

**LASER METROLOGY
AND
MACHINE PERFORMANCE IX**

9th International Conference and Exhibition on Laser
Metrology, Machine Tool, CMM & Robotic Performance

Lamdamap 2009

Hosted by:



Organised by:



TIB/UB Hannover 89

131 042 289



CONTENTS

Conference Keynotes

- Advanced Multi-task Machining Technology for Competitive Manufacturing (Abstract) 3
P. Hill
- Traceable Measurements of Large Gears for Wind Turbines (Abstract) 4
Dr. F. Härtig

Section 1: Machine Tool and CMM Performance Evaluation Methods

- Efficient Offline Thermal Modelling for Accurate Assessment of Machine Tool Thermal Behaviour 9
N. S. Mian, S. Fletcher, A. P. Longstaff, A. Myers, C. Pislaru
University of Huddersfield, Queensgate, Huddersfield, UK
- Reconfigurable Uncalibrated 3D Ball Artefact for Five-Axis Machine Volumetric Check 19
T. Erkan¹, J.R.R. Mayer¹, Y. Dupont²
¹*École Polytechnique de Montréal, Canada*
²*Pratt & Whitney Canada*
- Assessing the Impact of Rotary Axes on the Dynamic Accuracy of Machine Tools 28
G.H.J. Florussen, M.A.A. Morel, H.A.M. Spaan
IBS Precision Engineering BV, the Netherlands
- Compensation of Thermal Effects on Machine Tools using a FDEM Simulation Approach 38
Josef Mayr¹, Markus Ess², Sascha Weikert², Konrad Wegener^{1,2}
¹*IWF Institute of Machine Tools and Manufacturing, ETH Zurich, Switzerland*
²*Inspire, ETH Zurich, Switzerland*
- Evaluation of the Volumetric Length Measurement Error of a Micro-CMM Using a Mini Sphere Beam 48
Z X Chao, S L Tan and G Xu
National Metrology Centre Agency for Science, Technology and Research, Singapore
- Evaluation and Comparison of a Large Machine Tool Structure 57

with ISO Standard Alignment Tests

A. Myers, S M Barrans, A P Longstaff, S Fletcher, D G Ford
Centre for Precision Technologies, Univ. of Huddersfield, UK

A Methodology for Performance Measurement and 67

Assessment of Bench-top Precision Machine Tools

C. Lin^{1,2}, K. Cheng², H. Qiu³, D. Huo² and X. Sun²

¹*State Key Lab. of Mechanical Transmissions, Chongqing University, Chongqing 400044, China*

(Currently a visiting scholar at Brunel University)

²*School of Engineering and Design Brunel University, UK*

³*Department of Mechanical Engineering, Kyushu Sangyo University, 813-8503, Japan*

Defining and Computing Machine Tool Accuracy 77

S Fletcher, A Longstaff, A Myers

Centre for Precision Technologies, Univ. of Huddersfield, UK

Comparison of Volumetric Analysis Methods for Machine 87
Tools with Rotary Axes

AP Longstaff, S Fletcher, AJ Poxton, A Myers

Centre for Precision Technologies, Univ. of Huddersfield, UK

Investigating the performance of Coordinate Measuring 97
Machine scanning probe systems

A. E. Cox, J. Singh and J. N. Petzing

*Wolfson School of Mechanical & Manufacturing Engineering
Loughborough University, UK*

Specification Analysis and 3D Inspection Without Contact 106

David Joannic, Jean-François Fontaine, Ahmed Isheil, Mussa Mahmud

*Laboratoire d'électronique, informatique et image, UMR
CNRS 5158, Université de Bourgogne, Auxerre, France*

Section 2: Intelligent Manufacturing & Machine Condition Monitoring

Sensing Tool for Condition Monitoring 119

B. Kuhfuss, S. Allers

University of Bremen, Department of Machine Tools, Germany

Analysis and Compensation of Thermal Errors in a High-Speed 127
Micro-Milling Spindle

E. Creighton, A. Honegger, A. Tulsian and D. Mukhopadhyay
Microolution Inc., U.S.A.

Optimisation of Real-Time Implementation for High Speed Drives Models 138
C. Pislaru, D. G. Ford, S. Sztendel, A. Myers
University of Huddersfield, School of Computing and Engineering, UK

Developing Mechatronic Models of Modern CNC Machine Tools for Real-Time Implementation 147
S. Sztendel, C. Pislaru, A. Poxton, D. G. Ford, A. Myers
University of Huddersfield, School of Computing and Engineering, UK

BOM optimisation to advance assembly processes 156
T. Bányai, L. Kota
University of Miskolc, Hungary

Automated 2D Part Orientation Estimation Based on Neural Networks for a Real-time PLC Application 165
I.Boyadjiev, I.Topalova, A.Tzokev
Technical University of Sofia, Bulgaria

Novel Condition Monitoring Technique Used For Improved CNC Machine Tool Performance 176
C. Pislaru, D. G. Ford, A. Myers
University of Huddersfield, School of Computing and Engineering, UK

Section 3: Novel Manufacturing Technologies & Machine Tools

Innovative High Speed Machine Tool with Energy-optimized Jerk-decoupling Technology 187
B. Denkena, H.-C. Möhring, O. Gümmer*
Institute of Production Engineering and Machine Tools (IFW), Leibniz Universität Hannover, Hannover, Germany

Design of a Novel, Composite and Reconfigurable Micro Manufacturing Machine 196
R. Alsharif, C. Makatsoris*
School of Engineering and Design, Brunel University, UK

| | |
|--|-----|
| Design and Development of a New Machine System For The Mass Manufacture of Complex Shaped Tubular Components by Micro-Hydroforming Ch. Hartl, G. Anyasodor <i>Cologne University of Applied Sciences, Germany</i> | 206 |
| Internal Cooling of Cutting Tools E. Uhlmann, M. Roeder ¹ , E. Fries ² , F. Byrne ¹ ¹ <i>Institute for Machine Tools and Factory Management, Technische Universität, Berlin, Germany</i> ² <i>Fraunhofer-Institute for Production Systems and Design Technology, Berlin, Germany</i> | 215 |
| Integral Design Axis for the Accuracy Enhancement of Ultraprecision Machine Tools C. Brecher, P. Utsch, C. Wenzel <i>Fraunhofer IPT, Germany</i> | 224 |
| Nano-emulsion-mixed EDM Method for Finishing of Fine Surface Xiaoming Kang ¹ , Wansheng Zhao ^{1*} , Qingguo Meng ² , Qiang Ju ¹ ¹ <i>School of Mechanical Engineering, Shanghai Jiao Tong University, China</i> ² <i>YanTai University, China</i> | 234 |

Section 4: Surface Texture, Dimension and Form Metrology Techniques

| | |
|--|-----|
| Characterisation of the Metrological Properties of 3-D Microprobes N. Hofmann ¹ , A. Tibrewala ² , F.G. Balzer ¹ , T. Hausotte ¹ , E.Manske ¹ , G. Jäger ¹ , S. Büttgenbach ² ¹ <i>Ilmenau University of Technology, Institute for Process Measurement and Sensor Technology, Germany</i> ² <i>Braunschweig University of Technology, Institute for Microtechnology, Germany</i> | 243 |
| Least Squares and Outliers in Coordinate Metrology A B Forbes, C E Matthews <i>National Physical Laboratory, UK</i> | 253 |
| The Characterisation of Non-contact Con-focal Sensing in the 3D Surface Profile Measurement of a Reference Structured | 263 |

Surface

Z. Zhao, J. W. McBride

School of Engineering Science, University of Southampton, UK

Section 5: Advanced Manufacturing & Metrology using Laser Techniques

Development of a Metrological Atomic Force Microscope at Kuleuven 275

Jan Piot¹, Jun Qian¹, Hugo Pirée², Gerard Kotte², Alexander Volodin³, Chris Van Haesendonck³, Dominiek Reynaerts¹

¹*KULeuven, Department of Mechanical Engineering, Belgium*

²*FPS Economy, SMEs, Self Employed & Energy – SMD, Belgium*

³*KULeuven, Laboratory of Solid-State Physics and Magnetism, Belgium*

Concept of a New 3D- probing System for Micro Components 285

T. Liebrich¹, W. Knapp², K. Wegener^{1,2}

¹*Inspire, ETH Zurich, Switzerland*

²*IWF, Institute of Machine Tools and Manufacturing, ETH Zurich, Switzerland*

A 2D contact-type measuring system for profile measurement using laser interferometer 295

Yung-Tien Liu*, Chun-Lin Wang, and Han-Lin Wu

Department of Mechanical and Automation Engineering, National Kaohsiung First Univ. of Science and Technology, Taiwan, R.O.C.

Experimental Testing of the Dynamic Tracking Performance of iGPS and Laser Tracker 305

Z. Wang¹, L. Mastrogiacomo², P. G. Maropoulos¹, F. Franceschini²

¹*University of Bath, UK*

²*Politecnico di Torino, Italy*

Section 6: Precision and Ultra Precision Machining Technologies

Focused Ion Beam Machining 317

H. Yang, S. Ratchev, R. Ronaldo, J. Segal, P. Wentworth

Precision Manufacturing Centre, University of Nottingham, UK

| | |
|---|-----|
| Investigations on chip Formation in micro-milling F. Ducobu*, E. Filippi, E. Rivière-Lorphèvre <i>Service de Génie Mécanique, Faculté Polytechnique de Mons, Belgium</i> | 327 |
| Tool Failure Mechanisms While Single Point Diamond Turning Silicon L. Kirkwood, I. Durazo-Cardenas, P. Shore <i>Precision Engineering Centre, Cranfield University, UK</i> | 337 |
| Effect of Polishing Angle on Material Removal Rate and Surface Finish Using Bonded Abrasive Pads Stanley Obi ¹ , Xun Chen ² , Liam Blunt ³ <i>University of Huddersfield, UK</i> | 347 |
| Dynamical Problems in Interrupted High Precision Hard Turning D. Bachrathy, I. Mészáros <i>Budapest University of Technology and Economics, Hungary</i> | 357 |
| The Role of Computational Fluid Dynamics for Coolant Delivery in Industrial Grinding of Steels and Cast Iron V. A. Baines-Jones ^{1,a} , M. N. Morgan ^{2,b} , A. D. Batako ² , E. Brown ¹ ¹ <i>R&D Department, Cinetic Landis Ltd, Cross Hills, Keighley, West Yorkshire, BD20 7SD, UK</i> ² <i>AMTReL, General Engineering Research Institute, Liverpool John Moores University, Liverpool, UK</i> | 368 |
| Force Modelling in Diamond Machining with Regard to the Surface Generation Process C. Brandt ¹ , A. Krause ² , E. Brinksmeier ² , P. Maaß ¹ ¹ <i>Center for Industrial Mathematics, University of Bremen, Germany</i> ² <i>Laboratory for Precision Machining, University of Bremen, Germany</i> | 377 |
| Laser Monitoring of TiN Decoating Process to Facilitate Optimum Removal S. Marimuthu, D. J. Whitehead, P. T. Mativenga, L. Li <i>School of Mechanical, Aerospace and Civil Engineering, The University of Manchester, UK</i> | 387 |
| Precision Microfabrication of Millimetre Wave Components M. L. Ke ¹ , Y. Wang ¹ , X. Wei ² , K. Jiang ² , M. J. Lancaster ¹ | 397 |

¹*School of Electrical, Electronic and Computing Engineering, University of Birmingham, Birmingham, UK*

²*School of Mechanic Engineering, University of Birmingham, UK*

Precision-orient CAD/CAM Modelling for Spiral Bevel Gear 404

Numerical Control (NC) Machining

Y. Xing^{1,2}, S.F. Qin², T.Y. Wang¹

¹*School of Mechanical Engineering, Tianjin University, People's Republic of China*

²*School of Design & Engineering, Brunel University, UK*

A Study on Various Flexure-Hinge Parameters in A Micro-Gripper 413

Senthil Kumar A., Aravind Raghavendra M.R. *, Bhat Nikhil Jagdish

National University of Singapore, Singapore

Characteristics of Aluminium 6061 in the Microcutting Process of Single Point Diamond Turning 423

H. Wang, S. To*, C. F. Cheung and W. B. Lee

Advanced Optics Manufacturing Centre, Department of Industrial & Systems Engineering, The Hong Kong Polytechnic University, Hong Kong

Section 7: Metrology Applications to Improve Manufacturing Performance and Industrial Inspection

Approach for the Flexible Integration of CMMs into the Production Line 433

R. Schmitt, H. Zheng, S. Nisch

Laboratory for Machine Tools and Production Engineering WZL, RWTH Aachen University, Germany

Assembly of the Stem and Tip of an Innovative Micro-CMM Probe 442

D. Smale¹, S. Ratchev¹, J. Segal¹ R. K. Leach², J. D. Claverley²

¹*Precision Manufacturing Centre, Univ. of Nottingham, UK*

²*Industry & Innovation Division, National Physical Laboratory, Teddington, UK*

Advances in the Error Mapping of Machine Tools and Coordinate Measurement Machines (CMMs) by Sequential 452

Multilateration

R. Schmitt¹, P. Jatzkowski¹, H. Schwenke², C. Warmann²

¹*Univ. of Aachen – Germany*

²*Etalon AG – Germany*

Analysis of the Error Sources of a Computer Tomography Machine 462

V. Andreu¹, B. Georgij², H. Lettenbauer², J.A. Yagüe³

¹*Iberprecis S.L., Spain*

²*Carl Zeiss, Germany*

³*Univ. of Zaragoza, Spain*

Accuracy Enhancement of the Measuring Probe for a Camera Based Mobile CMM 472

F. Welkenhuyzen, N. Van Gestel, P. Bleys, J.-P. Kruth

Department of Mechanical Engineering, K.U.Leuven, Belgium

Using a Kinematic Model of a Machine Tool to Predict Component Feature Capability 482

H Lobato¹, S Fletcher², A Myers², N Orchard³, A

Charlesworth³ ¹*University of Birmingham – UK*

²*University of Huddersfield – UK*

³*Rolls-Royce plc - UK*

Development of a 1D-displacement Low-Cost Sensor Based on the Inverse Square Law. 492

J.A. Yagüe, J. Velázquez, J.A. Albajez, M.A. Lope, J.J. Aguilar

Department of Design and Manufacturing Engineering, University of Zaragoza, Spain

Section 8: Machine Systems for Micro-Machining

Design Concept for Micro Milling Machine Tools Based on Dynamic Dislocation Compensation 505

Eckart Uhlmann, Jörg Eßmann

Fraunhofer Institute Production Systems and Design Technology (IPK), Berlin, Germany

Manufacturing Error Sensitivity of Flat Pad Air Bearings 515

S.M. Barrans¹, N. Bhat², Kumar², A. Senthil²

¹*University of Huddersfield, UK*

²*National University of Singapore*

Fan Yang¹, Yifan Dai¹, Xiongwei Liu², Shengyi Li¹

¹*College of Mechatronics Engineering & Automation, National
University of Defense Technology, Changsha, China*

²*School of Computing, Engineering and Physical Sciences,
University of Central Lancashire, Preston, UK*