermometer/readout systems. This segment is intended for those who are new to temperature calibration, those who need to validate what they already know, or those who just have some nagging questions that need to be answered.

T14 - Introduction to NCSLI - RP-5-2010
Suzanne Castrup

This half-day tutorial provides an overview of NCSLI RP-5-2010 Measuring and Test Equipment Specifications. Attendees will be introduced to material regarding MTE specification documents, their interpretation and application. Methods used to establish MTE performance characteristics and develop specification tolerance limits are discussed and recommended practices for reporting MTE specifications are presented. Examples of how MTE specifications are used to estimate parameter uncertainties, compute test tolerance limits, determine in-tolerance probability and establish calibration intervals are provided.

This tutorial is primarily intended for technical personnel responsible for the development, manufacture, selection, application and support of MTE. However, this tutorial may also be useful for project managers, scientists and engineers that rely on measurement data for their analysis, evaluation and decision making processes.

T15 - Force Calibration: Methods and Uncertainties
Michael Tovey

Force calibration is a special discipline with many considerations not common to other areas of metrology. Often measurement uncertainties are underestimated due to the omission of significant error sources. Metrologists must consider both mechanical and electrical boundary conditions to achieve calibrations with low measurement uncertainties. Factors such as second order material responses, and interaction of undesired parasitic loading due to fixture characteristics, misalignment of load frame components, stiffness, etc. can have significant influence on the measurement result. This tutorial will cover the characteristics of force transducers, force calibration methods, force cali-
buration standards (E74 and ISO 376) and measurement uncertainty models for primary standards, secondary standards and field transfer standards. The tutorial begins at a basic level and leads to discussion of more complex issues.

**T16 - Metrology Management Software Implementation**
Walter Nowocin

This half day two-part tutorial will describe the key factors to consider in selecting and implementing a calibration management software solution for your laboratory, especially in a regulated environment. Part 1: SELECTING A CALIBRATION MANAGEMENT SOFTWARE SOLUTION The following topics will be discussed: Selection Process Overview, Identifying Key Business Representatives, Developing Business Requirements, Identifying Vendors, Sending Business Requirements to Vendors, Converting Requirements to Scoring Matrix, Selecting Vendors for Demonstration Phase, Evaluating Vendor Demonstration Software, Client Surveys, Vendor Financial Health, and Selecting a Vendor of Choice. Part 2: IMPLEMENTING A CALIBRATION MANAGEMENT SOFTWARE SOLUTION The following topics will be discussed: Implementation Process Overview, System Development and Validation Life Cycle, Data Conversion, Test Scripts, Training, and Project Planning.

**Sunday, July 25 | 1:00PM – 5:00PM**

**T17 - Microwave Network Analysis and Power Calibrations**
Bart Schrijver

This tutorial will focus on an introduction to microwave measurement concepts and specifically on network analysis and RF power measurement. The measurement architecture of both types of measurements will be shown and described in detail. In addition topics like signal flow diagrams, S-parameters, network analyzer calibration, calibration techniques, uncertainty analysis and traceability for both network analysis and power measurements will be reviewed.

**T18 - Estimating and Evaluating Measurement Decision Risk**
Howard Castrup, Ph.D.

Clause 5.3 of ANSI/NCSL Z540.3, “Requirements for the Calibration of Measuring and Test Equipment,” contains a requirement that limits the risk of incorrectly accepting out-of-tolerance equipment parameters to a maximum of 2%. Where the estimation of this risk is not feasible, the test uncertainty ratio (TUR) is required to be 4:1 or greater. This tutorial presents a synopsis of NCSL RP-18, Estimating and Evaluating Measurement Decision Risk, which provides methods for computing this “false accept” risk and also gives guidelines for managing in-tolerance compliance decisions. The latter includes methods for developing test guardbands that correspond to specified risk levels. Also discussed are other “measurement quality metrics,” such as false reject risk, and alternative means of computing risk, such as Bayesian analysis and the development of in-tolerance confidence levels. Also included are discussions of the impact of measurement reliability and measurement uncertainty on false accept risk and on computing and interpreting the fallback 4:1 TUR. This tutorial is intended for individuals with a need to develop and apply tools for the control of measurement decision risk, with special emphasis on compliance with Z540.3. Although some college level math will be employed, related concepts will be fleshed out to ensure comprehension by attendees with moderate mathematical training.

**GIDEP**
GRAS Sound & Vibration
Guideline Instruments
Hart Scientific
Heusser Newreign
ICL Calibration Laboratories
ID Label Inc.
IEEE E&M Society
IET Labs
INSCO Metrology
Instrulab
Inter-American Metrology System (SIM) Interface
Iotech North America
J M Test Systems
Kaymont Consolidated
King Nutronics Corporation
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National Research Council of Canada
National Scientific Centre “Institute of Metrology” NAVAIR North Island
Navy Inventory Control Point (NAVICP)
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Cole Parmer Instrument Co.
Colorado Engineering Experiment Station Inc. (CEESI)
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Davis Calibration
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April 2010 : Metrologist 11
World Metrology Day
May 20, 2010
What does World Metrology Day mean to you?

Metrology
Measurements in Science and Technology

Here’s what our members had to say…

When I launched WMD way back in 2005, I had no idea what it could have lead to. Usually such “messages from your leader” are rapidly consigned to the filing system on the floor but the encouragement I received from many of you to develop additional material, and the evident enthusiasm of individual metrologists and bodies like the NCSL, led us to add more and more. The subjects also were exciting and enabled us to work on metrology matters of interest to the general public – the 2008 WMD during the Olympics and its theme of measurement in sport was perhaps my favorite. So, for me, WMD is all about communication of a subject which we find fascinating to those who we need to impress or who we’d like to make more aware of our successes and our contribution…..and to do it as succinctly, clearly and convincingly as possible. I think we do it pretty well now and I hope the messages are getting through, and that you have fun in whatever events you wrap around 20 May. By the way, why 20 May? Simply, it was the day the Metre Convention was signed in Paris in 1875 and which laid the basis for national and international metrology – see the message on www.bipm.org/en/convention/wmd/2006/.

Have a Great Day!!

Prof. Andrew Wallard, Director of the International Bureau of Weights and Measures, Cedex France
EURAMET and many of its members are disseminating the poster prepared by the BIPM, e.g. via their websites. Generally, the NMIs in many European countries make use of the WMD to organize the “International Metrology Symposium” or other events for dissemination and awareness raising.

Wolfgang Schmid, Secretary of EURAMET

The World Metrology Day is a great opportunity for metrologists to enlighten their knowledge on the topic of metrology. NMIJ annually holds “International Metrology Symposium” along with the World Metrology Day. This year, the 10th International Metrology Symposium will be held on May 26th in Tokyo, and the theme is “Metrology—a bridge to innovation.”

Dr. Masahiro Okaji, NMIJ

Metrology Day once again in the year creates the awareness for us in developing countries to transit from non-traceable metrological practices in our trade, commerce and scientific works and join the global community of traceable metrology whereby our goods and service can cross the trade barriers that is inhibiting our penetration into the global market place.

Sunday E. Lijofe, Selfa Nigeria Limited, Lagos Nigeria

For thousands of years, measurements have been a fundamental part of all trade and quality related functions but do we really know what we are measuring? Generally measurements are considered simple but there are in fact many potential sources of errors, in every discipline. If we start off by assuming that there are errors and are prepared to look for the influencing factors, we are a long way towards getting the right answer and have some feeling for the associated uncertainty of measurement.

John Wilson, Accreditation & Metrology Services (Pty) Ltd., South Africa

This year’s theme for World Metrology Day resonates very strongly with what we believe here at the National Research Council’s Institute for National Measurement Standards: metrology is the bridge that moves us from the world of science to the world of technology. For example, the INMS strategy to help develop metrology at the nanoscale has made this vision real: we have engaged institutes from NRC’s Physical Sciences, Life Sciences, and Engineering portfolios to build a network of measurement expertise and instrumentation that goes far beyond what our Institute could offer alone. This approach transcends the classical view of metrology as a means of verification and calibration, and we are taking up exciting challenges of method development, data interpretation, and documentary standards setting in this new applications area. As Canada’s mandated National Measurement Institute, NRC is working to ensure that technology and innovation keep pace with cutting edge scientific research at the nanoscale. In this very real and immediate sense, metrology is our bridge to the future.

Dr. Alan Steele, NRC Canada

Since metrology clearly affects all of us, whether we are involved in the lab directly or indirectly, World Metrology Day highlights the fact that for most people this is unfortunately one area where they take it for granted that all is well and will continue forever in this fashion. However, for those of us, like myself who have spent a lifetime in this field of endeavour the reality is quite far from this wonderful and idealistic view presented above. For me, this is a day when we who are in the metrology business, should reflect on how we can ensure that what has been built over the decades will remain. It is clear that we need to find innovative ideas to attract new and enthusiastic entrants into the wonderful world of measurement in general and metrology specifically. World Metrology Day presents itself as ‘the’ day when all our efforts in this regard should come together in one worldwide harmonized event.

Steve Sidney, Director National Laboratory Association, South Africa

The process of measurement is of considerable importance in every field of human activity. To be meaningful, however, measurements must be underpinned by metrology, that is, the science of measurement. Worldwide, the total input to metrology is itself huge and is shared by the government and industry sectors of national economies. We recognize non-uniformity in measurement, testing and product certification as one of the major technical barriers to trade especially in developing countries like Antigua and Barbuda. Trade agreements now specifically require all signatories to recognize the results of measurement and tests performed by the trading parties. This policy is supported by WTO and will have major implications on national measurement system. Governments have over the years enacted a considerable number of laws and regulations that require reliable measurement systems for effective implementation.

Legal Metrology originated from the need to ensure fair trade and provide consumer protection and is still mainly focused in these areas. Developments worldwide, however, have led to the enactment of new laws and regulations, and most important to a broadening of legal metrology to protect society in areas such as health, safety, commerce, agriculture and the environment. Metrology is of critical importance for economic growth, international trade and the quality of life for the world’s citizens. Metrology is becoming ever more important as the sustainability of our domestic industries is threatened. Additionally, the fall in tariff barriers has been accompanied by a raise in non-tariff barriers. To overcome these barriers, the measurement used to characterize products and support conformity assessment must be globally recognized. Accurate, precise and reliable measurements apart from enabling globalization and boosting economic growth also enhance the quality of life for our citizens. In conclusion the usefulness, importance and need for continuous development of Antigua and Barbuda’s capacity for a sound metrology framework cannot be emphasized enough. This discipline of metrology is indeed invaluable to our effective and sustainable participation in global trade and commerce of goods and services. Metrology is not an expense, it is a good investment.

Dianne Lalla-Rodriguez, SIM Representative, Antigua W.I
A National Security Asset

Taking a design, breathing life into it and turning science into reality is what Honeywell Federal Manufacturing & Technologies (FM&T) is all about.

by Roger Burton, P. E., Principal Mechanical Engineer, Honeywell FM&T
Tanya Snyder, Sr. Public Relations Specialist, Honeywell FM&T

For more than 60 years, Honeywell FM&T has managed and operated the National Nuclear Security Administration’s Kansas City Plant (KCP) fulfilling its national security mission.

A multi-disciplinary engineering and manufacturing organization, KCP is one of the nation’s most diverse low-volume, high-reliability production facilities serving the Department of Energy, Homeland Security, and Department of Defense.

The plant combines complete system integration and product development under one roof. Its unique combination of technologies and secure environments makes the 3-million-square-foot facility a one-of-a-kind factory and prototype center.

Over the past six decades, KCP’s products have become smaller and much more complex to manufacture. The first weapon components relied heavily on aircraft technology and sheet metal construction. Electrical products made extensive use of vacuum tubes, large transformers, and bulky cables.

The Metrology laboratory was started in the late 1950’s to assure the quality and intercompatibility of systems and components.

Today, technologies have changed significantly. Design simulation and 3-D modeling through some of the fastest supercomputers in North America yield higher quality and more cost efficient products. The plant’s mechanical capabilities include precision machining and miniature microsystems that produce gears one-tenth the diameter of a human hair. KCP’s electrical capabilities include hybrid microcircuits and high-energy laser ignition systems.

With each passing decade, the parts built at KCP have become increasingly complex and critical to the safety, security and reliability of our nation’s defense systems. The mission of Metrology is the same now as it was in the beginning – to implement a standards and calibration program to assure accurate and traceable measurements within the plant.

Legacy of Business Excellence

As the NNSA’s top rated contractor, Honeywell FM&T has a long history of providing quality products and services for its customers. Honeywell is driving best commercial practices and successfully achieving productivity through world-class business management systems. This was recently confirmed when Honeywell FM&T was selected to receive the prestigious 2009 Malcolm Baldrige National Quality Award, the nation’s highest honor for innovation and performance excellence.

“Our employees are committed to doing a superb job every day for our customers in quality, delivery, value and technology. Receiving the highest honor for organizational innovation and performance excellence is validation of this work,” said Honeywell Chairman and Chief Executive Officer Dave Cote.

The Baldrige Award, named after the 26th Secretary of Commerce, is given by the President of the United States to organizations that apply and are judged to be outstanding in seven areas: leadership; strategic planning; customer and market focus; measurement, analysis, and knowledge management; workforce focus; process management; and results.

Each applicant goes through a rigorous review, during which examiners conduct an on-site visit of finalists to clarify questions and verify information. Honeywell FM&T was the only recipient in the manufacturing category.

“We are very proud of the work done at the Kansas City Plant with our Honeywell FM&T partners,” said NNSA Administrator Thomas D’Agostino. “This award symbolizes our enterprise-wide commitment to operational efficiency and excellence, none of
which would be possible without the hard work of our employees.”

Honeywell FM&T and the other four recipients of the 2009 Baldrige Award will be honored at a ceremony in Washington, D.C. in early 2010.

The Science of Measurement
At Honeywell FM&T, the Metrology laboratory’s commitment to quality and rigor truly reflects the caliber of a Baldrige Award recipient, and its activities are critical to the success of the organization. The lab provides standards calibration and support in DC and AC Electrical, Microwave, Temperature, Humidity, Pressure, Flow, Vacuum, Shock, Vibration, Light and Optics, Dimensional, Mass, Force, and Torque.

The Metrology lab provides support to three additional calibrating departments, Test Equipment, Tool and Gage Inspection, and Gage Repair and Calibration.

In 2009, the Metrology lab performed about 5,000 calibrations, and the other three calibrating groups performed about 34,000 calibrations.

The Metrology lab has been involved with NCSLI since its inception. Lab managers Bob James and Jim Hadley were involved with the effort to identify the need for NCSLI in the early 1960’s and Honeywell’s predecessor, Bendix, became one of the founding members of NCSLI in 1961. Jim Hadley served on the Board of Directors in the 1960’s and 1970’s and Leon Barnes was a Board member from 1996 through 2001. Roger Burton has been on the Board since 2006 and is currently the NCSLI Treasurer.

Commitments Made, Commitments Kept
KCP has never been a facility with normal or routine challenges. Out of necessity, Honeywell FM&T has become an innovator in continuous improvement, and with every challenge has adapted to consistently provide 99.9 % on-time delivery performance with the highest levels of quality.

Metrology has a long history of developing standards, measuring equipment, and processes to meet customer’s needs. This often requires coming up with new and novel solutions when commercial equipment isn’t available.

Lever Arm Calibrator
As an example, a lever arm calibrator was designed and built to provide the necessary resolution and accuracy for calibrating dial indicators and test indicators. A lever arm calibrator uses a micrometer head in conjunction with a lever to increase the displacement resolution of the anvil.

Commercially available lever arm calibrators utilize a simple 10:1 lever ratio to extend the resolution of the micrometer head by a factor of 10. With a 10:1 lever arm, every 0.0001 inch of micrometer head displacement results in an anvil displacement of 0.00001 inch.

In order to improve the resolution for this type of device, a compound lever arm calibrator was designed and built. Instead of a 10:1 lever ratio, a compound lever mechanism was designed to produce a 100:1 lever ratio. One of the key features of the compound lever arm is the use of small, flexible reeds for the pivots. These allow the needed rotation while reducing the mechanical hysteresis.

Absolute Shock Calibration System
The plant performs a wide variety of shock and vibration product testing using accelerometers. As a result, Metrology calibrates a large number of accelerometers. A common method of accelerometer calibration is accomplished by comparing one accelerometer to another. The uncertainty of this technique is limited by the uncertainty of the accelerometer used as the standard.

In order to reduce the uncertainty for accelerometer calibrations, Metrology designed and built an absolute shock calibration system. The absolute shock calibration system does not rely on a comparison technique, but instead is based on the fundamental definition of acceleration. It works by measuring the time it takes for an anvil to travel through a known distance, calculates the change in velocity, and measures the shock response data obtained from an oscilloscope.
This system is comprised of a shock tower that stands vertically and the accelerometer to be calibrated is mounted to a moveable anvil which is mounted inside an air bearing chuck. The anvil and accelerometer are held up in the air bearing chuck by a vacuum that is adjusted according to the weight of the anvil and accelerometer. The air bearing chuck has two through holes where two lasers are mounted on one side and two detectors mounted on the other side.

To operate the system, the anvil is placed inside the air bearing chuck which breaks the laser beams. The anvil is then impacted on the opposite end from the accelerometer and the anvil passes by the lasers as they both re-energize the detectors which triggers a dual input time interval counter good to ±0.05 %. The shock response data on the scope yields the area under the shock pulse good to ±0.5 %. The ratio of the area to the velocity gives the sensitivity of the accelerometer, good to ±1 % to ±3 % depending on the shock level and duration.

**Network Analyzers**

Coaxial air-dielectric transmission lines are used in the plant for calibrating network analyzers. A critical factor for this calibration is the impedance of the transmission lines. The impedance of the transmission lines can be calculated if the inside diameter of the outer conductor and the outside diameter of the center conductor are known.

Metrology developed an air gaging technique to accurately measure the dimensional characteristics of the transmission lines. The air gages are mastered using calibrated ring gages and plug gages. The center conductor’s outside diameter and the outer conductor’s inside diameter are measured at 1 cm intervals along the transmission line with an uncertainty of ±20 microinches. Once the dimensional characteristics are known, the transmission line impedance can be derived with an uncertainty of ±0.01 Ω to ±0.13 Ω up to a frequency of 50 GHz.

Network analyzers are used to measure the response of devices at RF and microwave frequencies. Measuring the response of a device makes it possible to characterize it and understand how it works within the RF or microwave circuit for which it is intended. Network analyzers are used to make measurements on a wide variety of components such as terminations, attenuators, couplers, splitters, power generating and measuring systems, and antennae for reflection coefficient and attenuation. Network analysis needs accurate measurements for the reflected signal and the transmitted signal.

A self-calibration is performed using the system components to establish the reference. A second calibration is performed at the end of the system cables called TRL for frequencies greater than 50 MHz and TRM for frequencies less than or equal to 50 MHz. An eight term error model and a Monte Carlo process are used to determine the uncertainty of the network analyzer system for measuring reflection coefficient (S11...
Reflection coefficient uncertainties can range from ±0.003 to ±0.01 for magnitude and ±0.5 ° to ±180 ° for phase, depending on the device being measured, the frequency, and the connector type. The attenuation (S12 and S21 parameter) is calibrated using a bootstrap technique which involves measuring a 10 dB standard attenuator and a repeatable step attenuator. Uncertainties can range from ±0.02 dB to ±2 dB for attenuation depending on the device being measured (0 to 110 dB), the frequency, and the connector type.

Laser Heterodyne System

The plant makes frequent use of helium-neon laser interferometers for dimensional measurements. These measurements are based on knowing the vacuum wavelength of the laser. In order to improve the uncertainty for critical dimensional measurements, the lab developed a laser heterodyne system to reduce the uncertainty component due to the laser wavelength.

The laser heterodyne system compares two similar helium-neon lasers and measures the difference between their frequencies. Since the frequency of a typical helium-neon laser is on the order of 0.5 petahertz (PHz), it cannot be measured directly. Using a heterodyne technique, the frequency difference can be on the order of megahertz (MHz), easily measured with a spectrum analyzer. Knowing the frequency of one of the lasers, the frequency of the other laser can easily be calculated. Once the frequency is known, the vacuum wavelength can also be easily calculated using the speed of light in a vacuum constant. The vacuum wavelength is generally given by the manufacturer and is stable to about ±1 ppm. By performing a heterodyne measurement, the measurement uncertainty of the vacuum wavelength can be reduced to ±0.027 ppm, a 37x improvement. By reducing the vacuum wavelength to such a degree, the major source of uncertainty for laser interferometers becomes air temperature and pressure measurements.
Automated Gas Monitor Calibration

Honeywell’s safety department uses gas monitors to detect the presence of poisonous and combustible gases or to detect low oxygen levels. The calibration of gas monitors was a manual process until recently when a new system was brought online to automate the calibration and to increase the availability of the instruments.

The new system provides automated monthly calibration of gas monitors and daily bump testing to ensure that the instruments will perform as needed. The system is configured to provide email notification of low calibration gas pressure, expiration of calibration gas, and marginal or defective gas monitors. Each time a gas monitor is used; the data is logged in the gas monitor and later downloaded into the system to give a complete history of any exposure to toxic gases or depletion of oxygen levels. The system is setup to provide traceability of exposure levels back to the individual who used the gas monitor.

The automated gas monitor calibration system is an example of modernization and improvement efforts that the lab has been involved in. The new system resulted in cost savings, increased reliability, increased equipment availability, and a reduction in the number of gas monitors needed by more than half.

Metrology has maintained NVLAP accreditation since 1997, which provides assurance that the lab is capable and competent for performing calibrations. The lab is currently accredited to ISO 17025 by NVLAP for 30 measurement parameters. The lab’s NVLAP accreditation provided the Baldrige assessors of an example of the plant being assessed by a third party.

Looking to the Future

Honeywell FM&T has embraced the NNSA’s vision to transform the Nuclear Security Enterprise from cold-war vintage infrastructures and capabilities, to a much more cost effective and correctly sized 21st century responsive infrastructure that exemplifies good stewardship of taxpayer resources while maintaining the nuclear deterrent.

At a high level, Honeywell’s “transformation” sums up the effort to adjust to changing business needs and customer expectations.

Specifically, Honeywell is transforming operations by significantly reducing annual operating costs and improving responsiveness. Together these changes are estimated to reduce annual operating costs by $100 million, while providing an infrastructure that is more responsive to potential changes in technologies and schedule demands. The transformation effort encompasses three main elements:

– Strategic sourcing and sizing
– Business process transformation
– New facility
Strategic Sourcing and Sizing

The first element of transformation calls for an increased use of commercially available services, including calibration services. Purchasing agreements are being developed for acquiring long term arrangements with commercial calibration suppliers. The use of accredited calibration labs gives assurance that calibrations can be sourced with a high degree of confidence in the results.

By utilizing calibration services available in the commercial supply chain, the footprint for the calibration lab in the new facility can be reduced.

Business Process Transformation

The second element, business process transformation, leverages several tools such as Six Sigma, Lean, and the Honeywell Operating System (HOS). HOS is a Honeywell wide approach that provides a rigorous communication methodology and an information flow that allows employees to become engaged in the business. Armed with the right information, employees can take an active role in operational decisions and have a strong voice in the operation of their department.

As part of Metrology’s HOS implementation, the lab conducts a daily stand up meeting where employees review the workload and resources available, provide updates on previously identified issues, identify any new issues that need to be addressed within the cell, and identify any new issues that need to be escalated to higher management levels for resolution.

To assure high levels of service and high customer satisfaction, the lab has worked to establish service level agreements with internal service providers and customers. For example, the agreement with Transportation services stipulates twice daily pick ups from Metrology’s shipping bay. The agreement with internal customers states that items sent in for routine calibration will be completed within three days of receipt.

A New Modern, Agile Facility

The third element has resulted in plans to build a new one million sq. ft. facility. The facility will use about 50% less energy than the current facility and will be LEED gold certified. Ground breaking for the new facility is planned for mid 2010, and move-in starting in late 2012. The move of approximately 6,400 pieces of Capital Equipment is estimated to take about 18 months to complete.

As soon as the first equipment is installed and operational at the new facility, calibration services will be required. The challenge will be to provide calibration services at both facilities for approximately a year and a half during the move.

The calibration program will be operated out of the existing facility during the first part of the move, and then the lab will move to the new building about midway through the process, and will operate out of the new facility for second portion of the move.

There’s no doubt that Honeywell FM&T has a forward-looking culture. Its “factory of the future” continues to challenge the status quo and delivers innovative solutions. Its mission now includes providing other government agencies with national security products to help fight the war on terror.

That pioneer spirit continues as Honeywell FM&T continues to serve the national security mission for many years to come.

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As a part of our quest for continual improvement in Learning and Development, and to more fully become an educational organization, this year NCSLI began asking Conference speakers to submit Learning Objectives along with their brief abstracts. This article provides additional information about what Learning Objectives are, what needs to be included in a well written Learning Objective, and how to identify a good Learning Objective. Why is this important to you? If you are a speaker, the use of Learning Objectives can help improve your focus on what you want an audience to do or know with the information after your presentation. If you are a participant, you can review the expected objectives to determine if you want to attend a session and if so, if you learned what was expected during the session. If you are an employer, you can review stated objectives to see if it is likely that your employees will come back to the laboratory and be better able to perform their jobs.

Here is an example of a Learning Objective for this article:

After reading this article, you (the learner) will be able to use the references and examples provided here to evaluate your own (and others’) stated Learning Objectives to determine whether they comply with the four aspects required of a Learning Objective. You will also be able to review Learning Objectives when provided for a training event or conference session to determine if you want to attend a session and if so, if you learned what was expected during the session.

Reviewing a list of topics covered in a course may not provide the level of detail needed by the speaker, a participant, or an employer. Let’s take an example of a course titled “Basic Uncertainties.” A list of topics covered might include:

- Guide to Expression of Uncertainties in Measurement (GUM)
- Use of Excel Tools
- Statistics and Mathematics

Let’s come back to this course example after we define and consider the standard criteria for Learning Objectives.

What is a Learning Objective?

A Learning Objective or Learning Outcome, is a specific statement, written from the participant’s perspective, which provides information about what the participant will gain during a learning event. They are focused on participant performance, not teacher performance.

“Learning objectives: Statements about what a student will gain from a course or activity. These are specific statements about exactly what a student should know, be able to do, or value as a result of accomplishing a learning goal. Learning objectives form the basis for curriculum and course development as well as testing (Reed, 2005).”

Standard Aspects of a Well Written Learning Objective

The ANSI/IACET b standard for continuing education units identifies four categories in Section 5 related to Learning Objectives.

1. They are written from the perspective of the learner, reflecting what the learning will achieve.
2. Learning objectives must be clear, specific, concise, and measurable (with four components):
   1) They state the performance the learner should be able to accomplish. (Behavior)
   2) They specify the conditions under which the learner is to perform. (Conditions)
   3) They specify the criteria for acceptable performance. (Criteria)
   4) They are directly related to the subject matter and content of the learning event.
3. Learning outcomes are established for each session within a large event, conference, or convention.
4. Instructional delivery includes discussion of learning outcomes.

If we expand on category number 2, and consider the four components of a clear, specific, concise, and measurable objective, here are some additional notes to clarify what is meant. Each Learning Objective should begin with: After this session (tutorial, paper, or workshop) the participant will________

Component 1: This component covers the expected behavior after the training. In previous articles, Bloom’s taxonomy, and various levels of learning have been covered (See references on the NCSLI website to review this topic). Think about performance in terms of active verbs related to what you want the participant to know, do, or be, after the training: identify, calculate, assess, present, analyze, and apply. Note the example verbs that are capitalized in Table 1. So, at this point, select an appropriate verb for the level of knowledge or application that is expected.
Component 2: What are the conditions? Can the participant use their notes? Can they use a documented procedure? Can they use a calculator? Are computers allowed? Must they use Excel for calculations? Are there additional reference materials provided? Will they have to be assessed from memory?

Component 3: What criteria will be used to judge acceptable performance? Is an 80% passing grade acceptable? For Item 2, given in Table 1, would it be okay if they submit their response in text-message format? Must they provide a written response or can it be oral? What will a valid uncertainty statement look like? (Instructors need to make sure criteria for performance is covered in the course!)

Component 4: Learning objectives must be directly related to the subject matter and content of the event. If you haven’t covered various types of statistical distributions in a course, you should not evaluate students against the criteria (unless of course it was given as a prerequisite). If knowledge of calculus is a required prerequisite, and you covered partial derivatives in the course, the Learning Objective given in Item 4 would probably make sense. However, if the course is on how to correctly perform pressure calibrations, it wouldn’t necessarily make sense to have Learning Objectives related to the laboratory management system. This component should be obvious!

So, let’s consider the first three components in a Behavior, Condition, Criteria model. The following Learning Objective uses this model: “Given a set of data the student will be able to compute the standard deviation.”

• Condition - Given a set of data;
• Behavior - the student will be able to compute the standard deviation; and
• Criterion - (implied) - the number computed will be correct.

Additional behaviors could include the ability to teach the process to another participant in the course. Additional conditions might include the use of a scientific calculator or a spreadsheet; it might include a step-by-step procedure. Another criterion might state that all steps must be shown.

If Condition and Criteria are omitted, it is often assumed that the conditions involve workplace conditions and standards which are set at perfection (but given the variety in the workplace for potential metrology participants – from technicians to NMI researchers – we ought to carefully consider whether we can assume standard conditions and perfection). The most important component for a valuable objective includes a written statement of the behavior using measurable or observable verbs.

What a Learning Objective is NOT....

A Learning Objective is not written in the form of what the speaker hopes to cover. My objectives as a speaker might be to cover six specific modules over the course of a two day workshop, but as a participant, you probably do not care about that! As a participant, you want to know WIFM (the wifem principle) or “What’s In It For Me?” When an instructor or speaker provides an overview of the course, you certainly have a map of what the presenter plans to cover, but there is no instruction for what you are supposed to know, be, or do with the materials and information. As a participant, I want to know what I am supposed to do with the information. I don’t want to leave a session thinking “So, what was the point?”

If a manufacturer has a new product or a National Metrology Institute (NMI) has some new research – sharing information at a conference so that the participant Learns about it or Understands a new technology – is also not an effective Learning Objective. Key phrases such as “learning” and “understanding” are too generic and nonspecific to be effective Learning Objectives and are discouraged.

If we look at our earlier example of the “Basic Uncertainties” course, the following example is not a good Learning Objective.

In this course we will cover the following items:

• Guide to Expression of Uncertainties in Measurement (GUM)
• Use of Excel Tools
• Statistics and Mathematics

There is no behavior stated, no conditions (other than possible required use of the GUM, Excel, and statistics/mathematics) and no criteria for performance specified.

Examples of Learning Objectives

Examples of possible Learning Objectives for our Basic Uncertainties course are given in Table 1. Depending on the level of knowledge that is expected at the end of the learning event, the various Learning Objectives might be too low, too high, or just right. This particular mix also might not be the best mix for a single course. However, written in this way, the instructor will know how best to focus his/her content and a prospective participant or employer will have a better idea of what to expect from the course.

For example, if all Learning Objectives are written at the level of Item 1, where the participant will be able to past a short quiz and list 80% of the essential items, this might be acceptable for a technician or a manager who is not involved in day-to-day uncertainty analyses as a good high level overview of what is required in uncertainty reporting. However, you probably want the person who reviews your Calibration Reports to get better than 80% right! Also, a metrologist or engineer who is required to evaluate all uncertainties in the laboratory, and who might perform uncertainty analyses on a day-to-day basis, might need to achieve the kind of Learning Objective given in Item 4.

Let’s consider our previous bad examples where we used generic terms for our manufacturer and NMI presentations. A good Learning Objective after a manufacturer’s session where they have presented new technology might be “participants will know how to perform accurate calibrations with this instrument.” After an NMI presentation, “participants will be able to apply this new research into the development of their next product (or calibration method).”

Activities and Assessments

A Learning Event Planning Worksheet is available on the NCSLI website under Trainer Resources: www.ncsli.org/NCSL/learning/Trainer_Resources.aspx (It is downloadable at the bottom of the page). It contains a table with the three columns as shown in Table 1. For each Learning
Objective (or Outcome) there should be a correlating Activity for providing instruction, and an integrated method for assessing whether the student has learned at the level stated as an expected outcome. Activities and Assessments will be covered in future Train the Trainer columns, but the most commonly known are Lecture (Activity) and Test (Assessment). Of course, these methods are also probably the least effective for effective adult learning. Unfortunately, most Conference papers use a lecture format and have neither expected outcomes nor assessments. You can look at Categories 7 and 8 on the Trainer Resources page for additional information and examples. Think about incorporating an interactive component in a technical presentation as a way to engage participants. Consider how you can gauge whether participants achieve the objectives you set out for them at the beginning of your talk or training session.

**Additional References**

Trainer Resources are useful for metrology professors and instructors, tutorial instructors, and conference speakers. The NCSLI website has a new section on Trainer Resources that provides additional resources and links that will be helpful as you develop as a speaker or instructor. See: www.ncsli.org/NCSLI/learning/Trainer_Resources.aspx

Category 5, of the IACET criteria, is especially applicable for this particular topic on Learning Objectives.

We will also have a ½ day Tutorial on Saturday before the conference on Writing Learning Objectives. We especially encourage any instructors and professors to sign up for this tutorial.

**Table 1. Example Learning Outcomes, Instructional Methods, and Assessment Methods for a Basic Uncertainties Course.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Learning Outcome</th>
<th>Instructional Method (Activity)</th>
<th>Assessment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participants will be able to use the references provided in this lecture, to successfully LIST 8 of the 10 items required in an Uncertainty Statement.</td>
<td>Lecture</td>
<td>Quiz</td>
</tr>
<tr>
<td>2</td>
<td>After participating in a brainstorming session, participants will be able to see the captured information and DESCRIBE (in complete sentences, in English) the importance of 3 to 5 key Uncertainty Components.</td>
<td>Brainstorming</td>
<td>Short Essay/Summary</td>
</tr>
<tr>
<td>3</td>
<td>After participating in the case study, using the technical resources provided, participants will be able to EVALUATE examples of Calculated Uncertainties and PRESENT and DEFEND an effective course of action.</td>
<td>Case Study</td>
<td>Presentation to the Group with Feedback</td>
</tr>
<tr>
<td>4</td>
<td>After hearing the lecture and seeing a demonstration, using partial derivatives and Excel, participants will be able to follow the step-by-step procedure to IDENTIFY components, CALCULATE results, and REPORT a correct calibration Uncertainty for their measurement that meets requirements of the GUM.</td>
<td>Hands-on Exercise</td>
<td>Evaluation of Calculated Results</td>
</tr>
</tbody>
</table>

1. From the University of Texas at Dallas, glossary: http://sacs.utdallas.edu/sacs_glossary.
2. ANSI/IACET: American National Standards Institute, International Association for Continuing Education and Training.
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A Systems Approach

Sandia National Laboratories is strengthening our future through the success of our students

by Amy Tapia, K-12 Education Program Manager, Sandia National Laboratories

At Sandia National Laboratories, one of the nation’s premier national security labs, we recognize the success of our nation’s future depends on the strength of our students. Sandia’s Education Partnership Programs engage elementary through high-school-age students to foster positive attitudes about science and to encourage them to consider careers in science, mathematics, engineering, and technology.

Our strategy is based on our systems-engineering culture, in which we provide innovative, science-based solutions to the nation’s most challenging national security problems. Throughout the K-12 system, we contribute where we can most comprehensively impact the system, utilizing our unique resources. Our key resource is scientists and engineers who eagerly share their passion for science and engineering. Other strategies include...
providing most of our activities outside of the classroom, presenting inquiry-based activities, engaging families, and offering resources for teachers.

Young children are fascinated with the unexpected. So are scientists. The challenge is engaging students with hands-on activities that encourage them to test theories, not just memorize facts. In elementary school, our goal is to help children understand the nature of science and discover that science is fun. One great example is the CSI:Dognapping program developed by our Advanced Materials Laboratory where children visit Sandia and solve a mystery of a stolen dog using science. The CroSSlinks program supports employees who take science into schools by providing standards-based, hands-on science kits designed for K-5 classrooms. Family Science Nights provides an evening of hands-on science at local elementary schools for students and parents. Each school year, more than 6000 students from 40 or more schools, and their parents, work together to conduct simple inquiry-based science activities. This successful program is easily replicated and our website includes material lists and activities in both English and Spanish. These same activities are also provided to children attending community center summer programs, and can be used in a variety of settings.

Middle school students are concerned with relevance as it relates to their place in the world. Unfortunately, many students begin to lose interest in science and math at this age. Drawing on their desire for competition, recognition and social activities, we provide fun activities that help students to see the connection between science, math and their world. The Department of Energy Science Bowl is a tournament-style academic team competition that challenges and recognizes student’s knowledge of science and mathematics. Partnering with our school district and a local utility company, Sandia also provides a hydrogen fuel cell car challenge that includes races, design, essays and oral presentations. Sandia’s workforce is diverse, and three of our outreach groups (Hispanic, African American, and Native American) provide an annual series of middle school career workshops for traditionally under-represented students.

High school is the time to begin identifying possible career choices and to seek opportunities to achieve one’s goals. Our programs seek to provide a variety of relevant experiences. Sandia organizes an annual School to World career exploration event that offers 8th and 9th grade students from around New Mexico an opportunity to learn about over 150 careers from over 500 volunteers in those careers. The STAR intern program is designed to provide an intense summer research experience for highly motivated and talented science and math students. Posing relevant questions to high school students is the focus of our Write Thing to Do scholastic essay competition which rewards students for their ability to understand and communicate about current scientific challenges.

Supporting teachers is paramount to student success. Each year, Sandia sponsors the Excellence in Science Teaching and Pi Awards to recognize outstanding science and math teachers. In addition to recognizing excellent teachers, we provide financial support for science and math teachers pursuing national board certification, as well as others types of professional development.
In an effort to integrate the teaching of science with the practice of science, teachers are invited to participate in Department of Energy research through our Academies Creating Teacher Scientists program. This program allows selected teachers to participate in a six-week research experience over three summers. The program provides sustained, intensive professional development that is experientially based, and effectively utilizes the unique resources that a national laboratory has to offer.

Sandia National Laboratories has been committed to STEM education for over 40 years. But creating sustainable programs that endure funding, personnel and political changes is difficult. Building enduring partnerships with local school districts, other businesses with similar concerns about education, and local government has been invaluable in creating strong programs that allow us to pool many resources to meet the needs of the students. Our systems-engineering approach enables us to forge these partnerships, and to utilize our greatest resource – our incredible employees!

The Human Element

Dr. Hy Tran is one of these dedicated employees. Hy is a metrologist, working in the Primary Standards Laboratory at Sandia National Laboratories. During a new employee orientation in 2004, Hy learned about Sandia’s community involvement programs. He became a CroSSLinks volunteer in the Albuquerque elementary schools. Hy also became active in the dimensional metrology activities of the National Conference of Standards Laboratories International (NCSLI). And as he became more active in NCSLI, he learned about NCSLI’s training, education, and outreach activities. At the 2009 Workshop & Symposium, he attended the Committee’s Education Liaison and...
Outreach meeting. He recruited Georgia Harris and Terry Conder from Committee 164 to speak at the Albuquerque section meeting in 2009 (following NCSLI’s board meeting in October 2009) about metrology outreach activities.

Hy continues to be involved in outreach activities. When the Native American Community Academy (NACA) (a 6th-12th grade charter school) asked Sandia for speakers about careers in engineering for 7th and 8th graders, Hy volunteered and used NCSLI’s Introduction to Metrology presentation. He also volunteered at School to World, talking with students, parents, and teachers about engineering and metrology as careers, and demonstrating the effect of an insulated cup to keep a beverage warm, compared to a non-insulated cup, using one of NCSLI’s training library outreach kits. Other helpful NCSLI materials included SI materials provided by Elizabeth Gentry at NIST, Engineering Go For It magazines, NCSLI Careers in Metrology posters, and NCSLI “World Metrology Day” rulers.

Hy is joined by over 500 employees each year who receive limited paid time off to participate as science fair judges, career presenters, visiting teachers, and tutors. Many employees also contribute a significant amount of volunteer time. Sandia remains committed to increasing the number of students who pursue science and engineering careers. We believe our greatest contribution to science education has been to support our employees’ efforts to work directly with students.

For more information about Sandia National Laboratories’ education programs, visit www.sandia.gov/ask.
If you’re old enough to remember what the world was like before about 1980, then you understand the incredible cultural difference that personal computers have made in everyday life.

by Michael Lombardi, NIST Contributing Editor

Before we spent countless hours typing away at word processors, crunching numbers with spreadsheets, surfing the web, answering emails, watching YouTube, downloading songs from iTunes, and playing video games, how did we possibly occupy our time? For many of us, it’s hard to even imagine those days. We can all argue if it was better or worse, but the world was certainly a different place before PCs took over our lives.

Computers have a unique set of measurement units. Knowing these units was once absolutely necessary if you wanted to understand how fast a computer ran or how much information it could store. Today, computers are so ubiquitous, powerful, and easy to use that that knowing the details is no longer required. For example, do you know the frequency of the microprocessor inside your computer? If so, pat yourself on the back, because most users don’t know.

Some people now buy computers based on what color they are. But in the early days, to paraphrase Henry Ford, you could have one in any color you wanted as long as it was white or beige. People didn’t ask about their color, but almost everybody who bought one knew how fast it ran. Computers were marketed by the frequency of their microprocessor just like cars are often marketed by the cubic inches or centimeters that their engines displaced. That information was considered so important that it was often included in the product’s name. Asking the engine size of a Volvo 1800 or the frequency of a Compaq 486-66 was equivalent to asking who was buried in Grant’s tomb. The answer was part of the question.

To be fair, in the very early days of personal computers, their frequency was talked about, but usually not bragged about. Computers were slow and the numbers weren’t particularly exciting. For example, I once wrote instrument control code on Hewlett-Packard 85 computers that ran at 613 kHz. We’re talking kilohertz here, not megahertz. Those HP 85s were replaced by Apple II computers that were more expandable and at least made it to the megahertz range, running at 1 MHz exactly. The biggest selling computer of all-time, the Commodore 64, also ran at about 1 MHz.

The “modern era” of personal computers began in August 1981 with the introduction of the IBM PC. The frequency of its microprocessor became one of the most famous of all frequencies, 4.77 MHz. It’s interesting to note that IBM arrived at that frequency by trying to save a few dollars, about 50 cents actually, on the cost of building a PC. IBM chose a microprocessor called the Intel 8088 that was able to run at 5 MHz. The 8088 required a companion clock generator chip called the 8284 that needed to run three times faster. IBM engineers found, however, that 15 MHz crystal oscillators were more expensive than 14.318 MHz crystal oscillators that had been mass produced for the television industry for many
The 14.318 MHz frequency was exactly four times the frequency of the “color subcarrier” which made color television possible. Therefore, the original IBM PC ran the 8284 at 14.318 MHz, and the 8088 at 1/3 that speed, or 4.77 MHz. The designers sacrificed a little performance (less than 5%) to save a little money.

To get a marketing edge, IBM’s competitors immediately started using faster crystals and “overclocking” the processor. Remember the PCs with Turbo buttons? With a click of a button, you could go from 4.77 to 8 MHz or faster. IBM then began using the 80286 processor that originally ran at 6 MHz, then 8 MHz, then 12 MHz, and with each new model, its competitors would offer a “clone” that was faster. The frequency race was on!

It used to surprise me that people who probably had little understanding of the units of frequency were so enthusiastic when talking smack about “megahertz.” I remember comments like, “Yeah, I almost got suckered into buying an obsolete 25 megahertz machine, but for a hundred bucks more I picked up this beauty. She runs at 33 megs.” With the exception of the radio, the computer probably taught more people about the concept and units of frequency than any other invention. Consumers at least had learned that a higher frequency meant a faster computer. Other types of products have worked hard to hide the concept of frequency from the consumer. For example, very few people know the frequencies received by their satellite TV service or the transmit/receive frequencies of their cell phone. Even the old analog TVs hid the concept by referring to channel numbers instead of frequencies. But 4.77 MHz and some of the faster PC frequencies became, at least for a time, household words.

The microprocessor frequency race is still on, although not discussed as much
Metrology in Pop Culture

as it once was, because most people now tend to be satisfied with the speed of their computers. Today, even the processor in the iPhone runs at 600 MHz. The fastest microprocessors in desktop computers run at about 6 GHz. That’s more than 1000 times faster than the original PC, an astounding amount of progress in a relatively short time.

Of course, frequency is only a small part of the story when measuring computer speed, the efficiency of the processor is usually more important. To give an oversimplified example, a 1 GHz computer that takes 5 clock cycles to execute an average instruction will be just as fast as a 2 GHz computer that averages 10 clock cycles per instruction. Microprocessors continue to get more and more efficient. For this reason, processor speed has long been measured using a unit called MIPS (million instructions per second) or sometimes MOPS (million operations per second). The original IBM PC ran at about 0.8 MIPS. In comparison, a current PC with a 3.2 GHz Intel Core i7 processor can do more than 75,000 MIPS, so the difference in processing speed (almost 100,000 times faster) is much greater than the difference in frequency (about 670 times faster).

To a metrologist, though, MIPS measurements seem a little shaky, and the measurement uncertainty must be large. Many factors can influence the results, including the mix of instructions used in the test and the programming language used to write the code. This makes it very difficult to do accurate comparisons between processors. For this reason, some computer scientists have only half-jokingly remarked that MIPS stands for “Meaningless Indicator of Processor Speed”.

FLOPS (floating point operations per second) is a unit related to MIPS that focuses on a computer’s ability to perform math operations. However, FLOPS are based on instructions per second and MIPS are based on millions of instructions per second. That means that megaFLOPS (or MFLOPS) are the floating point equivalent of MIPS.

Is there a more depressing name for a measurement unit than megaFLOPS? It sounds like a string of spectacular failures — “I thought buying Enron stock was bad until I invested with Bernie Madoff. What a series of megaFLOPS!” Don’t get used to the name, however, because today, megaFLOPS are old hat. The fastest desktop computers have now broken the tera-FLOPS (or TFLOPS) barrier, which means they can execute more than $10^{12}$ floating point instructions per second. In contrast, a cheap pocket calculator only needs enough processing power to do about 10 FLOPS.

The units for data storage are well known to programmers and software engineers. Everything is based on the binary number system (base 2), so there are only two digits (0 and 1). A binary digit is called a bit. Eight bits form a byte. There is also a mostly forgotten unit called the nibble which was named because it was

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half a byte (four bits). Some of you might remember that Byte and Nibble were the names of two excellent computer journals that both ceased publication in the 1990s. Byte covered all small computer systems while Nibble was dedicated to the Apple II.

The names and definitions of multi-byte units have changed in recent years. As we all know, the prefix “kilo” in the decimal world (base 10) refers to $10^3$, or 1000. In the binary world, however, “kilo” originally referred to $2^{10}$ or 1024, the power of 2 that was nearest to 1000. Thus, a kilobyte was originally defined as 1024 bytes. To comply with the SI, the kilobyte went “decimal” and is now officially defined as 1000 bytes; a SI megabyte is now $10^3$ bytes, and so on. However, computers are binary machines and it is often practical to use the binary based units. To preserve the binary units, the International Electrotechnical Commission (IEC) changed the name of the binary kilobyte to the kibibyte (KiB) in 2000. The binary megabyte is called the mebibyte (MiB), which equals $2^{20}$ bytes, and the binary gigabyte is called the gibibyte (GiB) and equal to $2^{30}$ bytes. The difference between a SI gigabyte and a gibibyte is large – 73, 741, 824 bytes to be exact.

All of this can get really confusing when you buy a computer, and the consumer seems to be getting short changed no matter which unit is used. For example, the little netbook computer I am writing this on claims to have a 160 gigabyte (GB) hard disk. That's what it said on the box! The system information utility in Windows tells me that it has only 154 billion bytes, which is 154 GB if SI units were used, or 143 GiB. However, Windows says that 154 billion bytes is 143 GB. That means that Microsoft is ignoring the SI units and calling a gigabyte a gibibyte (try saying that three times fast). It also means that I got less than I paid for, which would bother me a lot if we were talking about gasoline or bananas. But because I'll never need the extra space, I don't really care.

The computer makers must know that few people will care because (unlike gasoline or bananas) the cost of storage has gotten incredibly cheap compared to the old days. For example, the first hard drives I used with the Apple II computers held only 10 megabytes and cost about $1,000. That was a staggering $100 per megabyte, but it was still thrilling to have a single drive that could hold as much as 80 single-sided floppies. Some of you probably remember the old Seagate ST-225 drive, the best selling hard drive of all time, much faster and more reliable than its predecessors. It held about 20 megabytes and cost about $300, so the cost was now down to $15 per megabyte, which was then considered to be a great deal. I remember reading once that the cost of a hard drive would never drop below $1 per megabyte. Today, however, you can buy a 1 terabyte drive for $100, so you can get 10 gigabytes for a buck! That’s unreal.

Everything about today’s computers is unreal, including how fast they run, how much data they can store, how cheap they have become, and especially how much time that we waste on them. Even so, I sometimes miss the old days when a kilobyte was really a kilobyte, when computers weren’t used as media centers or to send messages, and when nearly everybody knew the technical details about their machines. My wife wants me to throw away the old pile of computers I have stacked up in the basement, but I don’t think I can. We recycled some old printers, and in a weaker moment I might be able to toss the Pentium 133. But please, not the Sinclair ZX81 or the Commodore 64 or the Model 100, and especially not the 486-33 with the turbo button and the big tower case. I mean let’s be sensible, I paid $3,500 for it.

Special thanks to Mark Kuster, the chair of the Calibration Intervals Committee (173.1), for suggesting the topic of this column.
A Tenth of a Second: A History

by Michael Lombardi, NIST Contributing Editor

A Tenth of a Second has a somewhat offbeat topic: it studies the impact that the time interval of 1/10 of a second has had on our history and culture. Jimena Canales, a professor of science history at Harvard University, tackles what would seem to be a limited subject with enthusiasm. The result is a well researched and engaging book -- a fine contribution to metrology history.

Canales begins by establishing the fundamental importance that the interval of 1/10 of a second has in science. When “moving pictures” were invented, at least 10 frames per second had to be displayed or else the illusion of continuous movement was destroyed. Human reaction time, such as the time needed to press the brakes in your car, is always near 1/10 of a second. A human can never pronounce a syllable in less than 1/10 of a second, and the electrical rhythm of the brain at rest is near 10 cycles per second.

Canales supports her arguments with many references from the scientific literature. She quotes A. E. Kennelly, Thomas Edison’s chief laboratory engineer who, referring to transmission times in communication systems, wrote in 1926 that “We all live on a tenth of a second world.” Three years later, the psychologist Edward Boring wrote that the importance of 1/10 of a second was “sacred” to his field.

Perhaps the book’s most interesting chapter is devoted to reaction time and the personal equation, a term used in many scientific fields from the late 18th to the early 20th century. The personal equation referred to the idea that every individual observer had an inherent bias when it came to measurements and observations. For example, astronomers making simul-
taneous observations would record slightly different values for the passage of the stars. Published experimental results often included the “personal equation” for the scientist, which was a correction factor that needed to be applied before the data could be compared to data collected by other scientists. Because there were no methods in place to make accurate measurements of short time intervals, debates raged for decades about whether the biases were related to reaction time, the speed of thought, or to the personal bias of the scientist. The book describes how this problem had a large effect on several scientific fields, including astronomy and experimental psychology.

Another fine chapter covers the development of photography and cinematography, and the impact that they had on science by “eliminating the observer” since the lens could record observations much faster than the human eye. This too created controversy, and the book relates the sad disagreement about the use of photography between the French astronomers Janssen and Trouvelot.

Throughout the book, Canales provides numerous examples of how scientists were both limited and influenced by their understanding of a 1/10 of a second, and by their ability to measure it. She continues this theme in the book’s later chapters that discuss early attempts to measure the speed of light, in particular the work of Alfred Cornu and Albert Michelson, and work related to Einstein’s theory of relativity. Her points are perhaps stretched a bit too far at times, but the discussion is always thought provoking.

Canales fails to bring her story full circle by describing how current technology has solved many of the historical measurement problems that she describes. For example, atomic oscillators and the high resolution time measuring instruments that we take for granted today are never mentioned. To be fair, the book was intended as an historical work and not as a review of current technology.

*A Tenth of a Second* nicely relates how advances in measurement science can solve problems once considered unsolvable, and that the solutions often result in new technologies that can have huge cultural impacts on everyday life. For that reason alone it should capture the interest of many metrologists.
Who is NCSL International

NCSL International was formed in 1961 at the request of the United States National Institute of Standards and Technology (NIST) to promote cooperative efforts for solving the common problems faced by measurement and testing laboratories. Today, NCSL International (NCSLI) is internationally recognized by academic, scientific, industrial, commercial, and government facilities in many countries as the leader in measurement science organizations.

NCSL International, working with National Metrology Institutes (NMIs) around the world and its members, coordinates recommendations for the advancement of measurement science to fill the needs of metrology and testing labs at all levels.

NCSL International is a nonprofit organization, whose membership is open to any organization with an interest in the science of measurement, and its application in research, development, education, or commerce. NCSLI is composed of members in 23 active regions around the world.

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It has been a very interesting and sometimes painful journey since our last Metrologist publication but we are getting back on track. We commenced the quarterly virtual Utility Committee quick hit meetings and are in the early phases of delegating committee tasks and modifying our infrastructure to better serve the committee. We will have more on those changes over the coming weeks and months.

Inter-Laboratory Comparisons ILC 153-2 and 153-3 are essentially complete. Dr. Pettis, in support of the ILC committee 142, reviewed our appeal for NCSLI sanctions and he was quite favorable. There were a couple of suggestions including one recommendation that we publish our results in Measure RP-15. The teams of Richard Brenia (SCE), Greg Cenker (SCE), Cory Peters (Exelon) and James Reid (Duke Energy) are working on the necessary publication documents. We will be presenting certificates of participation in the two ILCs to those involved and those who managed each ILC. The NCSLI 142, ILC Committee is working on a revision to RP-15 and Cory Peters agreed to join their committee as our liaison from the utilities committee. James Reid and Dave Schutte (Consumers Energy) may also be willing participants along with Bob Stout (DAEC). We will benefit from an internal exchange of information and better guidance or at least an understanding of the guidance to be in compliance with the committee requirements. Additional ILCs have been suggested 1) Triple point, 2) frequency, 3) digital torque, 4) torque transducer, and 5) digital dial indicator and will be selected by our committee through volunteerism and balloting.

Following along with NCSLI “Publications Writing Policy For Committee Working Groups” (June 4, 2009), we established the “Laboratory Justification” working group lead by Lynn Crawford (TVA) with Dennis Dubro (PSGE) and Dean Williams (Duke Energy) as members. The initial task for the group was to collect information from participating members to document the basis for or to justify the existence of our in-house labs. The core document was a presentation created by Lynn for his management team. Discussions with our stakeholders revealed that the term justification would not be in keeping with the essence of the national conference that embraces all forms of calibration entities. We will select an alternate group title that indicates the benefits of an internal metrology laboratory. Some of the points of interest for the utility labs are:

The demands of coordination within the committee require a secretary to handle the note taking and to act as the guide to keep the group on-task during meetings and events. This individual will also be the lead individual drafting meeting minutes and will be provided publishing authority for the new website.

Richard Brenia, the co-moderator for the utilities committee forum, Pete Buzzard and I are working with Larry Johnson (NCSLI) and Craig Gulka (NCSLI) to recover the Utilities Committee forum functionality on the new website. Part of that recovery is the capture of the historical forum content. Pete has posted some of the material and Larry has provided us with a file dump of the archive for our purposes. We are looking at several options and you will be informed of the status at each major change until the functionality is restored.

A former committee member, Mike Kurja (Exelon PowerLabs) spoke during the Senate Republican Conference Roundtable on Nuclear Energy last June. The level of increased activity in the nuclear industry is a good sign and reinforces the approaching critical lack of qualified and trained Metrologist that will be required to support the utility laboratories. You can watch the hearings on YouTube. http://www.youtube.com/watch?v=92mmHhHpng8

Our recent implementation of virtual Utilities Committee meetings has been an excellent adjunct to live attendance but is often difficult to manage. The use of Microsoft Live Meeting has been a plus but the audio infrastructure is still immature and needs to be developed to improve the experience. The Web 2.0 aspects of the virtual meeting are demonstrable and when meetings are initiated on a desktop basis alone the audio impact is not an issue. It was also noted that eLearning could easily be implemented to the benefit of the committee members through video training, live web training or podcasts. The quarterly one hour virtual meeting was also implemented in March. This meeting will be used to obtain collaboration on areas of interest to the committee and to resolve or address emergent issues. The technology is improving along with the infrastructure and it should be noted that during the MSC meeting in Anaheim in 2009, an INPO auditor in attendance at the Millstone Nuclear power plant in Connecticut deemed that in his opinion, the use of this technology was a strength and should be leveraged to its full potential.

We will be leveraging many situations over the next few months as we embrace new technologies, changes in the industry, graying of the workforce and rising opportunities within and without the science of measurement.
The Michigan section held another outstanding meeting on November 12, 2009. With over 60 attendees, the Metro Detroit area continued to show its strong commitment to measurement science. Furthermore, this demonstrates our worthiness as a host for a future NCSLI Conference.

Rhonda Carradine of DTE Energy hosted us at the Enrico Fermi Nuclear Power Plant in Monroe, Michigan. At 1.1 million kilowatts, the DTE Energy Fermi 2 plant represents 30% of Michigan’s total nuclear generation capacity. This single plant is capable of producing enough electricity to serve a city of about one million people. Fuel costs are about half those of the most efficient coal-fired plants. Fermi 2 began commercial operations in 1988. Since that time, the plant has produced more than 143 billion kilowatt hours of electricity for Detroit Edison customers. The plant employs about 900 workers and produces about 15% of the power generated by Detroit Edison power plants.

Todd Connor, DTE’s plant manager, gave the audience an overview of how DTE Energy turns nuclear energy into electricity. This is a very precise process comprised of over 30 million components plant wide. As a result, their metrology laboratory is heavily relied upon to support the operation with their precision measurement capabilities. With radiation exposure being a concern to the average person, Todd explained that even though he works in a nuclear facility, he receives less radiation exposure than what the average individual is exposed to by watching television a few hours per week.

Peter Coomar of Monroe County Community College provided us with an overview of their metrology program. It was refreshing to hear there are resources to nurture our future metrologists. Something, as a metrologist, we all take for granted is the ability to use basic measuring tools, like micrometers for example. Peter explained that learning this is a challenge for the non-metrologist. It is so much so that they spend six to seven weeks on that area alone. This really puts things into perspective when you consider the amount of non-metrologists that come to us for measurement expertise. Often what we find trivial and routine is not the case for everyone.

After Lonnie Spires of Dynamic Technology provided us with the customary NCSLI Board of Director’s update, Phil Smith from A2LA gave a presentation on specifying accreditation services. He utilized some visually appealing photographs from some of the Air Force’s standards labs to keep the audience focused. It was a nice touch. He explained how calibration services can be confusing and the customer almost has to be an expert when ordering them. Certainly one hopes they get what they are paying for but the key is to be certain you are ordering what you need in the first place. Because calibration certificates can be confusing, it is imperative that they are reviewed when they are received from vendors. Initialing them to signify they have been reviewed is also a good practice to employ.

Dave Stuart of VTI Instruments, formerly VXI Technologies, explained how they “get more instrumentation in a smaller package” utilizing the LXI platform. We learned that LXI combines the benefits of GPIB and Ethernet by eliminating bulky GPIB cables and replacing them with length friendly Ethernet cables. Furthermore, LXI is not simply an Ethernet connection; there are certifications required in order for equipment to bear the LXI logo. This is the newest and fastest growing measurement platform so we are sure to see more of these instruments in our calibration laboratories soon.

After an excellent lunch provided by DTE Energy, the afternoon was dedicated to a general, open forum discussion with a primary focus on delay dating. For those that are unfamiliar with the concept, the basic premise is that equipment is calibrated, and then placed in secure storage until the equipment needs to be utilized. The calibration “clock” does not start until the equipment is first used. This can effectively extend calibration intervals for lesser utilized equipment.

Patrick Butler of Robert Bosch, LLC, moderated this session. First, he went over some presentations that were given at other NCSLI section meetings regarding the topic. Then the audience joined in which helped to point out the pros and cons of a delay dating system. Conversations centered on questions such as, “Can any instrument be placed into this state of abeyance?” and “What is the maximum abeyance interval?” These questions are not easily answered because they are unique to an organization’s quality system. Regardless, there are some core components of a delay dating system that must be understood.

- Control of the equipment (to ensure first use is known)
- Storage environment (temperature, vibration)
- Dimensional vs. electrical equipment
- Implement by class or specific device
- Equipment history (real data to drive decisions)

Of course there are several other factors to consider and there is no one correct way to implement a delay dating system. The purpose of the forum was to arm the audience with information that they could take back to their individual organizations. Ultimately this is a tool that needs to add value to an organization and not create an administrative burden. There is no doubt that this topic will continue at the spring meeting.
The meeting closed with door prizes provided by the NCSLI Business Office, A2LA, and DTE Energy. After that, several attendees took a tour of the calibration laboratory. Bosch, DTE Energy, Dynamic Technology, VTI Instruments, A2LA, and the attending organizations represented continue to uphold the reputation that NCSLI has built for the measurement community. I want to thank each of them for their continued support and look forward to seeing them all soon.

pat.butler@us.bosch.com

Canales begins by establishing the fundamental importance that the interval of 1/10 of a second has in science. When “moving pictures” were invented, at least 10 frames per second had to be displayed or else the illusion of continuous movement was destroyed. Human reaction time, such as the time needed to press the brakes in your car, is always near 1/10 of a second. A human can never pronounce a syllable in less than 1/10 of a second, and the electrical rhythm of the brain at rest is near 10 cycles per second.

Canales supports her arguments with many references from the scientific literature. She quotes A. E. Kennelly, Thomas Edison’s chief laboratory engineer who, referring to transmission times in communication systems, wrote in 1926 that “We all live on a tenth of a second world.” Three years later, the psychologist Edward Boring wrote that the importance of 1/10 of a second was “sacred” to his field.

Perhaps the book’s most interesting chapter is devoted to reaction time and the personal equation, a term used in many scientific fields from the late 18th to the early 20th century. The personal equation referred to the idea that every individual observer had an inherent bias when it came to measurements and observations. For example, astronomers making simultaneous observations would record slightly different values for the passage of the stars. Published experimental results often included the “personal equation” for the scientist, which was a correction factor that needed to be applied before the data could be compared to data collected by other scientists. Because there were no methods in place to make accurate measurements of short time intervals, debates raged for decades about whether the biases were related to reaction time, the speed of thought, or to the personal bias of the scientist. The book describes how this problem had a large effect on several scientific fields, including astronomy and experimental psychology.

Another fine chapter covers the development of photography and cinematography, and the impact that they had on science by “eliminating the observer” since the lens could record observations much faster than the human eye. This too created controversy, and the book relates the sad disagreement about the use of photography between the French astronomers Janssen and Trouvelot.

To view upcoming NCSLI Region and Section Meetings go to www.ncsli.org
The Twin Cities Section 1311 conducted its first meeting of the year on February 4th, 2010. Our meeting was hosted by Roger Zematis (Dytec Instruments) and took place at the New Brighton Community Center in New Brighton, Minnesota. The meeting included seven speakers, group discussions, NCSLI news and an occasional splash of television and movie trivia.

We had 87 attendees representing numerous companies and industries throughout the region. This was a good turn out given the “wonderful” winter weather (rain, snow and ice) we experienced during the day. Ah yes, we love it here in Minnesota! Up here in the Twin Cities section, I’m very thankful for such an active and supportive membership.

The meeting started with a brief introduction and some announcements by yours truly followed by a round of 1970's TV show trivia. Our host, Roger Zematis from Dytec Instruments, conducted a presentation which included an overview of Dytec Instruments and their various roles in support of the metrology and measurement community.

Our first speaker was Haritha Peruru from Boston Scientific who presented “Accuracy and Test Point Determination.” When OEM and/or industry standard calibration procedures are not available or if they are lacking sufficient detail, this process is utilized to determine appropriate and sufficient calibration test points. Haritha provided an overview of this “How to Guide” in addition to flow chart examples associated with determination of calibration test points.

The second topic was presented in a tag team format by Terry Conder and Jim Ek from 3M who presented “Tech, Twists and Wizards – Educational Outreach for Students and Teachers.” Terry started the presentation with an overview and history of the educational outreach program at 3M. It was truly amazing to see the broad range of commitment from the 3M Corporation and the volunteerism of 3M employees. This educational outreach program includes an administrator, steering committee and various teams who partner with local schools and teachers. Jim continued the presentation by giving us a behind the scenes look into the recruiting and training of 3M employee volunteers. As a volunteer teacher himself, Jim shared various experiences of how rewarding the program is for teachers, students and the educational outreach volunteers themselves.

Our third topic was another tag team effort from Jane McDougall (Precision Repair & Calibration) and Harry Spinks (Boston Scientific) who presented “Creating a Partnership with Your Calibration Laboratory.” As a commercial calibration laboratory, Jane provided insight into common problems associated with insufficient calibration information and/or poor customer communication. As a supplier quality engineer, Harry gave us some perspective on the calibration supplier evaluation process and how utilizing proper communication can ensure a successful partnership. Various forms and criteria were also presented to highlight these critical communication components. From these perspectives, building and maintaining a successful relationship with your calibration provider requires clear and concise two-way communication.

After lunch, it was time for a few quick door prizes and a round of 1970's movie trivia. With everyone settled in for the afternoon, Terry Conder from 3M Corporate Metrology started us off with an update of recent NCSLI news and activities of the NCSLI Board of Directors.

Our sixth speaker of the day was Kim Anderson from FasTest Incorporated who presented “Pressure Calibration Productivity Improvements.” Kim provided examples, testimonials and videos of how increased productivity and efficiency can be achieved by implementing a variety of “quick-connect” style pressure fittings in the calibration laboratory. For laboratories providing pressure calibration services and finding themselves having to often deal with high volume, production line, remote and/or difficult locations, the information and examples that Kim presented was very intriguing. Kim also passed around numerous pressure fittings and adapters so everyone could get their hands on and play with these amazing devices.
After a quick break, it was on to our seventh and final speaker of the day. Walter Nowocin from Medtronic presented “FDA 483 Calibration Related Warning Letters.” Walter presented numerous examples of warning letters and resulting correspondence associated with FDA quality audits. Regardless of industry or profession, it was clear from Walter’s presentation there is certainly a right and a wrong way when responding to a quality auditor. Given the serious nature of any quality assessment, how you initially respond will often dictate the future course of action by the auditor.

I wish to thank Roger Zematis and Dytec Instruments for hosting our meeting, our seven speakers, door prize contributors, and the Twin Cities NCSLI section membership for their continued support, and my fellow Twin Cities section steering committee members for making this another successful and very well attended meeting. Our next section meeting will take place in May 2010.

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The winter meeting for the Maryland Section was held on January 14, 2010 at the Hampton Inn in Frederick, Maryland. The meeting was hosted by the American Association for Laboratory Accreditation or A2LA and was originally scheduled to take place at their facilities in Frederick, Maryland. However, the response for the meeting was so great that the venue had to be changed to the ballroom at the Hampton Inn located next door to A2LA to accommodate the just over 60 attendees.

Maryland Section Coordinator Mr. Robert Knake opened up the meeting with a brief introduction and welcome to all attendees. Robert was followed by Mr. Peter Unger, President and CEO of A2LA, who gave a host presentation and overview of A2LA which provided information on international accreditation issues. Ms. Carol Hockert, NIST Weights and Measures Division, then presented an update on the most recent NCSLI Board of Directors meeting.

After the introduction presentations the meeting was off and running. Mr. Jason Poore, A2LA Accreditation Officer and Ms. Ashly Bowers, A2LA Accreditation Officer, did a joint presentation titled “The 10 Most Common Deficiencies” which focused on the most cited deficiencies that laboratories receive during the ISO/IEC 17025:2005 accreditation process. The presentation gave example deficiencies as well as common causes for those deficiencies so that your laboratory might be able to avoid them during your next audit.

Our second speaker, who kicked off the technical portion of the presentations, was Dr. Ted Doiron, NIST Precision Engineering Division. His presentation was titled “Use of Air Showers to Reduce Soaking Time for High Precision Dimensional Measurements” and focused on a study that he was a part of in which they used a common house fan to lower equilibrium times in their dimensional calibration laboratories. The presentation also included some very interesting information on the use of an infrared camera, and black bodies to monitor the temperature of the experiment. As it turns out, you can buy a certain commercial black electrical tape that makes for an excellent black body.

Mr. Miguel Menendez, Vaisala, then presented “Humidity Calibrations and Challenges.” The presentation focused on common problems that they receive from the customers and the causes for those problems. The main point of the presentation is that humidity is a complicated calibration area and to reduce potential errors you really have to know the equipment and environment you are using for these types of calibrations.

After a morning of presenters everyone was ready for door prizes and lunch. The door prizes were provided by A2LA, Vaisala, and Western Environmental Corporation. No one walked away empty handed. Everyone then squeezed together for the group photograph, which was followed by lunch. Lunch was served at the meeting facility and was sponsored by Vaisala.

The afternoon presentations where kicked off by Mr. Tim VonderHaar, Western Environmental Corporation. Mr. VonderHaar’s presentation was titled “Laboratory Planning and Design” which focused on tips for a laboratory that is planning on building a new facility to avoid potentially expensive errors. The presentation gave a brief overview of the planning you should consider for your facility, from the ground up including an architectural example of a typical calibration facility design.

The afternoon was wrapped up by Mr. Bob Stern of Agilent Technologies, who stepped in for a last minute presentation. Mr. Stern’s presentation was not on the agenda, however, many people stayed to listen and learn about ANSI Z540.3-2006 Compliance Methods: Info Requirements and Implementation which described how his organization has approached compliance with the requirements of Z540.3 and the methods they use to meet the Probability of False Accept requirements of Section 5.3. It was an informative presentation that sparked a lot of discussion regarding the new standard and how a laboratory ensures compliance with the standard.

The meeting was concluded at 3:30 PM with some final announcements and appreciation given to the host, attendees, presenters, and sponsors. I again wish to thank everyone involved in this meeting on making my first meeting as Maryland Section Coordinator such a great success.

Keep an eye out for updates on the next section meeting, which will likely take place this fall.
The NCSLI Kansas City Section Meeting was held on Thursday, October 22, 2010 at the National Institute for Aviation Research (NIAR) in Wichita, Kansas. NIAR provided refreshments for the meeting and excellent assistance both before and during the meeting. Twenty-two people attended the meeting from ten different companies.

Dr. John Tomlin, Executive Director of NIAR, opened the meeting by welcoming everyone to the facility. Dr. Tomlin talked about the mission and history of NIAR and answered questions about the facility. Walter Lee, the Director of Quality and Performance, as well as the Calibration and Quality Laboratory Manager, gave an overview of NIAR.

Roger Burton, the NCSLI Secretary, provided a Board of Directors update. Roger talked about international activities, NIST news and this year’s NCSLI conference. He talked about the benefits of NCSLI membership, NCSLI scholarships, and new Metrology Outreach Resources.

After a quick photo of the group, taken in the conference room, Tracee Friess and Walter Lee led us on a tour of NIAR. The group toured the Environmental Testing Lab, the Mechanical Test Lab, the Walter H. Beech Wind Tunnel, the Advanced Joining and Processing Lab, and the Crash Dynamics Lab. The group stood inside the wind tunnel while our guide talked about its history and usage. The entire tour was interesting and prompted numerous questions.

Following the tour, Joe Cebulski, former chairman of the Airline Metrology Committee, gave a presentation on the NCSLI Airline Metrology Committee. Joe talked about when and why the committee was formed, how often the committee meets, and the number of companies involved. He listed the achievements that the committee has accomplished, which includes sharing of calibration procedures, training opportunities, feedback on vendors and tools, and round robins.

After a short break, Pam Wright, of A2LA, gave a presentation on the Most Common Deficiencies in Accreditation Assessments. Pam provided charts to show a breakdown of the most common deficiencies. She then went through the top ten deficiencies and common causes for the deficiencies. The presentation was very enlightening and provided useful information in preparing for an assessment.

Following a short break, Bob Ellis of the David L. Ellis Company gave a presentation on The Variable Resolution in Hardness Testing. Bob explained why it is difficult to know the actual resolution in hardness testing. He talked about the factors involved in determining the measurement uncertainty of a hardness test and their relative contributions. He then gave examples of different types of hardness tests and provided data to show the uncertainty in the hardness measurement due to the resolution of the device used.

Everyone was on their own for lunch. Maps and recommendations of local restaurants were provided.

Following lunch, Doug Kappler and Pete Morken of TriMet gave a presentation on New Methods for Large Scale Metrology, including a demonstration of a laser radar system. Doug discussed different methods for making large scale measurements, which included optical CMMs, coherent laser radar, IGPS, Adaptive Robotic Control, and Dynamic Motion Measurement. Doug talked about each type of instrument and used numerous pictures and graphics to provide visuals of the equipment and methods.

During the break that followed, meeting evaluation forms were handed out and completed. Following the break, an Open Forum Discussion was held. Topics discussed during the forum included A2LA certification, calibration management software, and RFID tracking of equipment. After the discussion, we drew for door prizes donated by NCSLI. The meeting was adjourned after the drawing for the door prizes.

The time and effort that each speaker put into this meeting is truly appreciated. There was a great amount of interest in each presentation as evidenced by the number of questions and comments. The conference facility and tour provided by NIAR was excellent. Their willingness to host this event was greatly appreciated.
18th Annual NCSLI-Japan Forum

The 18th Annual NCSLI-Japan Forum was held at the Tokyo Metropolitan Ohta-ku Industrial Plaza on October 30, 2009, with over 360 attendees.

The forum was organized as The Japan Measurement Standards Forum Seventh Symposium, and operated by NCSLI Japan and NMJJ in collaboration, under the auspices of the Ministry of Economy, Trade, and Industry. Other participating organizations were NITE, JAMP, JA-PIA, JARM, JCCLS, JEMIC, JQA, JMIJ, FAAR, CERI, JAB, JSA, JEMIMA, JEMA, JEITA, JTM, JMCT, JEMCA, MMRN, TRA. There were two courses of paper presentation sessions, Metrology Standards session and NCSLI-Japan session, and in parallel with them was the Posters Session.

The forum was opened with a greeting message by Mr. Shigenobu Watanabe of METI, followed by a keynote speech entitled “Measurement of GHGs for Climate Change” by Mr. Tomoyuki Nagamura, Mitsubishi Research Institute, Inc.

Mr. Hiroshi Taira of JQA presenting his paper ‘Calibration method and evaluation of uncertainty of sound level meter’.

Exhibitors:

Agilent Technologies International Japan, Ltd.
Alpha Electronics Corporation
Anritsu Meter Co., Ltd.
Fluke Corporation
Japan Accreditation Board for Conformity Assessment
Japan Association for Metrology Promotion
Japan Electric Meters Inspection Corporation
Japan Electronics and Information Technology Industries Assoc.
Japan Measurement Instruments Federation
Japan Quality Assurance Organization
Kawaguchi Electric Works Co., Ltd.
Key Techno Co., Ltd.
National Institute of Technology and Evaluation
Ohte Giken, Inc.
ORIX Rentec Corporation
Sankyo International Corporation
Shinyei Technology Co., Ltd.
Spectris Co., Ltd.
Yamari Industries, Ltd.

At the registration table, smiling volunteers, Ms. Fukushi (Orix Rentec) and Ms. Fujita (Yamari Industries).
The following papers were presented in the sessions

**Metrology Standards Session**

National standards of length using an optical frequency comb  
By Hajime Inaba of NMIJ/AIST

High accuracy 3D measurement for supporting manufacturing industries  
By Toshiyuki Takatsugi, Sonko Osawa, and Osamu Sato of NMIJ/AIST

Current Situation of the Guidance for Estimation of Measurement Uncertainty and International Situation  
By Hiromi Ishige of IA Japan/NITE

Uncertainty evaluation and its practical use to process control in semiconductor manufacturing /test process  
By Satoshi Aoyagi of NFRI/NARO

Systems Solutions Japan Inc. Production of GM soybean CRM  
By Akemi Yassui of NFRI/NARO

Calibration method of reference PV devices and its measurement traceability  
By Sanekazu Igari of PCPV/AIST

JCSS acquisition passage and problem in the future of small-scale office  
By Takashi Nakano of Yamato Seiki Co., Ltd.

**NCSLI Japan Session**

Evaluation of Room Temperature Type Direct Current Comparator Bridge  
By Takayuki Abe of JEMIC

Evaluation of Characteristics of Standard Capacitors  
By Atsushi Domae of NMII/AIST

On-site Calibration of JCSS Accreditation in the Manufacturing Site  
By Shingo Miyajima of Murata Manufacturing Co., Ltd.

Development of 10 femto ampere current source and its calibration method  
By Tetsuya Sawaki and Nobuyuki Kawamura of Kawaguchi Electric Works Co., Ltd.

Development of Low-Temperature Calibrator by Stirling Engin  
By Shinichi Honda of Shintei Technology Co., Ltd.

Calibration method and evaluation of uncertainty of sound level meter  
By Hiroshi Taira of JQA

Method of deciding TEST limit (Acceptance/Rejection) in Consideration of Measurement Accuracy (Uncertainty) and Risk  
By Toru Yamaguchi of Yamatake Corporation

The forum was organized by the following dedicated volunteers with many other helpers:

Akiu Yamazaki, Agilent Technologies International Japan, Ltd.
Hiromi Murata, NITE
Hisachi Mine, JQA
Hisao Nishiyama, Fuji Xerox Co., Ltd.
Isao Kishimoto, NMII
Jun Ode, Tokyo Metropolitan Industrial Technology Research Institute
Katsuhiko Setsurakku, Key Techono Co. Ltd.
Katsutoshi Kodaka, Fluke
Katsuya Sato, NMII
Kazumi Hayakawa, Fluke
Makoto Sata, Yamari Industries, Ltd.
Masanori Sakairi, JMIF
Mito Akihiro, NMII/AIST
Mitsuo Ishii, Metcal Co., Ltd.
Naomi Ito, JMIF
Norio Ishizaki, NITE
Shigeaki Hatakeyama, JEMIC
Takao Orihara, JEMIC
Takashi Sugiyama, JQA
Takashi Togo, ORIX Rentec
Takeharu Nishi, Yokogawa Rental & Lease Co.
Toru Yamaguchi, Yamatake Corporation
Toyoharu Sasajima, Toyo Tech Co., Ltd.
Yasusuke Matsumoto, CERI
Yoshinobu Kasumi, Yokogawa Electric Corp.
Yositaka Kato, Caltech Co.
And many others
Higher Education in Europe

Higher education plays an essential role in all societies, creating new knowledge, transferring it to students and fostering innovation. Europe has around 4,000 higher education institutions, with over 19 million students and 1.5 million staff. Education institutions throughout Europe are working to modernize, both in terms of the courses they offer and the way they operate.

The modernization agenda for universities is part of the Lisbon Strategy, an action and development plan for the European Union. It was set out by the European Council in Lisbon in March 2000, and the European Commission published in 2004, a modernization agenda for universities which was welcomed by the Member States and the main stakeholders in higher education. The main fields of reform are:

- Curricular reform: Introducing throughout Europe the bachelor-master-doctorate system, fostering competence based learning, flexible learning paths, recognition, mobility.
- Governance reform: University autonomy, strategic partnerships, including those with enterprises, quality assurance.
- Funding reform: Diversified sources of university income better linked to performance, promoting equity, access and efficiency, including the possible role of tuition fees, grants and loans.

Towards the European Higher Education Area – The Bologna Process

Reforms in education are promoted by the Bologna Declaration of the European Ministers of Education (June 1999). The Bologna Process, in which 46 countries in the wider Europe are participating, is a collective effort of public authorities, universities, teachers and students, together with stakeholder associations, employers, quality assurance agencies, international organizations and institutions aiming at lifelong learning and development. The priorities of the Bologna Process are:

- Introduction of the three cycle system (bachelor/master/doctorate) to harmonize education and academic degrees. The cycles are defined in terms of credits (or credit points, cp) of the European Credit Transfer and Accumulation System (ECTS):
  - 1st cycle: typically 180–240 ECTS credits, awarding a Bachelor’s degree.

This letter deals with *Education and Training* 2010. The expression was coined by the European Commission to characterize the activities improving the quality and effectiveness of education and the progress through agreed instruments.
The new evaluation methods reflect not only a student’s performance on exams, but also their lab experiments, presentations, and projects. The way credits are measured reflects how hard a student has worked. The new model comes closer to the North American and Japanese systems. It gives greater weight to practical training and to intensive research projects. The way credits are measured reflects how hard a student has worked. The new evaluation methods reflect not only a student’s performance on exams, but also their lab experiments, presentations, hours spent on study, innovation capacities, and so forth.

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**Engineering Degree**

### Measurement Science and Technology Courses (credit points, cp)

<table>
<thead>
<tr>
<th>Course</th>
<th>Country</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation Engineering (Master Degree after Bachelor)</td>
<td>Austria</td>
<td>University of Applied Sciences Vienna</td>
</tr>
<tr>
<td>• Measuring and microsystems technology (3 cp), Environmental measuring technology (3 cp), Non-contact measuring processes (3 cp)</td>
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</tr>
<tr>
<td>Materials Engineering (Master Degree after Bachelor)</td>
<td>Belgium</td>
<td>Catholic University of Leuven</td>
</tr>
<tr>
<td>• Materials characterization techniques, principles and measurement procedures (6 cp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automation and Measurement (Bachelor Degree)</td>
<td>Czech Republic</td>
<td>Brno University of Technology</td>
</tr>
<tr>
<td>• Measurement in electro-engineering (6 cp), Measurement of physical quantities (6 cp), Medical diagnostics techniques (5 cp), Electronic measurement systems (5 cp)</td>
<td></td>
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</tr>
<tr>
<td>Biosystems Engineering (Master Degree after Bachelor)</td>
<td>Denmark</td>
<td>University of Aarhus</td>
</tr>
<tr>
<td>• Measuring technique for mechanical systems, gases, liquids (5 cp), Sensor technology (5 cp)</td>
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<tr>
<td>Electrical Engineering (Bachelor Degree)</td>
<td>Finland</td>
<td>Arcada University of Applied Sciences</td>
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<tr>
<td>• Measurement and sensor techniques (5 cp)</td>
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<tr>
<td>Sensor Systems Technology (Master Degree after Bachelor)</td>
<td>Germany</td>
<td>Karlsruhe University of Applied Sciences</td>
</tr>
<tr>
<td>• Physical sensors, Optical sensors, Sensor-actor-networks, Real-time data processing (30 cp), Chemical and bio-sensor systems, Automotive sensors applications (30 cp)</td>
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<tr>
<td>Mechanical Engineering (Master Degree after Bachelor)</td>
<td>Netherlands</td>
<td>Eindhoven University of Technology</td>
</tr>
<tr>
<td>• Physics and measurement methods (3 cp), Microscopic measurement methods (3 cp)</td>
<td></td>
<td></td>
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<tr>
<td>Mechatronics (Bachelor Degree)</td>
<td>Poland</td>
<td>Technical University of Lodz</td>
</tr>
<tr>
<td>• Fundamentals of metrology (4 cp), Metrology and measurement systems (4 cp)</td>
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Table 1 Engineering Education in Europe: Examples of Degrees in Engineering, and Measurement Science and Technology Courses of Study

* One credit point (cp) corresponds to 25 to 30 hours of work for students.
** European universities awarded for excellence in supporting mobile students (2009)

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- 2nd cycle: typically 90–120 ECTS credits (a minimum of 60 on 2nd-cycle level). Usually awarding a Master’s degree.
- 3rd cycle: Doctoral degree. No ECTS range given.
- Recognition of qualifications and periods of study
- Quality assurance.

One academic year corresponds to 60 ECTS-credits that are equivalent to 1,500 to 1,800 hours of study. The new model comes closer to the North American and Japanese systems. It gives greater weight to practical training and to intensive research projects. The way credits are measured reflects how hard a student has worked. The new evaluation methods reflect not only a student’s performance on exams, but also his or her lab experiments, presentations, hours spent on study, innovation capacities, and so forth.

ECTS makes teaching and learning more transparent and facilitates the recognition of studies (formal, non-formal and informal). The system is used across Europe for credit transfer (student mobility) and credit accumulation (learning paths toward a degree). It also informs curriculum design and quality assurance. Institutions which apply ECTS publish their course catalogues on the web, including detailed descriptions of study programs, units of learning, university regulations and student services. Course descriptions contain learning outcomes (what students are expected to know, understand and be able to do) and workload (the time students typically need to achieve the learning outcomes), expressed in terms of credits.
Higher Education and the role of Measurement Science and Technology

Almost all engineering degree educations include courses on Measurement Science and Technology with at least five credit points corresponding to about 150 hours work for students as exemplified by Table 1.

The institutions named in Table 1 belong to 65 higher education institutions from 16 countries which have been awarded in 2009 with special European quality labels in recognition of their efforts to make it easier for students to study abroad. These labels are given to universities which have shown excellence in applying the European Credit Transfer and Accumulation System (ECTS) and the Diploma Supplement (DS), two European instruments that make teaching and learning more transparent and facilitate the recognition of studies and qualifications. Criteria for the ECTS label are, amongst others, that all relevant information for foreign students (information package, course catalogue) are available in English.

Concerning education in Chemistry, nine European universities have recently joined forces and have formed a consortium, which offers a jointly delivered Master’s degree program Measurement Science in Chemistry (MSC) (www.msc-euromaster.eu). The jointly delivered study program is a fully Bologna-compliant master’s level program with the volume of 120 ECTS points. The program is open to students worldwide with bachelor’s degrees in chemistry (or related). The intention of this consortium is to offer master-level education in analytical chemistry adapted to today’s job market requirements for analytical chemists, especially focusing on the quality assurance of analytical measurement results. This course covers the most advanced topics of MSC, including the key concepts of analytical quality – traceability, validation, measurement uncertainty, etc.

Training in Metrology in Chemistry

To facilitate the training of Metrology in Chemistry to laboratory staff, researchers, educators, decision-makers and accreditation assessors, the European TrainMIC program has been created (www.trainmic.org). The vision of TrainMIC is to improve the quality of analytical results by promoting and providing a European-wide, harmonized training program via a network of national providers sharing resources, including materials, training systems.

TrainMIC is operational across many parts of Europe via national teams. These teams use shareware pedagogic tools which have been harmonized at European level by a joint effort of many experts across Europe working in an editorial board. The trainers use presentations – e.g. on sampling, validation of measurement procedures, traceability, uncertainty, statistics, reference materials, interlaboratory comparisons, internal quality control – to provide theoretical training covering the topics related to metrology in chemistry and the require-ments of standards and guidelines (e.g. ISO/IEC-17025, ISO Guides 34 and 35 and ISO-17043).

The educational material has been translated into ten different languages. The Joint Research Centre Institute for Reference Materials and Measurements of the European Commission (JRC-IRMM) of-

Training in Industrial Metrology and Fundamentals of Metrology

As a unique training center for the science and application of traceable measurements, the Braunschweig International Graduate School of Metrology (IGSM) was established in 2007 by the Technische Universität (TU) Braunschweig and the Physikalisch-Technische Bundesanstalt (PTB) (http://igsm.tu-bs.de).

The University of Braunschweig focuses on scientific-technical fields with a strong Focus Field need for metrology. Three departments combine their expertise in the graduate school: the departments of (i) Electrical Engineering, Information Technology, Physics, (ii) Life Sciences and (iii) Mechanical Engineering.

The PTB is the national metrology institute of Germany, operating a number of worldwide unique facilities, mostly related to the primary implementation of the SI units. The PTB contributes to the graduate school with scientists and engineers with many years of experience and exceptional equipment. The TU Braunschweig provides all the necessary training capabilities.

The structure of the International Graduate School of Metrology is divided into two focus fields: Industrial Metrology and Fundamentals of Metrology.

- Industrial Metrology consists of Metrology for Production, Metrological Instrumentation and Nanometrology and is devoted to innovative concepts for the measurement infrastructure according to the demands of industry and trade. It includes topics such as in-line metrology, production engineering and next-generation electronics and other micro- and nanosystems.
- Fundamentals of Metrology consist of Metrology in Life Sciences, Quantum Metrology and Precision Experiments. It comprises all fundamental research aspects related to the implementation and dissemination of the units.

Research efforts aim at utilizing quantum effects and universal physical constants to implement next-generation primary standards.

The curriculum of the graduate school comprises also the mandatory lectures Foundations of Metrology. The lectures cover the basic metrological methodology, an overview of the base and derived units, the state-of-the-art technologies, how to implement them and the global measurement system. It aims at a common, broad and comprehensive metrological background and helps to overcome the fragmentation of the topics in the natural and engineering sciences.

The curriculum is supplemented by internships in local industrial calibration laboratories for students in the focus field “Industrial Metrology,” and by guest researcher opportunities in renowned research laboratories abroad for students in the focus field “Fundamentals of Metrology.” The lectures and courses are held in English.

The Summer School of Metrology takes place at attractive places around Braunschweig every two years and lasts about one week. It took place for the first time in 2008, with Nobel Prize winner Klaus von Klitzing as one of the lecturers. Leading international speakers are invited to give lectures on the latest advances in metrology. The summer school gives the students an opportunity for international networking and integration into the metrological community.
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