Association for Coordinate Metrology Canada

Association canadienne de métrologie de coordonnées

2007 ACMC Annual Workshop, Rochester, New York
21-22 June 2007

AGENDA: Thursday, 21 June 2007

08:30 - 08:50 CONFERENCE REGISTRATION
Continental Breakfast

08:50 - 09:00 Welcoming Remarks
Mr. Gary Vale—President, Technical Measures Inc. and ACMC Chairman
Dr. Steven D. Phillips—National Institute of Standards and Technology, Gaithersburg MD, USA
R. Stephen Flynn—President, Optical Gaging Products, Inc., a Quality Vision International Company
Miguel Viliesid—Centro Nacional de Metrología (CENAM), Querétaro, Mexico

09:00 - 9:45 Laser Trackers: Testing and Standards
Dr. Steven D. Phillips, National Institute of Standards and Technology, Gaithersburg MD, USA

Laser trackers are now the tool of choice for large scale coordinate metrology. They are transportable allowing reconfigurable production facilities at a lower capital cost than large CMMs. Trackers now include absolute distance measuring (ADM) capability in addition to traditional (HeNe) interferometry as the ranging sensor and some systems can use the passive reflectance of the work piece instead of cooperative targets. Recently, a new standard, ASME B89.4.19 Performance Evaluation of Laser Based Spherical Coordinate Measurement Systems, has standardized performance specifications and testing procedures. This talk will discuss the ASME standard and include several test results illustrating laser tracker capabilities.

09:45 - 10:30 ASME B89 Standards on Measurement Uncertainty and Traceability
Dr. W. Tyler Estler, Precision Engineering Division, National Institute of Standards and Technology, Gaithersburg MD, USA

The evaluation of measurement uncertainty in relation to specified requirements and the traceability of measurement results to the International System (SI) are central requirements for quality assurance and the facilitation of commerce. In 1998, the US ASME Committee B89 on Dimensional Metrology created Subcommittee B89.7 on Measurement Uncertainty. Since its creation, B89.7 has produced a series of published Standards and Technical Reports addressing a number of identified needs, including: decision rules in conformance testing; simplified uncertainty evaluation for dimensional measurements; the reliability of uncertainty statements; risk analysis; and the traceability of dimensional measurements. We will describe the evolution and content of these documents and give examples of their use in practice.

10:30 - 10:45 COFFEE BREAK - VENDOR TIME

10:45 - 11:30 **The 4:1 Rule for CMM Measurements**

Professor Ed Morse, University of North Carolina at Charlotte (UNCC), Charlotte NC, USA

Many of us are familiar with the idea of gage-makers tolerances. Historically, this meant that our gage needed to be made to tolerances 10x tighter than the parts that were being inspected. Over time, as manufacturing processes became more and more capable, this rule changed from 10:1 to a more permissive 4:1. This ratio is often referred to as the Test Uncertainty Ratio, or TUR. The application of the rule is fairly straight forward if the instrument in question is a caliper with an accuracy of 20 µm and we are measuring a length with a tolerance of ± 50 µm. What is less clear is how this rule can be applied if my CMM has a volumetric performance of 6.4 µm, and I am measuring a true position that has a tolerance of Ø 25 µm. This talk will examine the extension of the simple 4:1 rule to geometric tolerances, and provide examples of how the rule can be applied and mis-applied.

11:30 - 12:30 **Measurement experiment using CMMs**

John Rivers, Rivers Precision LLC, USA

This presentation will review the results of measuring the size and location of 15 features on a specially constructed test specimen. This specimen and a drawing were given to eleven different CMM operators using 11 different machines. The results were assembled on a spread sheet to easily compare the findings. The presenter will explain the test specimen as to how it represents features that are measured in the real world of manufacturing and then review the report with discussion as to why variations occurred.

Also shown and discussed will be a few examples of actual production part problems as they relate to the experiment.

12:30 - 13:30 LUNCH

13:30 - 14:30 **Feature Based Measurement Uncertainty in a Dimensional Measurement Industrial Setting**

Mr. Keith Summers, President, Productivity Quality, Inc., Plymouth MN, USA

The upcoming ASME B89.7.3.2 standard on *Guidelines for the Evaluation of Dimensional Measurement Uncertainty* is intended to provide a practitioner's guide to measurement uncertainty that reflects two facts:

1) *The ISO Guide to the Expression of Uncertainty in Measurement* (GUM) is the accepted national and international standard.
2) Capable determinations of measurement uncertainty are needed by a rapidly growing population of accredited calibration laboratories and dimensional inspection providers who may be constrained in their ability to apply the GUM due to personnel limitations and/or process demands of a production setting.

This presentation identifies how two areas of a single company; a calibration lab and a dimensional inspection area applied the ASME B89.7.3.2 standard in their daily operations.

While both areas had been accredited to IS0 17025 for a number of years: a draft copy of the ASME B89.7.3.2 standard led to an examination of current practices and how a more dynamic approach could improve the determination of measurement uncertainty without significantly increasing processing time. As the examination progressed, an initial expectation was realized: the limited reporting events (defined procedures leading to inspection certificates) in the calibration area made for a straightforward improvement process. The variables in the inspection area associated with multiple parts of different materials with unique measurement requirements requiring different measurement systems presented a much greater challenge.

To respond to this challenge it was decided to abandon the current system of fixed uncertainty statements by measurement process and instead establish a feature based system that examined the specific influence and input quantities for that feature and produce an inspection report that reflects the unique measurement uncertainty of that feature.

The feature based approach allowed for both better determinations of measurement uncertainty and, in many cases, a reduced measurement uncertainty by taking into account specifics of feature size, environment, and measurement technique.

The presentation includes an overview of system implementation and a detailed analysis of a typical part showing the process of contract review, work assessment, work assignment, result reporting and result presentation.

14:30 - 15:15 **Identification, Compensation, and Correction of Dynamic CMM Errors**

Dr. Allan D. Spence and David W. Chang, McMaster University, Hamilton ON, Canada

Software error compensation and correction of CMMs is widely established as a practical means of improving measurement accuracy. For touch trigger probes operating at low accelerations, static error mapping within the CMM motion controller is adequate. Newer analog touch and laser digitizer sensors, however, require accuracy correction during dynamic motion conditions. Conventional bridge CMMs, for example, can experience substantial uncorrected yaw errors during sudden acceleration. Air bearings gaps can also change, resulting in uncorrected pitch errors. This presentation illustrates these errors on a laboratory CMM, including dynamic measurement using a laser interferometer, and actual effect using a touch trigger probe and ring gauge. Solutions implemented include a parallel scale, and parallel drive including cross coupling motion algorithms implemented in an open architecture controller. Inexpensive lateral effect photodiodes, or position sensing detectors, are used with simple laser pointer style beams to verify the yaw correction, and to provide real time dynamic pitch error correction.

15:15 - 15:30 COFFEE BREAK - VENDOR TIME

15:30 - 17:00 **Best Practices in Multi-Sensor Metrology**

Bill Verwys, Applications Engineering Manager, Optical Gaging Products Inc., Rochester NY, USA

The capabilities of a number of sensor technologies used in dimensional metrology will be explained with examples of how each is used in manufacturing environments, pointing out the strengths and weaknesses of each technology. This presentation includes how a single measurement machine, that includes two or more different sensor technologies, can be used during a single measurement sequence to more completely characterize critical dimensions, angles, and relationships of features on the part. Technologies explored will include laser, video, contact probe, micro probe, dual-axis rotary tables, and scanning probes. A tabletop inspection machine will be present to show first hand examples of multisensor applications in the automotive, medical, aerospace, and consumer product industries. The machine will be equipped with video, touch probe, and laser sensors.

17:00 - 17:20 **Mexican CMM Club activities**

Miguel Viliesid, CENAM, Mexico

17:20 - 17:45 **ACMC Business, Annual Report, Election of officers**

18:15 - 19:00 CASH BAR

Rochester Yacht Club

19:00 DINNER

Rochester Yacht Club

20:00 AFTER DINNER SPEAKER

Dr. Steven D. Phillips

AGENDA: Friday, 22 June 2007

08:00 - 08:30 CONFERENCE REGISTRATION
Continental Breakfast

08:30 - 09:15 Spherical tip compensation methods
Dr. Rene Mayer, Département de génie mécanique, Section fabrication, École Polytechnique, Montreal QC, Canada
Dr. Adam Wozniak, Institute of Metrology and Measuring Systems, Warsaw University of Technology, Poland

Tip compensation is a key operation in coordinate metrology. Significant errors may be introduced in the corrected measured points especially in the presence of strong deviations of the part from nominal and when strong curvatures or discontinuities are measured. Two families of methods can be defined. Some methods use normal vectors to a surface, the others work directly with the indicated points and tip diameter. A review of current methods using the normal vector methods such as CAD model based and indicated measured point based with their limitations will be presented. The methods that do not use normal vectors have evolved with the availability of scanning technology which is now widely used in coordinate metrology. It is often applied to the measurement of sculptured features and of features that are small in relation to the tip diameter. The high density scans now possible results in a new context which can be called high definition coordinate metrology. The availability of such high point density allows the emergence of new approaches to the old problem of probe ball tip radius correction based on the successive positions of the probe tip without requiring the definition of a surface normal vector. Two methods will be described. One is based on a mechanical filtering approach. The other method is particularly, but not exclusively, suitable for the metrology of features with small radii as well as metrological discontinuities.

09:15 - 10:15 Extending the GD&T Capabilities of CMM Software
Evan Janeshewski, Axymetrix Quality Engineering Inc., Langley BC, Canada

Most CMM software provides functionality for evaluation of geometric tolerances, but the default GD&T functions are generally incomplete and not always compliant with ASME and ISO dimensioning and tolerancing standards. It is possible (and often necessary) to extend the software's GD&T functionality by applying its tools and algorithms in different ways. This presentation will examine several common cases in which the default GD&T functionality of many CMM software packages falls short. For each case, the geometric meaning of the required actual value will be analyzed in terms of feature component, tolerance zone, coordinate system, and degrees of freedom. Techniques to construct the desired actual values using commonly available CMM software functions will then be outlined.

10:15 - 10:40 COFFEE BREAK - VENDOR TIME

10:40 - 12:00 Open forum on GD&T – discussions of real drawings and solutions
CHAIR:
Greg Hetland—President, International Institute of GD&T, Hopkins MN, USA
PANEL MEMBERS:
Ed Morse—University of North Carolina at Charlotte (UNCC), Charlotte NC, USA
Kostadin Doytchinov—National Research Council Canada, Ottawa ON, Canada
Carlo Algera—Regional Manager, Origin International Inc., Markham ON, Canada
John Rivers—Rivers Precision LLC, USA

12:00 - 12:45 LUNCH - VENDOR TIME

13:15 - 15:15 Tour of Quality Vision International world headquarters

Established in 1945 Quality Vision International is the parent company of Optical Gaging Products, View Engineering, Ram Optical, Micro-Metric, Quality Vision Services, Quality Vision International Technologies and Kotem. The tour will take participants through the manufacturing facility of the world's largest supplier of video measurement systems. The tour will include machine assembly, optics, electronics, laser lab, precision machining, outgoing inspection, custom engineering and the application of finished product. Please allow two hours for the complete tour