



2010 ANNUAL WORKSHOP & CONFERENCE
04-06 AUGUST 2010
MINNEAPOLIS, MINNESOTA, USA

AGENDA: WEDNESDAY 04 AUGUST 2010

09:00 – 09:50 **Workshop Registration**

CONTINENTAL BREAKFAST

10:00 – 11:15 **Overview of ASME Y14.5-2009**

Dr. Greg Hetland, International Institute of GD&T (IIGDT), USA

Abstract: The latest Y14.5 Standard (2009) is now released and users need to understand the significant changes to determine implications to their companies prior to integration. This workshop will communicate the core changes and enhancements that will have the greatest impact on organizations.

11:15 – 11:30 *COFFEE BREAK*

11:30 – 12:45 **Overview of ASME Y14.5-2009 (continued)**

Dr. Greg Hetland, International Institute of GD&T (IIGDT), USA

12:45 – 13:45 *LUNCH*

13:45 – 15:00 **Dimensional Metrology Measurement Uncertainty Workshop**

Dr. Steven Phillips, National Institute of Standards and Technology (NIST), USA

Abstract: This workshop is appropriate for both managers and practitioners of dimensional metrology. The modern treatment of measurement uncertainty will be presented with emphasis on terminology (speak like a pro), economic implications, conceptual understanding, and modern methods of uncertainty evaluation (including Monte Carlo calculations). Several examples will be discussed and a handout of all the material presented will be available to attendees.

15:00 – 15:15 *COFFEE BREAK*

15:30 – 16:45 **Uncertainty Workshop (continued)**

Dr. Steven Phillips, National Institute of Standards and Technology (NIST), USA

AGENDA: THURSDAY 05 AUGUST 2010

08:00 – 09:00 **Conference Registration**

CONTINENTAL BREAKFAST

09:00 - 09:15 **Welcoming Remarks**

Dr. Greg Hetland, NACMA Chairman
Bill Farrell, Medtronic, Sr. Director of Design for Reliability and Manufacturability, USA

09:15 - 10:15 *SPONSOR INTRODUCTIONS*

Very short presentations from our sponsors on interesting metrology products and services.

- 10:15 – 10:55 **Impact of Measurement Uncertainty on Development and Manufacturing**
Mike Fletcher, Medtronic, USA
- Abstract: This presentation discusses the impact of measurement uncertainty on the product development and manufacturing system. Product quality, an output of this system, is achieved through a series of steps, each with their own inputs, outputs and sources of error. Those steps are Design Documentation, Tolerance Analysis, Manufacturing and Measurement. The associated errors are Design Intent Error, Tolerance Analysis Error, Manufacturing Error and Measurement Uncertainty respectively. A simple design example illustrates how measurement uncertainties can negatively impact the development effort and cause continued production issues. Since Measurement Uncertainty is an input to the major steps of development, it is considered to be as large a factor as Design Intent, Tolerance Analysis and Manufacturing errors in achieving quality products.
- 10:55 – 11:15 *COFFEE BREAK AND VENDOR TIME*
- 11:15 – 11:55 **Cost efficient risk based verification strategy**
Johan Dovmark, Novo Nordisk, Denmark
- Abstract: A proper functional related part specification (drawing) may very well encompass an enormous amount of specifications. Not all requirements are equally important or critical for the function of the product. Seen from the viewpoint of the production of the part, not all specifications are likely to exceed its tolerance limits. Proving conformance by measurements are often time consuming and expensive to perform. From an overall economical perspective it is often impractical to verify all requirements. Based on minimizing risk the presentation gives an overview and discusses some factors that should be taking into account for a sensible selection of the most favorable requirements to verify.
- 11:55 - 12:35 **A model for task specific CMM measurement uncertainty**
Dr. Henrik S. Nielsen, HN Metrology Consulting, Inc., USA
- Abstract: Assuming adequate data point density and software algorithms that match the measurand, the task specific uncertainty of CMM measurements depends firstly on the uncertainty of the individual points measured and secondly on how well or ill conditioned the measurand is mathematically. Inadequate data point density and software algorithms that do not match the measurand add to this baseline uncertainty. The presentation discusses how the baseline uncertainty may be calculated and shows examples of the consequences of inadequate data point density and typical software algorithm discrepancies.
- 12:35 – 13:50 *LUNCH AND VENDOR TIME*
- 13:50 – 14:30 **Micro-feature Measurements at NIST**
Dr. Bala Muralikrishnan, National Institute of Standards and Technology (NIST), USA
- Abstract: The different measurement capabilities for performing dimensional measurements of microfeatures on micro- and macro-scale artifacts at NIST will be described. These include a fiber probe developed internally at NIST that is mounted on the Moore M48 CMM that can perform measurements of 100 μm holes at expanded uncertainties of under 100 nm ($k = 2$). Other commercial systems and two new probing technologies will also be described. Some interesting measurements using the NIST fiber probe and some unique challenges in performing measurements with flexible probes will be addressed including some challenges in calibrating a non-spherical probe tip used in 3D measurements.

- 14:30 - 15:10 **Overview over the different measurement methods for geometry error correction for measuring machines and machine tools**
Dr. Eugen Trapet, Trapet Precision (ISM3D, Spain)
- Abstract: The presentation introduces into the different measurement methods for partial and full rigid body error mapping of Cartesian axes and compares them. Non-rigid body error mapping and rotary axes correction is briefly discussed as well. The needs to not only correct but as well to align the machines before correction and to verify them after the correction in front of the client are taken into account in these discussions.
- The emphasis is laid on the methods which are not so familiar for most machine installers:
- laser tracer
 - measuring systems which measure multiple degrees of freedom at once
 - artifact-based methods (using ball plate, dot plate or ball bar)
 - sensors for measuring artifacts (self-centering probe and camera based measurement)
 - multiple-line (including space diagonals) linear interferometer measurement
- 15:10 - 15:40 **Experiences with roundness testing of ultra-precision spheres for spindle error motion testing**
Mel Liebers, Professional Instruments (USA)
- Abstract: Nanometer-level error motion testing requires a good ball, a good gage, a good structure, and a good spindle. We will cover ball lapping and calibration, gage design, structural design, error separation, data processing, and evaluation of results. Examples range from old-school techniques to present-day testing at 10,000 rpm.
- 15:40 - 16:00 *COFFEE BREAK AND VENDOR TIME*
- 16:00 - 16:40 **Approximation of the uncertainty of coordinate systems**
Dr. Alessandro Balsamo, National Institute of Metrological Research (INRIM), Italy
- Abstract: Coordinate systems are essential to any coordinate measurement, usually established prior to any further measurement. This may lead to neglect its relevance to the overall measurement uncertainty. Even who does try to evaluate this uncertainty, is often unable to get to any usable result due to the intrinsic complexity of the problem. As a result, the uncertainty budgeting is not popular in coordinate measurement. In its first part, this talk will illustrate the importance of the uncertainty on coordinate systems, how to express it and how to propagate it to actual measurands. In its second part, the talk will address how to evaluate the uncertainty of coordinate systems. As a full evaluation in the general case as required by standards is very complicated, simple approximations will be illustrated, intended to be rules of thumbs in designing measurement strategies rather than means to formal statements of the uncertainty.
- 16:40 - 17:15 **Geometric Tolerancing and Coordinate Metrology**
Dr. Ed Morse, University of North Carolina at Charlotte (UNCC), USA
- Abstract: GD&T (Geometric Dimensioning and Tolerancing) is a method for unambiguously specifying the required geometry and allowable variations for workpieces. The ASME Y14.5 standard (both 1994 and the newly-released 2009 version) explicitly states that it is "not intended as a gaging standard" and thus the interpretation of the part inspection results is often left to the user of the equipment, either with or without the help of measurement software. This talk will cover challenges in the interpretation of GD&T that a metrologist may experience, and some common interpretation problems encountered by users of GD&T.
- 17:15 - 18:00 *OPEN DISCUSSION AND VENDOR TIME*

18:30 - 19:00 *NETWORKING AND CASH BAR*
Embassy Suites Hotel

19:00 - *DINNER*

AGENDA: FRIDAY 06 AUGUST 2010

08:00 - 08:30 *CONTINENTAL BREAKFAST*

08:30 - 09:15 **Uncertainty associated with CMM Software**
Dr. Craig Shakarji, National Institute of Standards and Technology (NIST), USA

Abstract: One source of uncertainty is associated with software errors, meaning the extent that software fails to correctly compute its objective. But another source of uncertainty is from the application of perfectly working software to imperfect problems. Fit objectives, filtering, and sampling come into play as various algorithms are applied to GD&T callouts.

09:15 - 10:00 **CMM Uncertainty Evaluation by Computer Simulation: The Full Monte**
Dr. Kim Summerhays, MetroSage, USA

Abstract: Task-specific uncertainty estimation for CMM-based evaluations of GD&T parameters is a non-trivial task, but one which offers a variety of potential benefits. Uncertainty information can support traceability, conformance decisions, process control and economic consequences attendant to all of these. The ISO has identified several alternative methods for uncertainty estimation in dimensional metrology. One of these, computer simulation, has been shown to provide an attractive set of attributes. This presentation will describe key factors influencing CMM measurement uncertainties, technologies employed in their simulation, instantiations of these technologies, illustrations of their application and uses of their results.

10:00 - 10:20 *COFFEE BREAK AND VENDOR TIME*

10:20 - 11:05 **Testing of trackers, arms, and scanners from a manufacturer's point of view**
Dr. Robert Bridges, Faro, USA

Abstract: For laser trackers and articulated arms, there are currently national standards in the United States and Germany, and work is beginning on ISO standards for these devices. Within FARO, our test methods for trackers and arms are designed to be as fast as possible and to have small test uncertainty, using methods that will be explained. For scanners, ASTM has begun work on a standard for mid-range scanners and ISO has begun work on a standard for close-range scanners attached to Cartesian CMMs. There are many challenging issues in creating standards for scanners, and some of these will be described. There is a need today for improved test methods for scanners, even before international standards are available.

11:05 - 11:50 **Software for Coordinate Metrology: Trends, State of the Art, Traceability**
Kostadin Doytchinov, Kotem Technologies – Canada

Abstract: Many modern non-contact measuring systems produce huge amounts of data which presents a big challenge to computer software used to evaluate and visualize measured data and perform tolerance assessments. To deal with this issue software manufacturers offer different ways for data reduction. This presentation will discuss methods for data reduction without losing crucial metrological information from a tolerance assessment point of view.

- 11:50 - 12:15 **Techniques for Ultra High Accuracy CMM Measurements and Uncertainty Calculations**
 John R. Stoup, National Institute of Standards and Technology (NIST), USA
- State of the art precision measurement is most often performed using specialized 1-D instruments purposely designed for the required measurement task. Although these devices have mechanical advantages over more flexible types of instruments, a national laboratory needs the ability to measure a growing array of precision artifacts and gauges at very low, and well characterized uncertainty levels. At NIST, the Moore M48 CMM has provided this capability for over ten years through a variety of unique measurement methods and applications. This talk will outline a generic set of considerations that need to be addressed for achieving world class level CMM measurements. These techniques will be demonstrated using past measurement examples and through reviews of the uncertainty budgets developed for the work.
- 12:15 - 13:00 **NACMA - CMM Certification**
 Stelian George-Cosh, Conestoga Institute of Technology, Canada
- Abstract: Human error is the most prevalent error in the outcome of an inspection report. In many cases a sophisticated CMM is operated by a poorly trained inspector and this is reflected in the measurement results. It is obvious that there is a need of a certain competency standard for CMM operators and that they should be certified to this standard. This presentation will make visible the existing situation in Europe and present status of work done in North America, especially Canada. It covers the certification requirements for a certifying body, and the accreditation criteria for educational institutions and examinations centers. It will analyze the necessary body of knowledge and examination alternatives and make recommendations for a unified certification process across North America under NACMA supervision and guidance.
- 13:00 - 13:15 **NACMA Business, Annual Report, Election of Officers**
- 13:15 - 14:30 *LUNCH AND VENDOR TIME*
- 14:30 *CONFERENCE CLOSES*
- 14:30 **Tour Medtronic**
 Medtronic Energy and Component Center North
 6800 Shingle Creek Parkway
 Brooklyn Center MN 55430
- A maximum of 45 individuals can be accommodated for this tour of one of Medtronic's manufacturing and metrology areas. Registration will be on a first come, first served, basis.
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