Measurement Accuracy and the Impact on Society

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Greetings! As I am writing this letter, it is a beautiful October day and I am reminded that one of the pleasures of living in Albuquerque, New Mexico, is enjoying the annual Albuquerque International Balloon Fiesta. This event has over 500 balloons each year and is the largest hot air balloon festival in the world. If you have never had the chance to attend, I encourage you to make a trip to Albuquerque in early October to experience it for yourself.

It was a pleasure to see many NCSL International members and attendees in Saint Paul, Minnesota at this year’s Workshop & Symposium, which had the theme, “Measurement Accuracy and the Impact on Society.” I would like to thank Paul Packebush, Conference Committee VP; Craig Gulka, NCSLI Executive Director; the NCSL International Business Office staff; Carol Hockert, Technical Program Chair; Dilip Shah, Tutorial Program Chair; and all the speakers, attendees and volunteers that contributed to making this another successful conference.

You can also begin to make your plans for the 2017 Workshop & Symposium which will take place at the Gaylord National Convention Center in National Harbor, Maryland on August 13-17, 2017.

The 2017 Technical Exchange is just around the corner, and will be held on January 23-24, 2017 at the Florida Hotel & Conference Center in Orlando, Florida. The Technical Exchange Measurement Training Program includes a wide range of intriguing courses related to many areas of metrology. The Measurement Training Program, schedule, and registration information are available at ncsi.org.

One of the great aspects of being involved with NCSL International is the opportunity to partner with International colleagues and be involved with issues of global importance. Most of us who work in the field of metrology and calibration utilize ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories. This standard is currently being revised, and three of our board members are involved in this task: Jeff Gust, Fluke Calibration; Tim Osborne, Trescal Corporation; and Georgette Macdonald, NRC Canada. We have a committee update from the ISO CASCO WG 44 in this edition of Metrologist.

It was a pleasure to recognize the 100-year anniversary of the National Research Council Canada (NRC), the national metrology institute in Canada. I sent a letter of congratulations on behalf of NCSL International, and Jack Somppi presented a plaque at the Canadian Regional meeting in recognition of the event.

Thank you all for your contributions to NCSL International. I very much look forward to seeing you in January at the Technical Exchange in Orlando, Florida.
From The Boardroom
Saint Paul, Minnesota

Dana Leaman
NCSLI Secretary
dana.leaman@nist.gov

The NCSL International Board of Directors held their third quarter meeting at the 2016 NCSLI Workshop & Symposium in Saint Paul, Minnesota. A total of 29 individuals attended over the course of the two-day meeting. In addition to the NCSLI Operational and Division Vice President presentations, the list of presenters included Greg Strouse, NIST; Georgette Macdonald, NRC Canada; Salvador Echeverria-Villagomez, CENAM; Yasuhiro Nakamura, NMIJ; Kamal Hossain, NPL and EURAMET; Doug Olsen, BIPM; Pavel Neyezhakov, COOMET; Chuck Ehrlich, OIML; and Pete Loftus, IET.

Reports from the NCSLI Operations and Division Vice Presidents highlighted various committee and section activities. Two writing proposals were approved for the creation of documents on the topics of evaluation of impacts associated with out of tolerance findings related to Measurement and Test Equipment (M&TE) as well as guidelines for conducting inventory of laboratory assets. In our International activities, the Memorandum of Understanding (MOU) with COOMET was re-signed.

The 2016 Slate of Candidates was also approved by the board. The following vice presidents are being submitted for re-election to the board for the 2017-2018 term:

Jeff Gust, Fluke Corporation; Rob Knake, A2LA; Mark Lapinskes, Tektronix; Marcus McNeely, McNeely Consulting Services; Bill Miller, Lockheed Martin; Tony Reed, Boeing; James Smith, Boeing; Robert Sawyer, Consumers Energy; and Jack Somppi, Measurements International. The ballot will be forthcoming to the membership for voting in August.

As part of the required board activities, Roger Burton reappointed Dana Leaman as the NCSLI Secretary for the 2017-2018 term. Also, the president noted the international appointments that had been re-confirmed at the February 2016 board meeting.

It was also noted that the present SIM Representative, Dianna Lalla-Rodrigues, would not continue in her role and Claire Saundry, NIST, was appointed to the position. A listing of the International Liaisons can be found in the NCSLI Who’s Who Directory both in print and on the NCSLI website.

The board also continued to discuss activities surrounding the adoption of the Carver Model for board governance. A workshop was held regarding activities for each of the three pillars. The groups also reviewed the administrative policies, procedures and guidelines for determination of ownership. Further development of the ends policies is planned for discussion at the next board meeting in Boulder, Colorado, October 16-18, 2016.
Welcome New Members
NCSL International Membership opens doors to personal growth and career advancement

A.K.O., INC.
50 Baker Hollow Road
Windsor, CT 06095
Contact: Jim Pagano
860-298-9765
jim@akotorque.com

A.K.O., Inc. is a custom manufacturer of torque calibration systems, which are used by such industries as: aviation & aerospace, power utilities, oil & gas, military, construction, transportation manufacturing, torque testing laboratories, torque wrench manufacturers and others. We also provide ISO/IEC 17025:2005 Accredited torque calibration services at our on-site torque calibration Lab. A.K.O. – “The Standard by which Torque is Calibrated.”

NASA WALLOPS FLIGHT FACILITY
34200 Fulton Street
Wallops Island, VA 23337
United States
Contact: Ralph Hickman
757-824-2451
ralph.e.hickman@nasa.gov

Wallops Flight Facility, located on Virginia’s Eastern Shore, was established in 1945 by the National Advisory Committee for Aeronautics as a center for aeronautic research. Today, Wallops is NASA’s principal facility for management and implementation of suborbital research programs. The research and responsibilities of Wallops Flight Facility are centered round providing a fast, low-cost, highly-flexible and safe response to meet the needs of the U.S. aerospace technology interests and science research. The 1,100 full-time civil service and contractor NASA Wallops employees act as a team to accomplish critical missions.

PROTEC EQUIPMENT RESOURCES, INC.
1517 North Carrier Parkway
Suite 116
Grand Prairie, TX 75050
Contact: Frank Wilde
972-352-5550
fwilde@protecequip.com

Protec Equipment Resources, Inc. has been a leader in electrical test equipment for over 10 years. Our service has become legend within the electrical testing community, and we pride ourselves at being the best at what we do by a wide margin. With more locations nation-wide, local inventory for better shipping rates, and great application support from local teams who work hard to get to know your special requirements, you can count on Protec to do what it takes to help you get the job done right. Our in house calibration lab offers accurate and affordable calibration services for all makes of electrical test and measurement equipment. We are there when and where you need us.

Our Mission
To provide the best opportunities for the world’s measurement science experts and practitioners
Recro Gainesville LLC provides solid dosage form product development, scale-up, analytical, manufacturing, and packaging services to the global pharmaceutical market. We have a long and successful history in the development and manufacture of pharmaceutical oral dosage forms for pharmaceutical markets worldwide. In addition, we have a proven track record of partnering with the commercial launch of multiple products worldwide.

TRINIDAD AND TOBAGO BUREAU OF STANDARDS
1-2 Century Drive
Trincity Industrial Estate
Macoya, Tunapuna
Trinidad and Tobago
Contact: Theodore Reddock
868-262-8827
theodore.reddock@ttbs.org.tt

The Trinidad and Tobago Bureau of Standards (TTBS) is a corporate body governed by the authority of the Standards Act No. 18 of 1997 and the Metrology Act No. 18 of 2004. Operating under the aegis of the Ministry of Trade and Industry, the TTBS’ primary role is to develop, promote and enforce standards to improve the quality and performance of goods produced or used in Trinidad and Tobago. It also aims to ensure industrial efficiency and development, promote public and industrial welfare, provide quality health and safety standards, and protect the environment.

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January 23 - 24, 2017 IN ORLANDO, FLORIDA

PRICING AND REGISTRATION

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Registration Includes:
- Materials Bag
- Breakfast, Lunch and Expert Measurement Training for that day!

HOTEL INFORMATION

THE FLORIDA HOTEL & CONFERENCE CENTER

1500 Sand Lake Road
Orlando, FL 32809

NCSL International Room Rate: $149

Call for Reservations: 1-800-588-4656

The NCSLI Technical Exchange will build and enhance specific hands-on skills in the calibration of measurement and test equipment. This two-day training will also teach best practices along with introducing new and innovative calibration hardware, software and calibration services. Each training session is taught by measurement science experts from throughout the industry.
Technical Exchange Measurement Training Program

TE-1 | Monday, January 23
8:00 AM - 5:00 PM | One-Day

**Understanding ISO/IEC 17025 Requirements**
Rob Knake, American Association of Laboratory Management (A2LA)

**Topic: Laboratory Management**
Full-day tutorial will cover highlights of ISO/IEC 17025 requirements. This course is applicable for organizations that are currently accredited, are in the process of obtaining their ISO/IEC 17025 accreditation or for those who are interested in applying the ISO/IEC 17025 requirements in their facility.

TE-2 | Monday, January 23
8:00 AM - 5:00 PM | One-Day

**Improved Performance via Process Mapping**
Dean Williams, Duke Energy

**Topic: Laboratory Management**
This workshop starts by providing a brief history and background for TLS (Theory of Constraints, Lean, Six Sigma) as an integrated performance improvement strategy. The workshop will then go on to describe the principals and practices from TLS associated with process mapping as a basic tool of continuous improvement. Included will be specific metrics that can be used to measure current and future performance of process flows within a calibration lab environment.

With that basic knowledge in hand, class members will then work as a group to create a typical current state process flow map, identifying “rocks” in the flow stream that will need to be removed to reduce drag and increase process flow. Applying the TLS tools the group was exposed to earlier, the class will then, as a group, develop a future state process flow map and a 30/60/90 day prioritized action plan for achieving the desired future state.

By the conclusion of the workshop the participants will be able to apply basic process mapping techniques, identify obstacles to process flow, and develop a prioritized action plan for transitioning from current state to a desired future state process.

TE-3 | Monday, January 23
8:00 AM - 12:00 PM | ½ Day AM

**Risk Based Thinking in Metrology**
Andy Oldershaw, National Research Council Canada (NRCC)

**Topic: Laboratory Management**
Management system standards are a one size fits all solution, tailorable through statements such as to the extent necessary, as appropriate, sufficient to... Risk based thinking has been a growing trend spreading to all aspects of the economy and society for many years. It will become more prominent for laboratories with the adoption of the upcoming ISO/IEC 17025 revision. This module will help those involved planning, managing, implementing and reviewing any aspect of laboratory management systems to apply risk based thinking to determine what these statements mean to their particular situation.

Tools and techniques to identify, analyse, respond to, monitor and review risks will be introduced. Participants will have the opportunity to put them into practice during class room exercises.

TE-4 | Monday, January 23
8:00 AM - 5:00 PM | One-Day

**Geometric Dimensioning and Tolerancing (GD&T) Application to Gage Calibration Requirements**
E.A. “Tony” Bryce, Sandia National Laboratories

**Topic: Dimensional**
A basic introduction to the concepts of GD&T and the application to gage certification requirements. This course is suitable for those individuals needing a basic understanding of the concepts related to drawing and CAD model definition. The course will cover symbol interpretation, feature control frames, datums and datum reference frames (DRF), material conditions (MMC & LMC), positional tolerancing, profile tolerancing, orientation (parallelism, angularity and perpendicularity), profile tolerancing and runout. Application of concepts to gage requirements. This course is based on ASME Y14.5 standard.

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Technical Exchange Measurement Training Program

TE-5 | Monday, January 23
8:00 AM - 12:00 PM | ½ Day AM

Vibration and Shock Sensor Theory and Calibration
Eric Seller, The Modal Shop
Topic: Physical
This four-hour tutorial on vibration calibration will dive into calibration theory, standards, and methodology for dynamic sensors as well as explanations of different sensor types and the operational theories behind them. Target audience is beginner to intermediate level.

TE-6 | Monday, January 23 and Tuesday, January 24
8:00 AM - 5:00 PM | Two-Day

Selection, Calibration, and Use of Contact Thermometers
Dawn Cross, National Institute of Standards and Technology (NIST)
Topic: Dimensional
In this seminar, we will discuss contact thermometers commonly used in industry for applications that use platinum resistance thermometers, thermistors, and thermocouples. Lecture topics covered will include:
• Thermometer overview of each type, characteristics, and expected uncertainties;
• Selecting a thermometer for a specific application;
• Creating a calibration uncertainty budget and a temperature measurement uncertainty budget;
• Selecting and using digital thermometers;
• Calibration techniques and measurement validation methods;
• Alternatives to traditional calendar recall dates for recalibration;
• Statistical process control and maintaining traceability to NIST;
• The step-by-step development of a Scope of Accreditation (e.g. uncertainty budgets) for different temperature calibration services;
• An assessor’s point of view during an on-site technical assessment, and
• Proficiency tests for achieving accreditation.
Laboratory session will include:
• Using digital thermometers;
• Using an ice melting to check the calibration status of your thermometer;
• Determining the uncertainty of a dry-well block calibrator;
Exploring the measurement differences and uncertainties between digital thermometers.

TE-7 | Monday, January 23 and Tuesday, January 24
8:00 AM - 5:00 PM | Two-Day

Pressure and Vacuum Measurement
Jacob Ricker and Julia Scherschligt, National Institute of Standards and Technology (NIST)
Topic: Dimensional
Making good pressure measurements from ultra-high vacuum to atmospheric pressure and higher requires the correct use of many kinds of gauges and proper use of vacuum technology. Among the most widely used gauges are ionization gauges, spinning rotor gauges, thermal conductivity gauges, capacitance diaphragm gauges, quartz bourdon tube gauges, and resonant silicon gauges. However, the incorrect use of any of these gauges can result in bad measurements that cost time and money. This two-day course will cover the fundamentals of pressure measurements from 10⁻⁸ Pa to 10⁺⁸ Pa (10⁻¹⁰ torr to 10⁺⁶ torr), focusing on the selection and proper use of appropriate gauging technology for a given application. A survey of calibration techniques will be presented along with recommendations for obtaining best performance. Part of the class time will be devoted to set-up of a simple vacuum calibration system. This will enable live demonstration of some of the gauges discussed in the course, and give students an opportunity to participate in the vacuum system set-up and disassembly.

New for this year is a section devoted to the use of piston gauges as the reference standard. We will also bring back the popular overview of good vacuum system design and construction using off-the-shelf vacuum equipment and fittings. Basic vacuum system design do’s and don’ts will be covered. Pumping systems, sealing systems, valves, and vacuum plumbing solutions will be briefly covered. For pressures substantially higher than atmosphere, proper selection and operation of piston gauges for gas and oil calibrations will be covered. Attendees are invited to share their own pressure measurement and or vacuum system design problems for in-class discussion.

TE-8 | Monday, January 23 and Tuesday, January 24
8:00 AM - 5:00 PM | Two-Day

Flow Measurement and Uncertainties
John Wright and Aaron Johnson, National Institute of Standards and Technology (NIST)
Topic: Dimensional
We will cover background metrology and fluid mechanics subjects that are important for flow measurement including:
• the transition from laminar to turbulent flow;
• pipe flow profiles and boundary layer concepts;
• the continuity equation and conservation of mass.

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• fluid and gas properties and their calculation
• Pressure and temperature measurement

The operating principles and equation of flow for the commonly used flow measurement techniques will be derived and explained including:
• Differential pressure devices (laminar flow meters, orifice plates, venturi tubes)
• Critical flow venturis and nozzles
• Ultrasonic flow meters
• Turbine and positive displacement meters
• Electromagnetic flow meters
• Coriolis flow meters
• Thermal meters
• Rotameters

Methods of flow meter calibration used in laboratory, including NIST standards will be covered. Field conditions will be discussed as well as installation effects and how distorted velocity profiles affect flowmeter accuracy. Flow calculations and uncertainty analyses for certain flow meter types will be taught.

Our goal is cover topics with a range of physics and mathematical difficulty so that the course will be of interest to students with a wide range of mathematical backgrounds and flowmeter experience. Distributed throughout the course, there will be optional, advanced sections of interest to only extreme flow geeks.

TE-9 | Monday, January 23
8:00 AM - 5:00 PM | One-Day
AC Current Measurements
Christopher Bailey, Fluke Calibration

Topic: Electrical
The course will cover AC Current using an AC measuring standard with shunts and addressing the uncertainty contributors. We will cover the AC/DC theory to set the reference to DC. Also we will have some hands on time to work thru the process with the AC/DC method and a newer method with the new A40B shunts.

TE-10 | Monday, January 23
1:00 PM - 5:00 PM | ½ Day PM
Microwave Measurement Basics
Ronald Ginley, National Institute of Standards and Technology (NIST)

Topic: Electrical
Have you ever wanted to learn more about microwave measurement techniques? This session is the place to be! An introduction to the measurement concepts for microwave power and scattering-parameters will be covered. Specific topics covered will include transmission line theory, practical handling or the do’s and don’ts for transmission lines and microwave connectors, Vector Network Analyzer calibration/measurements and real world sources of uncertainties, microwave power detectors types, power measurements and uncertainties, and the session will conclude with a discussion of verification techniques for microwave measurements.

TE-11 | Monday, January 23
1:00 PM - 5:00 PM | ½ Day PM
Humidity Calibration Uncertainty
Dr. Cesar “Jun” Bautista, Masy BioServices

This presentation will touch upon chamber calibration related topics with special emphasis on humidity chambers in terms of the most recent updates, proposed changes, recommended practices, and compliance to the mandates and conformance to established local and international standards and guidelines. Highlighted during this presentation will be the measurement uncertainties that may necessarily be considered when calibrating climatic chambers. I will also be demonstrating the concept of 0% RH as a reference (not a measurement) point and the rationale behind its usage. As a bonus, we will be exhibiting new concepts in climatic chamber design and manufacturing that support the measurement uncertainty elements in climatic chamber calibrations.

Learning Objectives:
• Climatic Chambers (Humidity Chambers) Design Concepts, 2 Pressure Generator vs. Vapor Mixing
• Calibration Methods
• Measurement Uncertainties in the Calibration and Certification of Humidity Chambers
• Future Look and Features of Humidity Chambers and the Market Demands and Challenges

TE-12 | Tuesday, January 24
8:00 AM – 12:00 PM | ½ Day AM
Achieving Accreditation: Traceability, CMC’s Software Validation and Assessment Survival
Greg Strouse, National Institute of Standards and Technology (NIST)

Topic: Laboratory Management
This seminar will discuss several topics regarding various aspects of achieving accreditation including:
• How traceability to the SI is created and defined
• Maintenance of the traceability chain
• How traceability plays a critical role in 17025
• Developing Calibration and Measurement Capabilities (CMCs) for inclusion in a Scope of Accreditation
Technical Exchange Measurement Training Program

- 17025 requirements of software validation and the assessor interpretation
- Preparing for an assessment—what does an assessor look for in the implementation of a Quality System
- Understanding the NIST and the international metrology puzzles

TE-13 | Tuesday, January 24
8:00 AM – 5:00 PM | One-Day
Measurement Uncertainty – Fundamental Applications
Dilip Shah, E=MC3 Solutions
Topic: Measurement Uncertainty
This is a full-day, beginner to intermediate level workshop targeted towards metrologists, technicians and engineers. This workshop will also be useful for specifiers of calibration services. This workshop covers the Measurement Uncertainty fundamentals for metrology professionals new to the subject. Statistical concepts relevant to Metrology and Measurement Uncertainty are introduced, explained and demonstrated. The process of measurement uncertainty estimation is demonstrated per the guidelines from the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

TE-14 | Tuesday, January 24
8:00 AM - 5:00 PM | One-Day
Understanding RF Power Calibrations at 1mW and 250W
Charlie Sperrazza, TEGAM, Inc.
Topic: Electrical
This one day workshop provides a practical introduction to 1mW RF power transfer between two coupled ports with discussions on key components and methods for power sensor calibrations. It includes Gamma correction and how to use Gamma correction to calculate power transfer and port match, and the importance of vector measurements to the precise knowledge of power transfer. The workshop will also cover typical arrangements of RF Power Sensor Calibration stations; the step-by-step process of calibrating thermocouple, thermistor and EEPROM power sensors; contributing factors to uncertainty of a calibration factor; practical examples, with Excel Spreadsheet and real data of calculating expanded uncertainty of a calibration factor; and understanding linearity of power sensors including new developments and designs in RF Power Sensors design has allowed for large power dynamic ranges. The workshop will also include an introduction to 250W power measurements and calibration techniques for wattmeter element test and calibration. Workshop will include a discussion of the components required to produce these measurements and the factors that contribute to uncertainties as well as the unique challenges of measurement and calibration at these power levels and methods to mitigate them.

TE-15 | Tuesday, January 24
8:00 AM – 5:00 PM | One-Day
Measuring and Characterizing Surface Topography
Hy Tran, Sandia National Laboratories
Topic: Dimensional
Surfaces cover everything—and they influence behavior and performance of parts. In this tutorial, we will focus on the topography of surfaces—the texture and roughness. Texture includes both short spatial wavelength components (what one would call roughness) and longer wavelength components (what one would call waviness and form). Texture may have directionality (lay). These qualities are specified in mechanical product drawings, and the evaluation of roughness is defined in both ASME and ISO standards. This tutorial provides an introduction to surface metrology and to the evaluation of roughness.

TE-16 | Tuesday, January 24
8:00 AM - 5:00 PM | One-Day
Good Weighing Practices
Ian Ciesniewski, Mettler-Toledo, LLC
Topic: Physical
Did you know that a balance calibration is incomplete, without a statement of measurement uncertainty? Or that balance uncertainty is largely independent of loaded mass? Most analytical balance weighing inaccuracies occur outside of the balance, but are attributable to influences within the control of the user. Most calibration regimes contain elements of legacy metrology programs that have been passed directly down from mechanical weighing instruments, even though the components of measurement uncertainty exhibit themselves differently, for an electronic weighing instrument. Many organizations “Over test” without generating much meaningful metrology. During this session, we will break down how measurement uncertainty exhibits itself, across the capacity of an electronic balance or scale. We will cover how to assess and assign a Measurement Uncertainty budget for an electronic balance or scale, and discuss robust, risk-based approaches to the assessment and estimation of significant, contributing uncertainty components, in
order to build a thorough, yet scientifically-sound risk-based metrology program for bench or floor weighing instruments. We will cover overcoming potential errors, and optimize a balance metrology regime. Focusing on:

• Factors influencing Measurement Uncertainty
• Balance location and set up
• User testing
• Personal weighing technique
• Increasing productivity from your weighing equipment

TE-17 | Tuesday, January 24
8:00 AM - 5:00 PM | One-Day

Temperature Monitoring and Traceability in the Cold Chain
Michal Chojnacky, National Institute of Standards and Technology (NIST)

Topic: Dimensional

In this seminar, participants will learn effective temperature monitoring strategies for use in cold-chain transport and storage of temperature-sensitive products. NIST has collaborated extensively with the Centers for Disease Control to develop improved guidelines for temperature monitoring of vaccines at the provider-office level. As the range of temperature-sensitive products in our world continues to increase, so does the demand for accurate, traceable temperature monitoring solutions, coupled with cost-effective calibration methodologies. This one-day seminar is designed to address the needs of staff directly involved with the management, storage and transport of cold-chain products, as well as device manufacturers and calibration facilities endeavoring to meet the needs of this rapidly-expanding field. The seminar includes a lecture session followed by a hands-on learning experience.

TE-18 | Tuesday, January 24
1:00 PM - 5:00 PM | ½ Day PM

Root Cause Analysis
Colin Reitman, American Association of Laboratory Accreditation (A2LA)

Topic: Laboratory Management

Root cause analysis is the foundation on which effective corrective and preventative actions are built. This course will give you the tools you need to perform root cause analysis, create clear corrective actions and preventative actions, and implement continual improvements to quality management systems. The emphasis will be on ISO/IEC 17025 requirements, and the course objectives will be achieved through lecture and several in-class activities.
This year’s NCSL International Workshop & Symposium, held in Saint Paul, Minnesota, provided an excellent venue for measurement science professionals to network and solve measurement challenges.

The conference started off with a keynote address from ASTM Chairman of the Board, Dr. Ralph Paroli. Ralph discussed the increasingly critical need to develop normative and calibration standards for use in the cannabis industry; a topic of concern and urgency as more countries and states decriminalize its availability. Expanding on the topic, Jeremy Applen, founder of Page Analytical, opened the keynote breakfast with his address on Thursday. Jeremy gave an insightful view into the measurement challenges of the $2.7 billion cannabis industry and how it is driving advancements in metrology across areas such as medicine, medical devices, analytical chemistry and quality management.

We continue to see dedicated participation from members, exhibitors, presenters and instructors throughout the conference. We held 64 technical presentations, 26 poster sessions and 22 hands-on tutorials for attendees to expand their knowledge and skills to be better prepared for measurement challenges within their discipline. We also hosted three panel sessions which provided opportunities to discuss and plan future requirements in the world of measurement science. There were networking opportunities provided for attendees at the Exhibitor Welcome Reception and Metrology Mixers.
Keynote Speakers

Ralph M. Paroli
DEVELOPING QUALITY STANDARDS FOR CANNABIS USING THE ASTM APPROACH

Jeremy Applen
CANNABIS: THE STATE OF THE SCIENCE

Tetrahydrocannabinol (THC)
Our tutorial program examined a wide variety of measurement practices, instruments, and fundamentals. Our tutorials included hands-on experience with subjects such as pressure metrology, gas flow measurement, test uncertainty, temperature calibration and radiation thermometry calibration. These tutorials varied in skill level, from beginner to advanced, so that attendees could participate in the program regardless of experience. As always, the tutorial program was a prime way for attending metrology professionals to hone their skills and learn about new advancements in different disciplines of measurement science.

During the technical program, we once again held our well-received Amazing Stories of Measurement sessions hosted by National Metrology Institutes and global leaders in measurement science.

The conference exhibit hall continues to grow every year, and our 2016 exhibit hall displayed companies and measurement science professionals within the global metrology industry. We would like to thank every company and organization that decided to participate in this year’s exhibit hall. I also want to thank our sponsors: The Boeing Company, Consumers Energy Laboratory Services, Fluke Calibration, Keysight Technologies, Mensor Corporation, National Instruments, Precision Environments and Quality Magazine for all the support.

I encourage all of you to consider sharing your accomplishments and research through posters, presentations, and tutorials at next year’s conference. Call for Papers for the 2017 Workshop & Symposium is open and the conference theme is “Precision & Performance with Measurement Science.” Set your calendar for August 13-17, 2017 and join us at the Gaylord National Convention Center in National Harbor, Maryland.
There were nine oral and two poster sessions during the NCSL International Workshop & Symposium. The oral sessions were made up of 64 speakers who presented concurrently in four different tracks. These amazing presentations were presented by invited speakers from National Metrology Institutes, calibration technicians, testing laboratory professionals, accreditation bureaus, metrology educators, and training experts. Each technical session addressed emerging issues such as additive manufacturing, remote auditing, infrared thermometry calibrators, proficiency testing, ISO/IEC 17025 revisions and measurement challenges associated with the healthcare industry.

Of note was the number of presentations associated with the redefinition of the kilogram, which is scheduled for 2018. These talks covered the development and characterization of equipment and processes to be used during and after the redefinition. They also highlighted the design of the future balance where manufacturers may be able to produce an instrument that will realize Planck’s constant on the shop floor, thus eliminating the need to maintain a set of calibrated weights. One of the papers associated with this subject, “The NIST Magnetic Suspension Mass Comparator,” written by the National Institute of Standards and Technology’s (NIST) Edward Mulhern, won the overall Best Paper award.

The three panel sessions were well attended and covered Healthcare Metrology, NCSL International Early Career Professionals: Industry & Military Committee, and the Revision of ISO/IEC 17025 – all timely topics. With the conference taking place in the Twin Cities, it made sense to have two additional sessions devoted to healthcare metrology. These healthcare-related sessions included presentations on electro-cardiograph simulators, measurement uncertainties in calibration of climatic chambers, accuracy of pipettes, FDA calibration-related warning letters, and use of ISO/IEC 17025 and ANSI/NCSL Z540.3.
A lot of activity revolved around the two poster sessions, which featured 27 great posters, including two that addressed economic evaluations associated with metrology provided by Centro Nacional de Metrologia’s (CENAM) Dr. Salvador Echeverria-Villagomez and AssetSmart’s Phillip Chase. Having the poster sessions right next to the lunch area created plenty of traffic for the presenters. One presenter commented they preferred the poster format over the oral presentation because there is much more interaction and dialogue. I hope this inspires some of you to produce a poster presentation for next year’s conference.

Plans for the 2017 Workshop & Symposium Technical Program are getting underway, I hope to see you August 13-17, 2017 at the Gaylord National Convention Center in National Harbor, Maryland!
2016 BEST PAPER Awards

“INFLUENCE OF ADAPTERS ON AC-DC DIFFERENCE MEASUREMENTS”
Authors: Stefan Cular, Thomas E. Lipe
National Institute of Standards and Technology (NIST)

“CALIBRATION OF ELECTRO-CARDIO GRAPH SIMULATORS”
Authors: Steven Yang, Aaron Y.K. Yan, Chris M.N. Ng
The Government of the Hong Kong Special Administrative Region Standards and Calibration Laboratory

“CALIBRATION OF OPTICAL FIBER TIME DOMAIN REFLECTOMETERS IN ACCORDANCE WITH IEC 61749-1:2009”
Authors: Samuel C.K. Ko (pictured), Aaron Y.K. Yan
The Government of the Hong Kong Special Administrative Region Standards and Calibration Laboratory

“UNDERSTANDING THE TEST MEASURAND AND THE PROFOUND IMPACT ON CALIBRATION, VERIFICATION, AND UNCERTAINTY”
Author: James G. Salsbury PhD (pictured)
Mitutoyo America

Best Overall Paper

“CHARACTERIZATION OF THE NIST MAGNETIC SUSPENSION MASS COMPARATOR APPARATUS AND FACILITY”
Authors: Edward Mulhern, Corey Stambaugh
National Institute of Standards and Technology (NIST)

NCSLI Measure Editors’ Choice Award

“THE NIST UNCERTAINTY MACHINE”
Authors: Thomas Lafarge, Antonio Possolo
National Institute of Standards and Technology (NIST)
AWARDS RECEPTION

[Images of people and awards]
Rakesh is a Master’s Student in Industrial Engineering from Caterpillar College of Engineering and Technology, Bradley University, Peoria, Illinois. He completed his Bachelor’s in Mechanical Engineering in 2010 while living in India. He then went on to work for four years at John Deere India as a Design Engineer and six months as Manager at Design for Escorts Agri Machinery, India. As a part of his Master’s curriculum, he is passionate towards quality and manufacturing integration. His course work covers topics such as manufacturing quality control, engineering statistical analysis, design and analysis of experiments, operations research, advanced computer aided manufacturing.

He also worked as a graduate teaching assistant for undergrad subjects such as metrology and instrumentation, manufacturing lab, lean manufacturing and engineering design. Rakesh possesses great skill in process and equipment such as CNC Machining, CMMO, FARO, GD&T, control charts, and ZeGage profilometer.

Rakesh has also been associated with American Society of Quality (ASQ) Heart Illinois Section 1211 as a Treasurer since August 2015. By being an active member and attending various technical meetings, he developed a keen interest in quality and measurement in different fields of study along with its importance and implementation. He served as an executive member for Bradley University ASQ Chapter and recruited several students from diverse departments to understand the importance of quality.

His Research Project at Bradley University is on “Form-error control and surface roughness reduction in bending-machining hybrid manufacturing” using metrology and quality as a primary factor for analysis and as an innovative approach to calculating the right dimensional accuracy. Hybrid manufacturing is the paradigm of manufacturing methodology combining additive, subtractive and other conventional manufacturing technologies that were traditionally used alone. As an enabling methodology, hybrid manufacturing seeks to merge the advantage of each individual process such that production of complex metal parts is possible and efficient by using each process where best suited. This can be done while maintaining the minimum variation in the part’s bend angle, bend radius and parallelism as desired to the theoretical measuring plane of the part. The primary focus of this research is to maintain the part parallel to the theoretical part in order to maintain its parallelism and surface roughness. The springback effect will lead to dimensional error in the workpiece and is difficult to control. Bending-Machining Hybrid Manufacturing intends to maintain the material utilization and material flow advantages from bending while taking advantage of the flexibility of machining process. However, the challenge lies in the control of form error and surface roughness as the hybrid process involves the machining of thin-wall workpieces. His research presents the methodology of form error control and surface roughness reduction simultaneously on such a hybrid manufacturing setup.

Rakesh has also won several distinguished awards at Bradley University including the Graduate Student Leadership and Service Award 2016, the Dean’s Award for his research from the Bradley University Scholarship Expo, and the Frank Gryna Scholarship 2016 from ASQ Heart of Illinois Section 1211.

In his spare time, Rakesh loves playing soccer and enjoys listening to music.
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Ronald A. Ginley was born in 1957 in Denver, Colorado. In 1981, he received a BS in Electrical Engineering from the University of Colorado and in 1983 he received an MS in Electrical Engineering from Carnegie-Mellon University. His area of study was solid state physics and Electromagnetic field theory. Mr. Ginley is currently employed by The National Institute of Standards and Technology (NIST) and has been for the past 34 years. At NIST, Mr. Ginley has several areas of responsibility which includes metrology research in the microwave scattering-parameter and power areas. He also leads the microwave measurement services which include the microwave s-parameter, thermal noise and power measurement services.

Ron is an active participant and contributor to the annual NCSL International Conference Tutorial Program and the NCSL International Technical Exchange where he regularly teaches tutorials about microwave measurement. He is also an active participant and contributor with the Measurement Science Conference (MSC), International Microwave Symposium (IMS), and Automatic Radio Frequency Techniques Group (ARFTG) Conference. He has participated in these organizations since the mid-1980s, presenting papers and serving on several standards and working committees. Ron currently is the treasurer and executive committee member of the ARFTG, a professional group dedicated to microwave/mm-wave measurements. He is also on the executive committees for the Global Symposium on Millimeter-waves (GSMM) and the Wireless and Microwave Technology Conference (WAMICON). Ron will be chairing the IMS 2022 Symposium, the 90th ARFTG Microwave Measurement Symposium in 2017 and the 2018 GSMM Conference.

Ron has many different duties while working for what is now the RF Technology Division of the Communications Technology Laboratory of NIST. Ron is a sought after international expert in the areas of microwave scattering-parameter and microwave power measurements. He has helped develop many of the different systems and...
techniques that are employed in those areas at NIST and throughout the world.

During the 1980s, he was principally responsible for advancing the design and theory of the NIST developed Dual Six-port Automatic Network Analyzers. This included improving the hardware and software of the six-port systems which resulted in faster systems with reduced uncertainties. In the late 1980s and early 90s, Ron took on responsibility for the microwave power measurement services offered at NIST. Through the 90s, he was responsible for the advancement of the microwave power measurement systems. In the late 1990s, he became the project leader for all the connectorized microwave measurement services. Included in his responsibilities were the strategic planning for the measurement services, quality system for the services, and advancement of systems and capabilities.

In 2005, Ron became the group leader of the RF Electronics Group of the then Electromagnetics Division. He left that position in 2014 to return to research work. The areas that he influences include microwave measurement services; fundamental research in the areas of power, thermal noise and scattering-parameters; high speed electronics, THz network analysis, remote sensing for climate change monitoring, and electromagnetic properties of materials. In 2009, Ron became the quality manager for the Electromagnetics Division. He is also an internal quality auditor for NIST and has participated in many audits.

Ron participates in many outside activities related to his work. He is the treasurer of ARFTG and chairs the ARFTG standards committee. He regularly teaches portions of the ARFTG Short Course and this year he is teaching about vector network analyzer verification along with millimeter and sub-mm wave systems and calibrations. He is the chair of the IEEE P287 Standards Committee (coaxial connector standard), the vice-chair for the IEEE P-1785 (waveguide connectors above 110 GHz) and he participates in many other IEEE committees. He is also involved with various NCSL International committees such as the Measurement Comparisons Committee, Intrinsic and Derived Standards Committee, and the US National Standards Requirement Committee. Ron has also been the liaison between ARFTG and NCSL International. Outside activities include being a volunteer ski patroller at the Loveland Ski Area, wood working, just about anything related to the outdoors, and sewing.
Mark Ruefenacht is Quality Assurance Manager of Heusser Neweigh, a family owned calibration company that was recently acquired by Rice Lake Weighing Systems. With over 30 years of metrology and consulting experience, he specializes in pharmaceutical and forensic metrology and quality assurance applications. His metrology experience includes mass, balances and scales, pipettes, thermometry, dimensional, time, metrological traceability and uncertainty analysis. Mark is currently serving on the federal Organization of Scientific Area Committees for Forensic Science.

Mark Ruefenacht is an active instructor for NCSL International’s Annual Conference Tutorial Program, NIST Office of Weights and Measures, accreditation bodies, forensic laboratories and numerous other organizations. Mark is a much sought-after trainer who designs and delivers exceptional training courses and receives amazing evaluations and feedback from his students.

Mark has instructed, or co-instructed, at least 15 NCSL International Annual Conference Tutorials since 2005 on the topics of balances and scales, pipettes, and traceability with uncertainties. He regularly attends Train-the-Trainer sessions at the annual conference and applies what he learns to his own courses, providing creative hands-on activities and adult education concepts. He coordinates the use of balances and mass standards with the balance manufacturers to ensure hands-on opportunities for the students. Mark never has a simple “lecture only” session. Mark also provides guidance and mentoring to other instructors on improving their skills as instructors and presenters.
Mark’s Outreach – Knowledge Transfer and Impact of Metrology Education for the Forensic Community

Mark worked with Laurel Farrell to develop and present the American Society of Crime Laboratory Directors Laboratory Accreditation Board (ASCLD/LAB) Level 100 and Level 200 Measurement Confidence training courses to hundreds of forensic practitioners. This is one of the most effective examples of the transfer of metrology concepts to another scientific community. ASCLD/LAB is an accrediting body that since 1982 has focused laboratory accreditation efforts in the forensic science community. ASCLD/LAB customers were having difficulty understanding the concepts of and requirements for measurement traceability, measurement assurance, and measurement uncertainty. These difficulties went beyond needing an understanding of metrology vocabulary and the intent of the accreditation requirements. Customers were struggling with knowing how to interact with external calibration service suppliers, how to read scopes of accreditation and how to read calibration certificates and reference material certificates to ensure that the measurement traceability for the test or calibration performed in the forensic laboratory was defensible in a court of law.

Mark had been interacting with individual customers in the forensic community for years by providing education to one laboratory, one scientist at a time, but agreed to work with ASCLD/LAB to develop and deliver training material for the community and to educate the assessment staff. The Level 100 Measurement Confidence Course web-based training provides foundational concepts on three topics: measurement traceability, measurement assurance and measurement uncertainty. It also provides information on applicable accreditation requirements. Many participants who completed the Level 100 course also completed the classroom Level 200 Measurement Confidence course that covered more of the “how to” general concepts since participants found themselves with greater responsibility in their organizations when it comes to establishing measurement traceability; setting up and maintaining measurement assurance programs; and doing the estimation of measurement uncertainty for one or more processes. Mark co-taught the Level 200 courses for four years. Since launch of these courses in July 2011, 950 participants completed the Level 100 course series and 315 completed the Level 200 course. Course participants represent forensic science service providers from local, state and federal government in the United States as well as some international providers.

Mark has helped design and teach training content as part of the International Association for Continuing Education and Training (IACET) accredited NIST Office of Weights and Measures training program. He has taught as a team member of this NIST program for over 10 years, and has provided training in over 30 one to two-week courses for over 500 students. Courses he has taught have included: Fundamentals of Metrology, Mass Metrology, Length and Volume Metrology, Intermediate and Advanced Mass Metrology, as well as special topics at Regional Measurement Assurance Program (RMAP) training sessions which include over 120 metrologists each year.

Course attendees are from all over the world, with approximately 50 percent coming from legal metrology laboratories. The rest come from the Department of Defense (DOD), the Department of Energy (DOE), pharmaceutical and aerospace industries as well as NIST staff and other National Metrology Institutes.

Charitable Work for Non-Profit Organizations

Mark is recognized internationally as the founder of Dogs4Diabetics (D4D), the first medical-alert assistance dog program in the world to help insulin-dependent diabetics in managing their disease. He and his faithful companion, the late Armstrong, have been recognized in the Guinness Book of World Records 2015 as the first scientifically-trained glycemic-alert dog team. Mark has been recognized as one of the 100 most influential dog trainers in the world by Bark Magazine, and has received the Bronze and Silver Medals from the Jefferson Foundation, started by Jacqueline Kennedy, for his service to the community.

Dogs4Diabetics is an innovative non-profit that provides medical-alert assistance dogs to clients of all ages, at no cost. The dogs are trained to statistically-validated standards of performance to assure that their critical scent-discrimination skills are proven and sustained. [https://www.Dogs4Diabetics.com](https://www.Dogs4Diabetics.com)
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CONFERENCE REVIEW
SSL MEASUREMENT CHALLENGES

DO OR DIODE: THIS ISN’T EDISON’S BULB ANYMORE

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Solid State Lighting modules are quite different from the incandescent lamps that have been the work-horses of the industrial revolution since roughly the creation of the incandescent bulb almost 150 years ago. SSL modules are built from Light Emitting Diodes (LED) powered by low voltage direct current (DC) electrical circuitry enabling small and large scale lighting and optical radiation systems to utilize simpler and safer electrical power sources.

Single LED’s are known to be robust, with no filament or glass bulb to break, and for their very long service life of upwards of 50,000 hours. The light is produced electronically through the emission of a photon inside the Light Emitting Diode device as an electron changes its energy state. This results in much cooler room temperature operation, as opposed to the finger-burning hot filament incandescent bulb. Moreover, the light emission is almost instantaneous and is readily controlled electronically, providing extremely responsive control of lighting parameters and characteristics.

The miniature size of each LED, cool operating temperature, and low voltage DC operation enables arrays of LED’s to be assembled into unique shapes and sizes, depending upon the required application, limited only by imagination.

In addition to their versatile physical characteristics, LEDs’ spectral properties provide the opportunity for an extensive range and control of lighting colour. The light emitted by individual Light Emitting Diodes depends upon the material and spectral bandwidth of the diode.
White light Solid State Lighting modules may be made either by the combination of several LEDs of different colours (red, green and blue), or by the addition of a phosphor layer on top of a blue LED.

So where does metrology come into play, and why is it so important for the future of LED technology?

Some predictions have estimated that by 2020 there will be no major manufacturers producing incandescent lamps for general lighting applications. Incandescent lamps have been used for years as the basis for standard calibration sources due to their stable behaviour and uniform spectral output. With the loss of a source of these lamps and the production of SSL devices, it will be necessary to find SSL devices that can provide the characteristics necessary to act as calibration sources. The international community is working diligently to design sources using the best available LED manufacturing and design technologies that could be used for this purpose.

Building upon 85 years of accurate light measurements and calibrations, the National Research Council of Canada (NRC) is developing measurement facilities to provide accurate, SI-traceable, photometric and spectral measurements and calibrations of solid state lighting (SSL) devices. This includes the characterisation of luminous flux and efficacy of new SSL products as well as the measurement of both calibration standards and modules used for commercial lighting products.
Typical LED spectral distributions compared to an incandescent lamp. The peak in this LED spectrum is blue emitting from the LED chip itself and the broad distribution is emission from a phosphor that is coated on top of the chip that absorbs the blue and re-emits at longer wavelengths.

Credit: National Research Council of Canada

The unique advantages of SSL components also result in unique measurement challenges. The measurement of light, or photometry, has developed an accurate system of measurement based primarily upon the use of incandescent lamps as the source of optical radiation. With minor modifications, this system has been adapted to include the measurement of lighting based upon fluorescent, compact fluorescent and some discharge lamps. The physical, geometrical and spectral characteristics of Solid State Lighting modules require a near complete rethink of measurement and analysis procedures.

For example, incandescent lamps are resistive devices, which allows for a rather simple measurement of the electrical operating conditions of the light source. A critical property of light sources is their efficacy, measured by the quotient of the luminous flux emitted by the power consumed by the source (e1v.cie.co.at/termlist). Although the Light Emitting Diodes themselves operate using low-voltage direct current electrical supplies, present consumer applications utilise alternating current (AC) power. The conversion electronics built into each SSL often become their Achilles heel, and create significant problems in measuring the electrical power supplied to the SSL module, which is required in determining the efficacy.

Next, photometers that have been developed for use with incandescent lighting have used the broad-band and smooth spectral output of incandescent source to their advantage. The typical photometer is composed of a silicon pho-todiode coupled with a filter that produces a final detection response approximately equal to that of the standard human eye. The spectral output of Solid State Lighting devices is not a smooth function of wavelength, and contains several more narrow-band spectral features, making accurate calibration of photometers diffi-cult. The best solution is to measure the optical radiation with a spectroradiometer and calculate the photometric quantities from the radiometric quantities. But this requires more complex equipment and more detailed calibrations.

Similarly, the geometrical distribution in the light output of incandescent lamps may be made to approximate that of a point source of radiation. The packaging of LEDs results in devices that have a very non-uniform geometrical output. As a consequence, the geometrical properties of SSL devices need to be measured in greater detail to enable their subsequent use in lighting systems.

As the switch to long-lasting and energy-saving LED lights accelerates, the race is on to identify suitable calibration sources to ensure the technology works correctly and with a predictably high degree of accuracy. Without proper integration and calibration of the individual components, failure rates will lead to increased cost, decreased user satisfaction and could more importantly lead to the results from light-dependent research being inaccurate, the prevention of which NRC is continuously working towards.
Welcome back. Good to see you again after a two-issue absence. World metrology advancements waft along as always, and all too often seem to gust by, leaving us winded and puffing to catch up. Most folks survived the 1990s uncertainty cyclone and assembled budgets to qualify at least their accredited measurements; hopefully without too much inflation. Measurement decision risk (MDR) with its attendant conformance decision rules (guardbands) looks like another looming gale. Don’t forget NCSLI RP-18 to help you batten down those hatches.
Since the January article, the MII in particular has burst into a flurry of activity, whilst other vortexes have blown this column off course. The last installment described potential MII data interchange formats and settled on XML¹ as a default choice. We’ve not discussed web services or other communication options for automated data exchange, or ontology frameworks for standardized terminology; the latter of which has come to a head as we will see. So let’s postpone communication options, attempt to catch up on events, and begin discussing terminology before the MII whirlwind grows to a Category 5 hurricane.

**NCSLI 2015 Zephyrs**

Fifteen months ago at the 2015 NCSLI Workshop & Symposium, Mike Schwartz of Cal Lab Solutions gathered an ad-hoc AB² representative group and proposed to capture SoAs³ in an MII-style electronic format. The web server hosting an MII SoA database might then facilitate such MII features as smart searches for accredited labs (as opposed to error-prone text searches). Mike particularly emphasized measurement uncertainty validation—calculating and reporting uncertainties in compliance with an accredited lab’s scope along with automated confirmation. Cal Lab Solutions offered to provide participating ABs an accreditation scope authoring application that would enforce correctness and generate the machine-readable MII file.

The AB reps expressed keen interest in the project, but also some feasibility reservations regarding complexity and standardized terminology. They wondered how well it would work and how much effort it would require. Some ABs had in fact attempted similar projects before and encountered road blocks such as normalizing measurement range and quantity nomenclature. This column has, of course, addressed standardization, developed MII document data models, and highlighted technology and resources that theoretically cover the jargon-to-taxonomy normalization problem. Metrologists, however, expect to prove the pudding, not take the recipe for granted, so we won’t fully believe it until we see it work.

David Zajak, also of Cal Lab Solutions, therefore set out to prove the concept and created an XML schema to encode CMCs⁴, the most complex SoA piece. David then assembled software to reproduce several published SoA formats from their XML representations, thereby demonstrating proof of concept. The schema leverages MathML⁵, previously mentioned in this column, to render the math operators and symbols we will inevitably encounter in our field; in this case CMC uncertainty expressions such as “1 hPa + 0.05 % of indication.”

CMCs naturally require a measurement unit system. We considered NIST’s UnitsML⁶ as a ready-made resource, but found no active support or development, so David built a new measurement quantity and units schema. You will find much more detail in his conference paper, “Creating a Standardized Schema for Representing ISO/IEC 17025 Scope of Accreditations in XML Data” in the 2016 proceedings or on the MII Community page at www.ncsli.org. That brings us up to the most recent NCSLI Conference.

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¹ eXtensible markup language
² Accreditation body
³ Statements of accreditation
⁴ Calibration and measurement capabilities
⁵ Math markup language (XML for mathematics)
⁶ Units markup language
NCSLI 2016 MII Forum
Enter Colin Walker of Qualer, a metrology service software development company and recent NCSLI member. The MII concept had piqued Qualer’s interest through this column some time before and Colin contacted NCSLI for further information. After exchanges among the interested parties, this led to an MII Forum at the 2016 NCSLI Workshop & Symposium. There, we presented the MII concept, background and vision and the value of a machine-to-machine communication standard; Cal Lab Solutions highlighted its MII accomplishments to date and the Metrology.NET® perspective; and Qualer advocated an agile technology approach to develop a minimum viable product (MVP) to quickly create real value for a small targeted user base. Colin suggested that MVP version one encompass encoding, storing and searching SoAs in the Cloud.

To understand the version-one MVP’s scope, consider Figure 1. Colin labeled our MII document exchange diagram with insightful order-of-magnitude instance counts. Based on these rough numbers and David’s existing work, SoAs and their relationships to measuring entities and ABs seemed the least daunting and most fruitful section to address first.

Instrument specifications and other MII topics also interested the attendees, but the SoA-first strategy gained acceptance. An informal version-one charter then emerged to produce an MVP by Q1 2017, demo it to stakeholders and mold version two to their wishes. Participants also discussed proposing a committee to the NCSLI Board of Directors and performing the work under those auspices, a prospect we will return to at a later date.

Figure 1: MII document exchange network.
**Project Beagle**
A team coalesced soon after the NCSLI forum and kicked off the MVP project. Mike Schwartz named this phase Beagle. The team discussed various development, web hosting and database technologies with which to implement the demo MVP. The current tack includes a web server that will accept MII XML accreditation scopes, convert them to JSON\(^7\) for speedier searches and store them via MongoDB, an open-source database technology. The team expects this NoSQL\(^8\) data store technology to facilitate agile sprints between rapidly changing data structure iterations. MongoDB also supports BSON\(^9\) which would allow storing the original XML document as a blob with the JSON data for reference.

The MVP will also provide a web interface that allows smart, though manual, SoA searches and perhaps a follow-on API\(^10\) for machine-to-machine searches. Depending on which way the wind blows, future options include a move to the BigchainDB open-source decentralized database that leverages the blockchain technology underlying Bitcoin money. In such a scheme, auto-synched distributed hosts would contain and serve up traceable MII documents while allowing authors (ABs, manufacturers, labs, distributors, etc.) to retain document ownership. BigchainDB has yet to fully mature but you may learn more at https://www.bigchaindb.com.

Sometime after David designed the XML CMC schema, ATS Metrology’s Kevin Sullivan pointed the team to more information and access to the NIST’s UnitsDB project, which provides a wealth of data and structure for measurement quantity and unit systems. As we transition from a proof-of-concept to a full MII implementation, the XML schema may well expand to absorb many of the UnitsML features. In the meantime, we plan to populate our reference data from UnitsDB.

Keep in mind that MII software requires no particular technology other than that for reading, writing and exchanging MII documents. The implementation details behind an MII gateway, or inside MII-aware applications, fall outside the MII proper and every vendor or metrology organization may manage and structure measurement data within its systems as it wishes. The MII itself, the data interchange standard, revolves in this case around the accreditation scope data model we designed in previous issues and the Cal Lab Solutions XML implementation. We mention the MVP’s technology choices mainly so that readers may consider their own options, to underline the MII’s viability, and interest volunteers versed in such tools.

**Keeping Tabs:**
Much remains to do, as you may imagine. Though an internal Qualer server currently hosts the main development effort, you may keep tabs on the project at:

- **High-level updates**
  https://trello.com/b/xJ7scrkB/project-beagle
- **Technical and reference data**
  http://miiknowledge.wikidot.com/
- **Open source code releases:**
  https://github.com/CalLabSolutions/TheBeagle

**No Hot Air**
At the time of this writing, the Beagle has already sniffed the breeze and tracked its way to the point at which we should standardize the nomenclature that falls within the project scope. As yet, the current XML schema relies on unpopulated taxonomies for equipment, measured quantities, and other concepts. We therefore want to identify standard taxonomy sources.

Some have already leapt out at us: The accreditation scope data model we developed has the element “AB ID” in its top level, basically the AB that issued the SoA and whose name and logo appear thereon. ILAC\(^11\) provides a nice numerically-indexed machine-accessible AB list in its MRA\(^12\), from which to populate this MII element’s picklist. Similarly, the ISO/IEC80000 standard series provides us the Measuring Function (measured quantity) taxonomy, which the Influence and Input Quantity elements will also follow.

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\(^7\) JavaScript object notation

\(^8\) Structured query language (NoSQL dispenses with SQL’s complexity)

\(^9\) Binary JSON

\(^10\) Application programming interface

\(^11\) International Laboratory Accreditation Cooperation

\(^12\) Mutual recognition arrangement
Other SoA data elements that should accept only pre-defined values include General Function (the service accredited, e.g., calibration), Category (broad discipline, e.g., dimensional), Subcategory (specific field, e.g., length). Beyond that we have Measuring Systems and Measuring Instrument nomenclatures, Applied Methodology (measurement method), plus Function and Range identifiers. If you know definitive taxonomies for any of these data elements, please forward us your information.

Some readers may remember this sworn testimony from a certain politician of dubious distinction: “It depends on what the meaning of the word ‘is’ is.” Such dust devils, even if technically based, obscure the intended meanings. In order to retain technical accuracy at the machine level and also support familiar notions at the human level, the MII will likely feature a disambiguation layer.

For example, the standard international term “electric tension” has a well-defined meaning (IEC80000-6) but you won’t often find it on American SoAs. So, though machine-readable MII documents may reference “electric tension”, “electric potential”, or “electric potential difference” in their internal measurement descriptions, authors will probably want the option to render “voltage” on the human-readable version. The dictionaries will require as many aliases as required to satisfy human authors and readers, not to mention the world’s various languages, yet strictly hold to the unambiguous terms within the machine-readable document.

This leaves the human reader with the same ambiguity that conventional SoAs have, which may sometimes imply an MII application behavior that differs from the actual well-defined machine behavior. That will continue as long as human authors prefer common terminology over technical terms and as long as the international standards governing SoAs and certificates do not prohibit non-standard terms. The MII will work either way, and in fact give us humans a way to read between the lines and resolve the ambiguity.

**Filling the Sails**

Because no single organization should expect to succeed in isolation, Colin has called for volunteers in two tracks to aid the effort. To paraphrase him, track one includes technologists—developers, product designers and project managers—to design architecture, commit code and participate in biweekly technology track meetings. Champions, a wider circle of metrology professionals, comprise track two and act as advisers, industry researchers, advocates, resources and domain experts to guide the development process through bimonthly product demos and review meetings. To date, William Cornelison of Boeing, Marcus McNeely and yours truly have volunteered to champion the cause, with Qualer, Boeing and Cal Lab Solutions contributing to the development team.

As always, please email us your MII ideas or post them on the MII community discussion forum or wiki at www.ncsli.org and then Committees | Communities | MII from the menus. Join us and take shelter in the eye of the storm.
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AN ODYSSEY SPANNING TWO DECADES

Christopher L. Grachanen
chris.grachanen@hpe.com
ON JULY 22, 2016, the US Bureau of Labor Statistics (BLS) published their second federal register denoting proposed changes and additions for the upcoming 2018 Standard Occupational Classification (SOC) system. The SOC is the official listing of occupations recognized by the US Government. The SOC is the basis for categorizing citizen occupations for the US census as well as determining which occupations are contained in the BLS’s Occupational Outlook Handbook (OOH). The following is from the second federal register:

’Significant updates were made to the management, business, finance, information technology, engineering, social science, education, media, healthcare, personal care, extraction, and transportation occupations. Among the occupations new to the proposed structure are “Project Management Specialists” (13–1082), “Sustainability Analysts” (13–1191), “Financial Risk Specialists” (13–2054), “Data Scientists” (15–2051), “Calibration Technologists and Technicians” (17–3028), …’

The proposed 2018 SOC addition of Calibration Technologists and Technicians is the first time the BLS officially recognized calibration professionals. This milestone for the profession was made possible through the efforts of hundreds of volunteers. Readers may remember an initiative spearheaded by American Society for Quality (ASQ), Measurement Quality Division (MQD), NCSL International (NCSLI), and Measurement Science Conference (MSC) to get Metrologist, Calibration Engineer and Calibration Technician occupations included in the 2010 SOC. This initiative involved volunteers participating in job analysis surveys, submitting job descriptions, helping draft and review the proposal, etc. These efforts yielded a +30-page proposal that was submitted to the SOC. Unfortunately, the SOC made the recommendation to reject this proposal citing the following:

‘Response to Comments on 2010 SOC: Multiple Dockets on Metrology-Related Workers:

Multiple dockets requested new detailed occupations, or modifications to existing SOC definitions, in order to improve classification of metrology-related workers. Proposed new occupations included: Calibration Engineers, Calibration Technicians, Instrument Engineers, Instrument Technicians, Metrologists, Metrologists and Calibration Engineers, Metrology Engineers, Metrology Specialists, and Quality Engineers.

The SOCPC did not accept the recommendations for new detailed occupations based on Classification Principle 1 which states that occupations are assigned to only one occupational category and Classification Principle 9 on collectability. Metrology and calibration functions or tasks may be performed by workers in several occupations, such as Electrical Engineers, Industrial Engineers, Mechanical Engineers, Aerospace Engineering and Operations Technicians, Electrical and Electronic Engineering Technicians, Electro-Mechanical Technicians, Industrial Engineering Technicians, and Mechanical Engineering Technicians. The number of workers performing metrology and calibration tasks as their primary activity is not substantial enough to support new detailed occupations.

The SOCPC reviewed and modified definitions for engineers, engineering technicians, and production workers, to clarify coverage of metrology and calibration tasks. Also, the SOCPC recommended removing “Calibrators” from the title of 51-2093 “Timing Device Assemblers and Adjusters.”’
So how did the new 2018 SOC proposal overcome this 2010 SOC mindset?

In early 2015 I received an email from Craig Gulka, NCSL International’s Executive Director, asking if it was too late to submit a proposal to add Metrologists, Calibration Engineers and Calibration Technicians to the upcoming 2018 SOC (the deadline for submission had passed three months prior). I contacted the chair of SOC engineering occupations and was able to negotiate approval to submit a proposal provided it was received within the next three weeks. Three weeks! It had taken nearly three months and scores of volunteers to draft and review the 2010 SOC proposal. If there was to be a fighting chance to meet this deadline a new proposal would need to be created ASAP. This new proposal would need to address the following reasons for prior rejection:

1. Workers performing metrology and calibration tasks as their primary activity is not substantial (unique) enough to support new detailed occupations, and that metrology occupations are dispersed across many industries i.e. uniqueness of tasks

2. The number of workers (population) performing metrology and calibration tasks as their primary activity is not substantial enough to support new detailed occupations i.e. population of metrology works
TO CUT TO THE CHASE, the new proposal would need to build the case for uniqueness and adequate population. I began researching the other occupations SOC administrators referenced in their ‘Response to Comments on 2010 SOC’. After much contemplation, I determined it was the convoluted use of the term calibration which was giving the perception of non-uniqueness. The job descriptions for some of these other occupations included the term calibration denoting an adjustment task, not a metrological task. Primed with this insight I started drafting the 2018 SOC proposal using the VIM (International Vocabulary of Metrology) as the foundation for the contention of uniqueness. The following are some of the VIM excerpts used in the proposal:

**Calibration**: Operation that, under specified conditions, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards …

**Adjustment of a Measuring System**: Adjustment is a set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

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As a result of the proposal’s logical contention for the metrological use of the term calibration SOC administrators proposed the following 2018 SOC changes (blue square outlines) for other occupations:

<table>
<thead>
<tr>
<th>Detailed</th>
<th>17-3021</th>
<th>Aerospace Engineering and Operations Technologists and Technicians</th>
<th>Operate, install calibrated, and maintain integrated computer/communications systems, consoles, simulators, and other data acquisition, test, and measurement instruments and equipment, which are used to launch, track, position, and evaluate air and space vehicles. May record and interpret test data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed</td>
<td>17-3023</td>
<td>Electrical and Electronics Engineering Technologists and Technicians</td>
<td>Apply electrical and electronic theory and related knowledge, usually under the direction of engineering staff, to design, build, repair calibrated, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering staff in making engineering design decisions. Excludes “Broadcast Technicians” (27-4012).</td>
</tr>
<tr>
<td>Detailed</td>
<td>17-3024</td>
<td>Electro-Mechanical and Mechatronics Technologists and Technicians</td>
<td>Operate, test, maintain, or calibrated unmanned, automated, servo-mechanical, or electro-mechanical equipment. May operate unmanned submarines, aircraft, or other equipment. May be responsible to observe or record visual information at sites such as oil rigs, crop fields, buildings, or for similar infrastructure. Deep ocean exploration, or hazardous waste removal. May assist engineers in testing and designing robotics equipment.</td>
</tr>
<tr>
<td>Detailed</td>
<td>17-3027</td>
<td>Mechanical Engineering Technologists and Technicians</td>
<td>Apply theory and principles of mechanical engineering to modify, develop, test, or calibrated machinery and equipment under direction of engineering staff or physical scientists.</td>
</tr>
</tbody>
</table>

Fig. 1.0 Preliminary 2018 SOC definitions with changes tracked
After establishing the metrological definition of the term ‘calibration’ the next uniqueness proposal step was to identify tasks performed only by metrology and calibration workers. The following denotes some of these tasks:

- Create definitions for measurement units in terms of naturally occurring physical phenomena i.e. volt, second, etc., or artifacts of international consensus i.e. kilogram
- Create physical devices (measurement standards) which implement (realize) measurement unit definitions
- Create and execute procedures (techniques) for insuring measurement standards fulfillment (realization) of measurement unit definitions
- Develop and execute methodologies for determining the performance of primary measurement standards as compared to the performance of working measurement standards (e.g. calibration procedures for standards)
- Develop and execute methodologies for determining the performance of working measurement standards as compared to the performance of measurement devices (e.g. calibration procedures for measurement devices)
- Authenticate calibration traceability of measurement standards (needed to comply with international mutual recognition agreements to insure universal expectancy of measurement results)
- Conduct uncertainty analysis of measurement (calibration) processes
- Evaluate primary measurement standards to determine their adequacy/suitability in determining the performance of working measurement standards i.e. determine if primary measurement standards have the necessary attributes such as precision, repeatability, reproducibility, etc. needed to calibrate working measurement standards
- Evaluate working measurement standards to determine their adequacy/suitability in determining the performance of measurement devices i.e. determine if working measurement standards have the necessary attributes such as precision, repeatability, reproducibility, etc. needed to calibrate measurement devices

The aforementioned tasks were helpful in creating short job descriptions necessary for proposal submittal. The following are the proposal’s job descriptions:

**METROLOGIST AND CALIBRATION ENGINEER**

Apply measurement science, mathematics, physics, and engineering principles in defining and implementing definitions of measurement units by means of measurement standards. Create and execute procedures and techniques for calibrating and maintaining measurements standards. Authenticate calibration traceability of measurement standards and perform uncertainty analysis of measurement processes.

May develop and/or design and support measurement systems, processes, and procedures based on analysis of measurement problems, accuracy and precision requirements. Use statistics to analyze measurement standards and processes. Monitor compliance with calibration laboratory and/or departmental quality systems. Develop software to assist in calibration laboratory and/or departmental processes. May perform laboratory and/or departmental administration and management.

**CALIBRATION TECHNICIAN**

Apply knowledge of measurement science, mathematics, physics, and electronics in creating and executing procedures and techniques for calibrating measurement devices. Authenticate calibration traceability of measurement devices. Determine measurement standard suitability for calibrating measurement devices.

May perform corrective actions to address identified calibration problems. Adapt equipment, measurement standards, and procedures to accomplish unique measurements. Maintain and calibrate measurement standards. Perform laboratory and/or departmental housekeeping.

Note: Metrologists and Calibration Engineers may be tasked in managing the activities of less senior Metrologists and calibration engineers as well as calibration technicians.
Having completed the ‘uniqueness’ portion of the proposal, the ‘population’ portion of the proposal needed to be created. The 2010 SOC proposal had addressed metrology and calibration worker population using numbers inferred from professional association membership, conference attendance, student enrollment in Metrology based programs, etc. One must remember that unless an occupation is recognized by the SOC, government compiled population demographics for an occupation is non-existent making it extremely difficult to obtain these numbers. Given that the 2010 SOC population contention was rejected by SOC administrators, a new source for determining metrology and calibration worker population was needed. After much pondering I hit on a solution, social media! LinkedIn, being a business-related social network, contains thousands of individual profiles with their occupational titles. The following table show the results of a LinkedIn search for Calibration Technicians, Calibration Engineers and Metrologists as well as other similar occupations that are recognized by the SOC.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Pop.</th>
<th>Occupation</th>
<th>Pop.</th>
<th>Occupation</th>
<th>Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration Technicians</td>
<td>10,268</td>
<td>Calibration Engineers</td>
<td>12,105</td>
<td>Metrologists</td>
<td>4,622</td>
</tr>
<tr>
<td>Electronics Engineering Technicians</td>
<td>10,941</td>
<td>Computer Hardware Engineers</td>
<td>15,057</td>
<td>Hydrologist</td>
<td>7,912</td>
</tr>
<tr>
<td>Electro Mechanical Technicians</td>
<td>6,085</td>
<td>Agricultural Engineers</td>
<td>8,505</td>
<td>Geographer</td>
<td>4,339</td>
</tr>
<tr>
<td>Environmental Engineering Technicians</td>
<td>4,511</td>
<td>Marine Engineers &amp; Naval Architects</td>
<td>2,542</td>
<td>Prosthodontics</td>
<td>3,106</td>
</tr>
</tbody>
</table>

To further substantiate these LinkedIn numbers a comparison was presented contrasting these numbers to published OOH 2012 populations.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>LinkedIn Pop.</th>
<th>OOH Pop. 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Engineering Technician</td>
<td>4,511</td>
<td>19,000</td>
</tr>
<tr>
<td>Electro Mechanical Technician</td>
<td>6,085</td>
<td>17,300</td>
</tr>
<tr>
<td>Computer Hardware Engineer</td>
<td>15,057</td>
<td>83,300</td>
</tr>
</tbody>
</table>

Comparing these numbers one may infer OOH occupation numbers are likely to be greater than LinkedIn occupation numbers. Following this train of thought, occupation numbers for metrology and calibration workers are likely understated as reported by LinkedIn.
The aforementioned ‘uniqueness’ and ‘populations’ aspects of the proposal were combined with other SOC proposal requisites which were not contested in the 2010 SOC proposal (updated to reflect the current state of affairs such as available Metrology based academic programs) to complete the 2018 SOC proposal draft. This draft was shared with interested parties from ASQ, NCSL International, MSC, etc. in order to obtain feedback and incorporate recommended changes. The final draft was submitted to the SOC on April 3, 2015 two days before the three-week deadline (and yes, it took over a year for SOC administrators to published their recommendations). The following is the official SOC response to the 2018 SOC proposal;

Docket Number 1-1311 -- Metrologists and Calibration Engineers; Calibration Technicians (17-2000, 17-3000) Docket 1-1311 requested new detailed occupations for (1) Metrologists and Calibration Engineers and (2) Calibration Technicians. The SOCPC did not accept the recommendation to add Metrologists and Calibration Engineers based on Classification Principle 9 on collectability. However, the SOCPC did accept the recommendation to add Calibration Technicians and proposes establishing a new code for this occupation, 17-3028 Calibration Technologists and Technicians, and removing mention of calibration duties from the appropriate 2010 SOC occupations.

The SOC Classification Principle 9 reads as follows;

The U.S. Bureau of Labor Statistics and the U.S. Census Bureau are charged with collecting and reporting data on total U.S. employment across the full spectrum of SOC major groups. Thus, for a detailed occupation to be included in the SOC, either the Bureau of Labor Statistics or the Census Bureau must be able to collect and report data on that occupation.

The following is the SOC’s proposed job description for Calibration Technologists and Technicians;

Create and execute procedures and techniques for calibrating measurement devices, by applying knowledge of measurement science, mathematics, physics, and electronics, sometimes under the direction of engineering staff. Authenticate calibration traceability of measurement devices. Determine measurement standard suitability for calibrating measurement devices. Adapt equipment, measurement standards, and procedures to accomplish unique measurements. May perform corrective actions to address identified calibration problems.

The SOC will be accepting comments on their 2018 SOC recommendations through 2016 with their final recommendations due for completion late 2016. MQD leadership is posed to launch an initiative to solicit from metrology and calibration workers, Metrology associations and other interested parties their comments / recommendations regarding the exclusion of Metrologists and Calibration Engineers from 2018 SOC consideration as well as the SOC’s proposed job description for Calibration Technologists and Technicians ... stay tuned.
So what is the big deal about the US Government officially recognizing the calibration occupation? The following are some of the benefits:

- Population demographics for understanding trends i.e. people entering/ exiting the occupation
- Population demographics for making better informed decisions such as:
- Location / re-location for businesses dependent on local metrological support
- Location for conferences, seminars, training, education programs, etc.
- Resource allocation for public relations and marketing
- Standardized categorization of workers i.e. metrology and calibration workers not lumped with other occupations and their associated skill sets, education requirements, pay scales, etc.
- Standardize job descriptions across industry and a company’s business units

I believe by far the biggest benefit to the calibration profession is inclusion of the occupation in BLS’s OOH. The OOH is the premier resource used by counselors and job placement professionals to inform students and prospective job candidates about an occupation’s education requirements, required skill sets, prospective job growth, salary ranges, etc. The following is the OOH’s website for electrical and electronics engineering technicians:

![OCCUPATIONAL OUTLOOK HANDBOOK](image)

This type of public domain information will help spread the word about the calibration profession to folks making education / employment career decisions. So you see, getting the US Government to officially recognize the calibration occupation is kind of a big deal.
August 13 - 17, 2017

Precision & Performance with Measurement Science

Gaylord National Convention Center | National Harbor, Maryland
As standards laboratories, the world expects and critically depends upon, the very best from us. So naturally we must demand the best from ourselves.

That is why we periodically agree to hold our personnel, policies, and procedures to ever higher standards. Now is one such time, as our community begins to adjust to new, more stringent requirements specified in the impending revision of ISO/IEC 17025. It marks the first time in 16 years that the principal benchmarks for quality and integrity in testing and calibration will be changed.

Those new criteria will require us to re-examine the ways in which we ensure traceability, bring new clarity to the statements of compliance, improve methods used to evaluate and state uncertainties in measurement, review how we handle technical records, manage information, and structure management systems, among other changes. The impact will be felt not only in calibration laboratories, but in manufacturing, research, quality control, education and training, and proficiency testing.

How will you and your organization respond to the update of ISO/IEC 17025? Do you have implementation plans that you can share with others? Are there provisions of the revised standard that are particularly hard to meet or that will require new ways of doing business? How will it affect evaluations of competence or accreditation in your field? We invite you to submit papers and/or suggest a panel session on these issues and related topics for the coming 2017 NCSL International Workshop & Symposium.

No doubt there will be some significant challenges in complying with the new standards. But if we pool our ideas and expertise, we can make a smooth transition and further strengthen the trust and respect we earn from our clients and customers.

**GENERAL REQUIREMENTS**

Abstracts are required for all proposed papers, panels and workshops.

**ABSTRACT REQUIREMENTS AND DEADLINE**

Abstracts must be 350 words and submitted electronically using the NCSLI Abstract Management System no later than January 6, 2017. After paper acceptance, speakers will be sent a new link where they will upload their papers.

**ABSTRACT ACCEPTANCE DATE**

Speakers will be notified on or before January 31, 2017 if their abstract has been accepted. Once abstracts are selected for the NCSLI Technical Program, authors will be provided manuscript instructions.

**MANUSCRIPT REQUIREMENTS AND DEADLINE**

All manuscripts must be uploaded by April 3, 2017. All papers received by the manuscript deadline will be included in the NCSLI International Conference Proceedings CD.

**SPEAKER DISCOUNTS**

- All speakers who upload their abstract by the January 6, 2017 deadline (and are accepted) will receive a $150 discount off of registration.
- All speakers who upload their manuscript by the April 3, 2017 deadline will receive a $350 discount off of registration.
- All deadlines must be met to receive the speaker registration discount of $500.

**BEST PAPER AWARDS**

To be considered for the Best Paper Award, all deadlines must be met.
**INTRODUCTION:** On behalf of NCSL International members, this document contains the fundamental tenets regarding the revision of ISO/IEC 17025. This information shall be communicated to ISO CASCO, ILAC, and standards writing bodies of other interested countries.

1. **Statements of Compliance:** ISO/IEC 17025:2005 clause 5.10.4.2 requires uncertainty of measurement to be taken into account when making statements of compliance. This requirement has been broadly interpreted from extremes of requiring a specific decision rule to be used, all the way to ignoring uncertainty completely in the compliance statement. The majority of calibrations performed are not calibrations as per the definition of the VIM, but are, in fact verifications, where the measurement results are compared to a metrological specification and a statement of compliance is produced. This requirement needs much clearer definition of declarations of statements of compliance.

**Result:** Compliance relates to items of a regulatory nature. Therefore, and to be consistent with ISO terminology, where compliance was used in the Standard and not related to regulations, the word was replaced with conformity.

**Result:** A new sub-clause has been added to 7.8 on the Reporting of Results, called Reporting Statements of Conformity (clause 7.8.5). This clause discusses the application of decision rules when making statements of conformity. It is important to note the Standard does not require a specific method of risk assessment (or a specific decision rule), but that risk is taken into account when agreeing upon, documenting and applying the decision rule. “When a statement of conformity to a specification or standard for test or calibration is provided, the laboratory shall document the decision rule employed; taking into account the level of risk associated with the decision rule employed and applying the decision rule.” 7.8.1.1 on Reporting of Results states, “shall include all the information agreed with the customer and necessary for the interpretation of the results and all information required by the method used.” Clause 7.1.1.3 states, “When the customer requests a statement of conformity to a specification or standard for
the test or calibration, the specification or standard, and the decision rule shall be clearly defined. Unless inherent in the requested specification or standard, the decision rule selected shall be communicated to the customer.”

2. ISO 9001: Laboratories accredited to ISO/IEC 17025 should not need to maintain ISO 9001 registration/certification in addition to ISO/IEC 17025 accreditation. There should be a clear distinction between the requirements for registration/certification and accreditation associated with this document. The language in ISO/IEC 17025 should clearly state that a laboratory accredited to ISO/IEC 17025 meets the intent of the management system requirements of ISO 9001 for the testing/calibration activities detailed on their scope of accreditation.

Result: ISO TC176 reviewed WG44’s request to evaluate ISO/IEC 17025 CD2 against the principles of ISO 9001:2015. TC 176 concluded “Laboratories that conform to this International Standard (17025) will also operate generally in accordance with the principles of ISO 9001.” The Quadripartite Agreement (Joint BIPM, OIML, ILAC, ISO Declaration on Metrological Traceability, 9 Nov 2011) will be modified and re-released with the change in wording to support that statement. If Option B is embedded in the system, then it stands to reason that a laboratory that is ISO/IEC 17025 accredited and applies Option B (8.1.3) that it meets the principles of ISO 9001:2015. TC 176 was not willing to state differently.

3. Measurement Uncertainty: The ISO Guide to the Expression of Uncertainty in Measurement1 and its supplements should be specified in the requirements of ISO/IEC 17025 as the means to estimate uncertainty of measurement. ISO/IEC 17025 should have more clarity on the ability of the laboratory to perform these calculations, and on the storage of these calculations as a quality record. Measurement uncertainty reported on certificates of calibration must not be lower than the laboratory’s assessed capability (scope CMC).

Result: Clause 7.6.3 NOTE 3 references the GUM. However, the Standard was not changed to address the competence of the laboratory (ability) to perform the calculations. In 7.6.3, the clause states, “When evaluating the measurement uncertainty, all components which are of significance in the given situation shall be identified and taken into account using appropriate methods of analysis.” The storage of these calculations is not specified, however, as a requirement in the standard 7.5.1 (Technical Records). The laboratory shall ensure that technical records for each laboratory activity contain the report of the results, and sufficient information to facilitate, if possible, identification of factors affecting the measurement uncertainty and enable the repetition of the laboratory activity under conditions as close as possible to the original. Reporting results in line with a laboratory’s scope (CMCs) was not considered a competency issue, but rather a matter that related specifically to accreditation — therefore this was not included in the standard.

4. **PT/ILC:** Proficiency Testing and Interlaboratory Comparisons are important to evaluating laboratory competence, and for some laboratories the period for participation can be infrequent by design. Section 5.9 is intended to be activities that the laboratory routinely performs to assure the validity of measurement results, which seems to be overlooked so long as PT/ILC participation is employed. We recommend that PT/ILC activities be addressed in a section that clearly separates them from the other activities mentioned in 5.9 and recommend that PT/ILC activities should preferably be conducted by an organization that is accredited to or complies with ISO/IEC 17043 (call ISO/IEC 17043 out specifically in the standard, and other important documents).

**Result:** Clause 5.9 has been moved to clause 7.7 while retaining the previous heading name. A separate section was not created for specifically for proficiency testing activities. However, the working group did acknowledge that internal quality assurance activities should be separated from external and, so, created two subsections to this clause. Clause 7.7.1 address internal quality assurance and clause 7.7.2 address external activities, i.e., proficiency testing or interlaboratory comparisons. It is important to note, the working group agreed, in principle, that a balanced approach to the use of internal and external quality assurance activities is vital to managing product risk.

5. **Traceability:** Metrological Traceability may be conveniently demonstrated through calibrations recognized by the ILAC MRA or CIPM MRA, but any revisions of ISO/IEC 17025 should not specify these as the only way to achieve Metrological Traceability. Other appropriate methods for the assessment of Metrological Traceability must be allowed and equal in preference. Traceability of Intrinsic standards should be moved from notes to formal requirements.

**Result:** Clause 6.5 on Measurement Traceability was restructured to provide clarity and direction. Traceability is established in one or more of the following: a) calibration; b) certified values of certified reference materials with stated metrological traceability to the SI; or c) direct realization of the SI units which conform with the mises en pratique, as described in the SI Brochure, and ensured by comparison, directly or indirectly, with national or international standards. Intrinsic standards (direct realization of the SI units) are, now, part of the formal requirements. The Draft also provides two exceptions when traceability to the SI cannot be met using: a) certified values of certified reference materials provided by a competent producer; or b) results of reference measurement procedures, specified methods or consensus standards that are clearly described and accepted by an appropriate authoritative body as providing measurement results fit for their intended use and ensured by suitable comparison. Clarity about the CIPM MRA and the ILAC MRA are covered but discussed only in Annex A (Informative).
6. There are many places in the standard that use vague terms that lead to wide variations in interpretation and application of the standard. Use of these terms results in differences between the accreditation bodies and their interpretation of the standard, thereby creating technical barriers to trade (TBT) and confusion for [end] customers of exactly what they should receive for an “ISO/IEC 17025 compliant calibration.” We recommend eliminating or limiting the use of references to “and/or,” “where necessary,” “where relevant,” “where applicable” and “where appropriate.” The standard should also be clarified by converting notes into requirements wherever possible.

**Result:** And/or focused primarily between testing and/or calibration. In this particular case, the phrase “testing and/or calibration” was changed to “laboratory activities” to reduce the cumbersome nature. Below is a summary of changes for the other phrases. **Note:** This is not exhaustive and may change as the document moves through the maturation and approval process.

<table>
<thead>
<tr>
<th>PHRASE</th>
<th>17025:2005</th>
<th>17025:201X</th>
<th>DISCUSSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>And/Or</td>
<td>5.2.1 Personnel - experience and/or demonstrated skills, as required.</td>
<td>6.2.2 Personnel</td>
<td>Made into a requirement</td>
</tr>
<tr>
<td></td>
<td>5.2.5 Personnel - shall include the date on which authorization and/or competence is confirmed.</td>
<td>6.2 Personnel</td>
<td>Not required to have the date</td>
</tr>
<tr>
<td></td>
<td>5.4.5.3 Validation of Methods - limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object.</td>
<td>7.2.2.3 Validation of Methods</td>
<td>Moved to a NOTE under 7.2.3.3</td>
</tr>
<tr>
<td></td>
<td>5.5.2 Equipment - It shall be checked and/or calibrated before use</td>
<td>6.4.4 Equipment</td>
<td>Made into a requirement</td>
</tr>
<tr>
<td></td>
<td>5.6.2.1 Measurement Traceability for calibration - The calibration certificates issued by these laboratories shall contain the measurement results, including the measurement uncertainty and/or a statement of compliance</td>
<td>6.5 Metrological Traceability</td>
<td>Removed; discussed in 7.8 Reporting</td>
</tr>
</tbody>
</table>

2 Any exceptions can be included as notes.
<table>
<thead>
<tr>
<th>Phrase</th>
<th>17025:2005</th>
<th>17025:201X</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6.2.1.2 Measurement Traceability for calibration - use of specified methods and/or consensus standards</td>
<td>Removed</td>
<td>Clarified in Annex A</td>
<td></td>
</tr>
<tr>
<td>5.6.2.2.2 Measurement Traceability for testing - Where traceability of measurements to SI units is not possible and/or not relevant... agreed methods and/or consensus standards, are required as for calibration laboratories</td>
<td>Removed</td>
<td>Clarified in Annex A</td>
<td></td>
</tr>
<tr>
<td>5.10.4.1 Calibration Certificates - the uncertainty of measurement and/or a statement of compliance with an identified metrological specification or clauses thereof</td>
<td>7.8.5.2 The laboratory shall report on the statement of conformity such that the statement clearly identifies: a) to which results the statement applies; b) which specifications, standard or parts thereof are met or not met; and c) the decision rule applied (unless it is inherent in the requested specification or standard).</td>
<td>Applies only when a statement of conformity to a specification or a standard is provided</td>
<td></td>
</tr>
</tbody>
</table>

**Where necessary**

<table>
<thead>
<tr>
<th>Phrase</th>
<th>17025:2005</th>
<th>17025:201X</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.2.2 Document Approval &amp; Issue - documents are periodically reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements;</td>
<td>8.3.2 The laboratory shall ensure that: b) documents are periodically reviewed and updated, as necessary</td>
<td>Changed order for clarity</td>
<td></td>
</tr>
<tr>
<td>4.3.2.1 A master list or an equivalent document control procedure identifying the current revision status and distribution of documents in the management system shall be established and shall be readily available to preclude the use of invalid and/or obsolete documents.</td>
<td>8.3.2 Control of Management System Documents - d) relevant versions of applicable documents are available at points of use and where necessary their distribution is controlled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.9.1 d) where necessary, the customer is notified and work is recalled</td>
<td>7.10.1 e) where necessary, the customer is notified and work is recalled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3.5 Accommodation and Environmental Conditions - Measures shall be taken to ensure good housekeeping in the laboratory. Special procedures shall be prepared where necessary</td>
<td>Removed</td>
<td>Covered in 6.3.4 in more general terms with the focus on suitability based on laboratory activities</td>
<td></td>
</tr>
</tbody>
</table>
### Table: Changes from ISO/IEC 17025:2005 to ISO/IEC 17025:201X

<table>
<thead>
<tr>
<th>Phrase</th>
<th>17025:2005</th>
<th>17025:201X</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not present</td>
<td></td>
<td>7.8.2.3 Reports - Where the laboratory is responsible for the sampling stage, in addition to the requirements listed in 7.9.2.1 and 7.9.2.2, reports containing the results of sampling shall include the following, where necessary for the interpretation of test results</td>
<td>Added clarification for where sampling occurs. Some companies can contract this service out to a competent supplier.</td>
</tr>
<tr>
<td>5.10.3.1 Test Reports - In addition to the requirements listed in 5.10.2, test reports shall, where necessary for the interpretation of the test results, include the following</td>
<td></td>
<td>7.8.3 In addition to the requirements listed in 7.8.2, test reports shall, where necessary for the interpretation of the test results, include the following:</td>
<td></td>
</tr>
<tr>
<td>5.10.3.2 Test Reports - In addition to the requirements listed in 5.10.2 and 5.10.3.1, test reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:</td>
<td></td>
<td>7.8.3 In addition to the requirements listed in 7.8.2, test reports shall, where necessary for the interpretation of the test results, include the following:</td>
<td></td>
</tr>
<tr>
<td>5.10.4.1 Calibration Certificates - In addition to the requirements listed in 5.10.2, calibration certificates shall include the following, where necessary for the interpretation of calibration results</td>
<td></td>
<td>7.8.4.1 In addition to the requirements listed in 7.8.2, calibration certificates shall include the following:</td>
<td></td>
</tr>
</tbody>
</table>

### Where relevant

<table>
<thead>
<tr>
<th>Phrase</th>
<th>17025:2005</th>
<th>17025:201X</th>
<th>7.8.2.1 Each report shall include at least the following information, unless the laboratory has valid reasons for not doing so, thereby minimizing any possibility of misunderstanding or misuse: l) a statement to the effect that the results relate only to the items tested or calibrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.10.2 Test Reports / Calibration Certificates - where relevant, a statement to the effect that the results relate only to the items tested or calibrated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.10.3.1 Test Reports – b) where relevant, a statement of compliance/ non-compliance with requirements and/or specifications</td>
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<td>7.8.3 Test Reports - b) where relevant, a statement of conformity with requirements or specifications (7.8.5.1)</td>
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### Where applicable

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<th>17025:201X</th>
<th>DISCUSSION</th>
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<td>5.9 a), 5.9.2</td>
<td>7.7.1 Assuring the Quality of Results - d) use of check or working standards with control charts, where applicable</td>
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<td>5.10.3.1 Test Reports - where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer’s instruction so requires, or when the uncertainty affects compliance to a specification limit</td>
<td>7.8.3 Test Reports - c) where applicable, the measurement uncertainty presented in the same unit as that of the measurand or in a term relative to the measurand (e.g. percent), when it is relevant to the validity or application of the test results, when a customer’s instruction so requires, or when the measurement uncertainty affects conformity to a specification limit</td>
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<td>6.4.9 Equipment - d) the current location, where appropriate</td>
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<td>5.5.5 Equipment - the maintenance plan, where appropriate, and maintenance carried out to date</td>
<td>6.4.3 The laboratory shall have a procedure for handling, transport, storage, use and planned maintenance of equipment to ensure proper functioning and in order to prevent contamination or deterioration. 6.4.9 Records shall be maintained for equipment which can influence the laboratory activities. The records shall include at least the following: g) the maintenance plan and maintenance carried out to date, where relevant to the performance of the equipment</td>
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<td>5.4.1 Method Validation - The laboratory shall use appropriate methods and procedures for all tests and/or calibrations within its scope. These include sampling, handling, transport, storage and preparation of items to be tested and/or calibrated, and, where appropriate, an estimation of the measurement uncertainty as well as statistical techniques for analysis of test and/or calibration data.</td>
<td>7.2.1.1 The laboratory shall use appropriate methods and procedures for all laboratory activities and, where appropriate, for evaluation of the measurement uncertainty as well as statistical techniques for analysis of data.</td>
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<td>5.9.1 This monitoring (validity of laboratory activities) shall be planned and reviewed and shall include, where appropriate, but not be limited to, the following:</td>
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<td>5.10.2 Reports – i) the test or calibration results with, where appropriate, the units of measurement</td>
<td>7.8.2.1 Reports - m) the test or calibration results with, where appropriate, the units of measurement</td>
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<td>5.10.3 Test Reports – d) where appropriate and needed, opinions and interpretations (see 5.10.5)</td>
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The NCSL International LA/Orange County section meeting was held on August 9, 2016 at Keysight Technologies in El Segundo, California. There were a total of 50 participants in attendance for the meeting. This particular meeting covered a range of topics related to improving uncertainty and automation of measurements. Tours of the Keysight laboratories were conducted throughout the meeting as well.

Jon Sanders, LA/Orange County section coordinator, provided the welcome and introduction to NCSLI. Jon’s presentation covered membership benefits and divisional highlights. Following Jon, Ilyas Nuri gave the host introduction about Keysight Technologies. Keysight Technologies sponsored the venue, refreshments and lunch for the meeting attendees.

Matthew Woerner, Keysight Technologies, started the technical portion of the meeting with a presentation on “Automation to Assure Quality Calibration Results.” He provided several examples of how Keysight has recently been able to apply near real-time statistical analysis for quality process control in their calibration labs which has resulted in significant improvements when combined with periodic proficiency testing. He discussed how the process works and provided data from examples of their quality monitoring.

Howard Zion, Transcat, was the next presenter covering “In Tolerance Non-Conformance Investigation.” Many presentations focus on out of tolerance (OOT) non-conformance investigation and the steps required to ensure the results are not biased. Howard explores the conditions where an instrument could be believed to be in tolerance, but actually have a negative impact on the process it is used in. Guard banding and decision rules were discussed within this presentation.

In the afternoon, Michael Schwartz, Cal Lab Solutions, discussed “Systems-of-Systems Metrology Software – Metrology.NET.” This presentation focused on software system architecture design that bridges the islands of metrology into one unified solution.

Matthew Woerner then presented his second topic on “Conformance Decision Rules to Support ISO/IEC 17025 CD Under Revision.” This presentation highlighted understanding and implementing four simple decision rules for assessing “Pass” or “Fail” conformity decisions along with associated false-accept and false-reject risk.

The LA/Orange County section would like to thank all of those involved with preparing the facilities at Keysight. They did a fantastic job and the tours were very much appreciated. We would also like to thank our attendees, speakers, and NCSL International for their continuous support of the metrology community.
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“And now for something completely different” is a quote which I think best described the New England Region’s fall meeting held October 12, 2016. It started with the location...Southbridge, Massachusetts. Located about 60 miles west of Boston, Southbridge describes itself as the “Eye of the Commonwealth,” a phrase which harkens back to the town’s long history of manufacturing optical products. The venue itself was also very untraditional for a region meeting. Once a cannery, the building at 12 Crane Street now houses a music hall, brewery, pub and, pertinent to our meeting, the Optical Heritage Museum.

The museum houses over 3,000 items relevant to optics. There are microscopes, lensometers, dioptrometers and standard lenses which at one point were calibrated by NIST. Exhibits range from some of the first steel-framed spectacles produced in America to the development of fiber optics that was sponsored by the CIA.

Even the original wide screen version of the film Oklahoma, which premiered in New York City on October 11, 1955, is on display. This was the first Todd AO film, and used a process and lens developed at American Optical. The American Optical Company and its affiliates were instrumental in many innovations through history including the solid state laser, cardiac defibrillator, safety goggles and the executive bifocals. Items on display include an order from John F. Kennedy for executive bifocals which was received by mail at the plant the day JFK was assassinated.

Our tour guide through the museum was Dick Whitney, Executive Director at Optical Heritage Museum. He is presently the Manager of Global Standards for Carl Zeiss Vision and is an FDA Ophthalmic lens impact testing expert.

After the tour, we settled in to learn about vibration measurement and testing. Our subject expert was Bob Craft. Bob is an Application Engineer with Bently Nevada, a subsidiary of GE, and has over 35 years of experience in the field of condition monitoring.

Norman Rockwell was commissioned to do paintings for American Optical and they now reside in the Optical Heritage Museum.
monitoring systems. He developed and instructed the courses that taught TRIDENT class submarines forces, who work regularly with TRIDENT ballistic missiles, how to use the installed Noise and Vibration Monitoring System for both ship silencing and machinery condition analysis. He also worked in the nuclear power industry at Detroit Edison’s Enrico Fermi Unit 2 Nuclear Generating Station as the lead vibration engineer.

Bob related to us that the US Navy was one of the major forces behind the development of modern vibration analysis and monitoring systems. Vibration analysis involves monitoring critical systems for abnormalities. The “normal” vibrations of a properly running system need to be filtered out, so things like bearing degradation, or gear tooth issues, and other anomalies of interest can be detected.

A properly engineered system allows for detection of machinery defects long before a critical failure or unplanned outage is encountered. Vibration systems can also provide alarms and shutdown for machinery in critical applications, and can protect not only machinery, but can be a major factor in plant safety as well.

Bob described the major types of sensors used in today’s modern systems. These are primarily accelerometers and proximitors. Each has their specific benefits, depending on the application. As with most modern-day instrumentation, much is dependent on the software and he touched on the complexity of that as well.

Bob left us with the overriding principle that proactive maintenance is important in any number of industries and applications. The Navy found that by monitoring critical systems, they had a 3:1 savings when comparing costs of unplanned repairs and downtime to the cost of the monitoring equipment.

A key point, as Bob explained, is that functional failure is a process and not an event. The trick is in detecting the process early on. With today’s systems, changes as subtle as contaminated or degrading lubricants in machinery can be detected.

With that, we were back on the topic of visible elements and turned the meeting over to Dr. Jing Zhou. For the past 10 years she has been engaged
in research and development of optical measurement systems and calibration for both academic and industrial fields. Dr. Zhou also presently works for International Light. Light measurement takes on increasing importance as we evolve from incandescent light sources to other technologies at home and in the workplace. Dr. Zhou first discussed the concepts and techniques of measurement in the visible spectrum which, for humans, is in the range of approximately 380 to 770 nm.

Important facts to understand are the definitions and parameters unique to light measurement. Radiant flux is the measure of radiometric power. Luminous flux is the measurement of visible light and is expressed in lumens and weighted to match the responsivity of the human eye. Finally, Scotopic flux measurements are weighted to the human eye in the dark-adapted state.

Measurement geometries were discussed and illustrated. Of the many challenges in measuring light, key factors are choosing the right detector(s), input optics and filters. Particular challenges with measuring in the UV regions were presented. Dr. Zhou mentioned that a new 2.4 micron laser-driven Zenon source was helping them expand their capabilities on this frontier. An excellent reference, The Light Measurement Hand Book, is available to browse or download from International Light’s website (www.intl-lighttech.com). The handbook even introduces the basic principles of setting up an optical bench.

What happens when you run light down a glass “pipe?” Fiber optics! Tony Irujo, a technical support Engineer with OFS, led us on a mission of exploration in terminology and applications for fiber optics. There are a multitude of advantages to using fiber in the use of high speed data transmission. They include no EMF, low signal loss and the cables are small, light, and easy to test.

Multi-mode, typically 850 nm/50 micron, is usually a shorter run vehicle of transmission, and used in data centers and networks, whereas single mode (8 micron) is used for runs sometimes in access of 100 miles. For even longer runs, such as transoceanic cables, repeaters are utilized. The concept of the cones of acceptance (angle of light entrance to the cable) was introduced and diagrammed for both fiber types.

Modal dispersion, the cause and effect of signals arriving at different points in time, was discussed, as were the ways OFS engineers have met the unique challenges of signal transmission in a world that sees a need for exponential growth for transmission rates of data.

Causes of other transmission problems, such as attenuation from microbending and macrobending, were discussed. However, Tony explained that the vast majority of transmission link failures were not from the fiber itself, but rather due to improper or
dirty interfaces and connections.

Instrumentation for fiber measurements were introduced, including the use of Optical Time Domain Reflectometers (OTDR). Tony also shared a video with us that highlighted the science that goes into drawing the fiber at their plant in the neighboring town of Sturbridge.

Rounding out the meeting, we were honored to have a speaker all the way from NIST, Dr. Yoshi Ohno, who spoke on the fundamentals of colorimetry. Dr. Ohno’s presentation blended quite well with the museum venue as he expounded on not only color measurement technique, but also presented how the technology had changed and the progression of the science over time.

The CIE 1931 RGB color space and CIE 1931 XYZ color space were the first defined color quantities. They were created by the International Commission on Illumination (CIE) in 1931. The foundation for these came from experiments done in the late 1920s by William David Wright and John Guild. Additional developments included the 1960 CIE and the plotting of the Planckian locus on the MacAdam (u, v) chromaticity diagram.

Dr. Ohno brought us through the historical refinements in the technology and to the challenges in measurement with today’s fluorescent and LED lighting. The specification of white light chromaticity was introduced. He reviewed recent research on the preference of white points outside the current standard. NIST has a spectrally tunable lighting facility which has been utilized for studies with as many as 40 participants. The goal is a preferred and improved color quality of lighting.

I’d like to thank all the speakers for an interesting program. I think it was nice to take a break from measurement uncertainties for at least one meeting! I would also like to thank all of the meeting attendees for making the trip out to Southbridge.

Our attendees came from as far away as Rochester, New York and Rochester, New Hampshire! The feedback from the meeting was that those in attendance really liked the unique venue as well as my wife’s orzo salad, which we had with lunch. I’d like to mention that my employer, Cal-Tek Company, Inc., sponsored the meeting by providing the meeting room rental, sandwiches and additional refreshments. I would like to thank Cal-Tek as well as NCSL International for their support.

Thoughts and suggestions for future meetings included Network Analyzer calibration training and more hands-on sessions. Have a suggestion for a potential meeting topic? Please contact me via email.
On Thursday, June 2, 2016, the Washington/Oregon section of NCSLI International convened for a spring meeting at Energy Northwest in Richland, Washington. A wide variety of topics were presented by subject matter experts in the fields of industrial, legal, and scientific metrology. These diverse topics gave metrology professionals exposure to areas they may not have been familiar with while showing newcomers a portion of what the metrology profession has to offer.

Hands-on demonstrations using cutting edge measurement equipment and software were provided by Fluke, New River Kinematics, Tegam, Rosco Precision Machinery, and Measurements International. Presentations in industrial metrology included revisions to standards, resistive traceability, and combining measurement uncertainties of different coordinate measurement devices when capturing a point in three dimensional spaces. Regarding legal metrology, uncertainty in forensic measurements was discussed and how it can impact false positives in trials. For scientific metrology, the Laser Interferometer Gravitational-Wave Observatory (LIGO) theory of operation and calibration for measuring gravitational waves was presented by Dr. Evan Goetz, a LIGO physicist, followed by a tour of the LIGO Hanford detector.

To begin the meeting, attendees were introduced to NCSLI and what membership within the organization has to offer such as development of new or improved measurement techniques and standards, facilitating training within the field of measurement science for industry professionals, NCSLI’s technical publications, and measurement science community outreach. NCSLI’s Marketing VP, Jack Somppi, followed up with describing the numerous benefits that come along with being a member.

Upcoming changes to ISO/IEC 17025 were presented by NCSLI Western Division VP and Boeing Quality Systems Specialist, Tony Reed. This international standard outlines the accreditation requirements for Testing and Calibration laboratories and is currently being reviewed.
by the ISO/CASCO WG44 committee. As part of the revision process, conceptual as well as proposed changes were reviewed and the impact to laboratories discussed by attendees.

Jack Somppi, Measurements International, discussed how resistive devices and artifacts obtain their respective values, uncertainties, and traceability to the International System of Units (SI). Jack’s presentation included an overview of equipment ranging from the intrinsic standard for resistance through primary, secondary, and working resistance standards and instruction on key considerations and concerns for their best use.

Scott Sandwith, New River Kinematics, presented the use of three dimensional measurement stations and instruments in the alignment of advanced scientific apparatuses and large scale manufacturing. Several case studies provided by Scott showed how station uncertainties play a direct role in three dimensional measurement network uncertainty. He also showed how uncertainty outcomes can demonstrate the choice of which sensors to use and how they should be positioned for a given survey.

Many attendees were introduced to the details of legal metrology via attorney-at-law Ted Vosk’s presentation on “The Epistemology of Forensic Measurements.” Ted discussed how metrology provides a framework for building epistemologically robust knowledge through scientific measurement. He also discussed that regardless of the field, metrology provides a rigorous evaluation of all measurements, including those found in forensics, that judges can use to provide confidence in the verdicts they issue.

Finally, Dr. Evan Goetz, a physicist with LIGO Hanford detector, presented on how LIGO measures gravitational waves and how the apparatus is calibrated. Dr. Goetz provided insight on how LIGO measures gravitational waves (the stretching and compression of space-time by accelerating masses) via two of the most precise instruments ever constructed for measuring relative displacement. He went on to describe the precision calibration of the detectors’ outputs via photon radiation pressure actuators. Afterward, Dr. Goetz led attendees on a tour of the nearby LIGO Hanford detector which detailed the different aspects of the apparatus and how it isolates itself from a variety of external and internal influences to maintain its sensitivity to the expansion and contraction of space-time.

Overall, the meeting was a huge success and enjoyed by all attendees. It served as a great opportunity for measurement science professionals in Eastern Washington
and Oregon to network and share knowledge about industrial, legal, and scientific metrology. We thank our host Energy Northwest for providing a fantastic facility for the section meeting and the exhibitors for giving attendees the chance to try a variety of cutting edge measurement test equipment and software.

We would also like to thank our presenters for providing the knowledge breadth and depth critical for learning, LIGO Hanford for a once-in-a-lifetime tour of a historic scientific apparatus, and NCSL International for their continuous support of the metrology world.

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