2011 Annual Workshop and Conference • November 2-4, 2011
Centre Technologique en Aérospatiale (CTA) • Montréal, Canada

Agenda: Wednesday November 2, 2011

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. Steve Phillips, National Institute for Standards and Technology (NIST), USA

Abstract: This workshop is appropriate for both mangers 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. Steve Phillips, National Institute for Standards and Technology (NIST), USA

Agenda: Thursday November 3, 2011

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

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

09:15 - 10:15 **Sponsor Introductions**

10:15 – 11:00 **NPL freeform verification artefacts for optical based co-ordinate measuring systems**
Dr. Mike McCarthy, National FreeForm Centre ~ NPL ~ UK

Abstract: Traditionally, 3D coordinate measurements of engineering components have been commonly made using fixed metrology-room based CMMs, usually fitted with single point or scanning tactile probes. More recently, with the rapid uptake in the development of portable optical-based 3D coordinate measuring systems, complex freeform surfaces can be quickly digitised.

To assist industry in the verification of these optical based systems, the National Physical Laboratory (NPL) has developed a number of freeform verification artefacts ranging in size from nominally 30 mm to 400 mm.

This presentation addresses, the problems typically encountered when making such measurements and the development of the NPL Freeform reference artefacts. It also describes a measurement inter-comparison between different optical based systems.

11:00 – 11:30 **Coffee Break and Vendor Time**

11:30 – 12:15 **How a measurement uncertainty statement can be used for product development, rather than just end item inspection of aerospace parts**
Mr. Brian Parry, The Boeing Company, USA

Abstract: As part of a continuous quality improvement program to reduce weight and cost, the redesign of an airplane structural element was performed. During the redesign activity, it was identified that the new process would require some stringent measurements to be performed. As part of the cost savings, the use of existing equipment was preferred, rather than development of any new measurement technology. To address this issue, a GUM compliant uncertainty statement was developed that was used in an iterative manner to make changes in the proposed manufacturing and assemble processes.

Agenda: Thursday November 3, 2011—*continued*

12:15 - 13:00 **Evaluating traceable microparts on CT Devices – illustrating new application of micro gears.**

Dr. Frank Härtig, Head of department Coordinate Metrology, PTB, Braunschweig, Germany

Authors: Dr. Frank Härtig, Dr. Markus Bartscher, Dr. Karin Kniel, Dr. Ulrich Neuschaefer-Rube, PTB Germany; Mr. Kostadin Doytchinov, Kotem Technologies Inc., Canada

Abstract: Measurement of micro parts as involute micro gears enables specially the use of new measuring instruments and sensors as they have been used for example in the x-ray tomography or measuring instruments equipped with optical sensors. In contrast to the classical procedures, the relevant surfaces of the objects are completely captured. A norm conformance evaluation requires however additional prerequisite to the containment of measurement points. In addition it is shown, how a surface related evaluations ansatz could be used to comprehensively evaluate the involute gear flanks.

13:00 – 14:10 **Lunch and Vendor Time**

14:10 – 14:40 **NACMA—CMM Certification**

Mr. 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.

Agenda: Thursday November 3, 2011—*continued*

14:40 - 15:10 **Integration of automated metrology in complex machining operation**

Mr. Félix-Étienne Delorme, B. ing., Pratt & Whitney Canada Corp., Canada

Abstract: Pratt & Whitney Canada is manufacturing high accuracy part made from low machinability material in small volume and small production lot. These machining processes are relying on highly qualified operator and quality is based on many human interventions during the process. This presentation will show how the Metrology and Automation Technology group is working to minimize or eliminate the human intervention to improve the quality and reduce the total cycle time of these complex machining operations.

15:10 - 15:40 **Coffee Break and Vendor Time**

15:40 - 16:25 **Multisensor coordinate measurement technology applied to microprecision dimensional metrology Issues**

Dr. Christian Baldo, Centre for Mechanical and Electrical Metrology - CME Institute for Technological Research - IPT, São Paulo, Brazil

Abstract: In recent years new measurement techniques such as X-ray computed tomography (CT) and optical-tactile measuring sensors have been developed, continuously improved and made available to dimensional metrology users. CT, first developed to image internal structures of the human body, and under permanent evolution, has become an important dimensional metrology suite. The development of new measuring microsensors mounted on coordinate measuring machines has enabled metrologists to handle dimensional engineering challenges such as miniaturization of parts and structures.

In this lecture the main features and range of potential uses of both techniques are outlined, practical measurement issues and preliminary findings discussed under a metrology perspective. In particular, CT measurements of plastic and metallic parts, and microprobe measurements of microstructures are compared against classical measuring techniques in order to evaluate their potentials and gaps.

16:25 - 17:10 **Optical-Probe CMMs: Task-specific techniques to reduce measurement uncertainty**

Dr. Jim Pekelsky, Canadian Dimensional Metrology, Ottawa, Canada

Abstract: With every CMM measurement job, there is a range of achievable measurement uncertainty associated with a commensurate range of operational cost. This uncertainty vs. cost budget determines, for example, whether a dimension is the outcome of a single measurement or whether one can afford the average of many repeats. For most production jobs, routine performance that is good enough is deemed affordable; better than needed is not. For special tasks, however, lower uncertainty may be needed and justifies the higher cost of slower, repeated measurements of carefully considered set-ups and critically-defined measurands.

A good example of a special task is the calibration of the x-y axes of an optical-probe CMM using a dot plate. In this case, it behooves the owner/operator to apply specific techniques to transfer the traceability of the calibrated dot plate to his CMM with the smallest increase in uncertainty. Otherwise, there is a risk that, for example, systematic optical-probe distortions become imbedded in the x-y geometry mapping corrections, and thereby disturb the accuracy of all subsequent production use of the CMM.

- This presentation describes uncertainty-reducing techniques such as:
- kinematic support of the workpiece, to ensure reproducible bending of the dot plate,
- using the optical probe as a null detector, to minimize image scale & distortion effects,
- choosing the optimal image processing tools (e.g., centroid vs. edge-points circle) to determine the dot center (x,y) coordinates.

The latter refers to the importance of defining the measurand such that the CMM user/operator measures the dot center (x,y) coordinates using the same definition and set-up criteria as used by the service provider that calibrated the dot plate. These techniques are illustrated by examples of dot plate calibration made by the author while at the National Research Council of Canada.

17:10 - 18:00 **Open Discussion and Vendor Time**

18:00 - 18:30 **Travel time to Fairmont The Queen Elizabeth for dinner (Note: travel times for shuttle may require 60 minutes)**

18:30 - 19:30 **Networking and Cash Bar**

19:30 - **Dinner**

Agenda: Friday November 4, 2011

08:00 - 08:30 **Continental Breakfast**

08:30 - 09:00 **NRCC portable target case for short-range 3-D imaging systems characterization**

Dr. J.-Angelo Beraldin, Principal researcher, NRC Canada - IIT

Authors: J.-Angelo Beraldin, Benjamin Carrier, David MacKinnon, Luc Cournoyer, NRC, Canada

Abstract: In the last 25 years, short range 3-D imaging technology has expanded considerably and the number of players in this area continues to increase; however, standard procedures for characterization and verification have not kept pace with technological development. We present a set of tests to fully characterize the capability of a 3-D imaging system to accurately measure the geometric properties of a given artifact which is part of a portable target case (PTC). The approach used to perform these tests consists of scanning known artifacts characterized by measurements with known uncertainties which are much less than the measurement uncertainties produced by the system under test (SUT).

Agenda: Friday November 4, 2011—*continued*

09:00 - 10:00 **The GD&T measurement conundrum**

Dr. Jim Salsbury, Corporate Metrologist, Mitutoyo America, USA

Abstract: We all want to measure “right”, but sometimes measuring “wrong” is the best decision to make. Modern measuring equipment and sophisticated software provide significant benefits in versatility and automation, but with great flexibility comes great responsibility in implementation. Equipment like coordinate measuring machines (CMM) provide seemingly endless options for any specific measuring task. The CMM user needs to understand design intent (GD&T), software options, and their machine limitations to determine the optimal measuring approach. In many cases, the “theoretically correct” method does not provide the most accurate method nor the most economic overall solution. This presentation will use a variety of measurement examples to highlight the GD&T Measurement Conundrum and present best practice strategies when using modern measuring instruments.

10:00 - 10:30 **Coffee Break and Vendor Time**

10:30 - 11:30 **Impact of measurement uncertainty on development and manufacturing**

Mr. Mike Fletcher, Senior Program Manager - DRM, 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.

Agenda: Friday November 4, 2011—*continued*

11:30 - 12:15

Applications of computer simulation in coordinate measuring Machine Uncertainty Evaluation

Dr. Kim D. Summerhays, MetroSage LLC, USA

Abstract - Comprehensive tools for evaluating the uncertainty of measurements made with coordinate measuring machines (CMMs) have been available for several years, yet their widespread application has generally lagged the existing technology, presenting significant problems for producers and consumers of CMM measurement results as well as for auditors of CMM measurement operations. In searching for reasons for this slowness to embrace currently available tools, we regularly come upon two factors. The first of these is confusion about the significance and applicability of various kinds of indices of CMM measurement uncertainty.

Secondly, the depth of understanding of CMM measurement strengths and weaknesses, and their impact on product profitability, which can be developed from a comprehensive investigation of CMM measurement uncertainty, are not widely understood. We hope to clarify some of these issues and to encourage both producers and users of CMM results to enhance the value of their CMM data by application of these now technically mature tools.

12:15 - 12:45 **Testing the accuracy of a laser scanner into CNC machine**

Mr. Serge St-Martin, Mr. Michel Barrette, Project Managers, Centre technologique en aérospatiale, Canada

As part of a normal manufacturing process, it's interesting to see if the part is still metrologically good before continuing on a subsequent operation. The primary goal is to avoid stops into the workflow.

12:45 - 13:15 **Extreme Metrology - Advances in speed and Accuracy**

Matt Mulherin, Application Engineer, Nikon Metrology, Canada

Advances in metrology include faster and more accurate laser scanners mounted on Coordinate Measuring Machines (CMMs), improved software that allows for increases on the speed and analysis of the parts scanned, and in the non-destructive testing of X-Ray/CT machines that provide a look inside the part scanned at extremely precise levels.

13:15 - 14:30 **Lunch and Vendor Time**

14:30 - 15:30 **Tour Pending, To be announced**