

35th ASPE Annual Meeting 2020

Online
20 – 22 October 2020

ISBN: 978-1-7138-2046-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2020) by American Society for Precision Engineering (ASPE)
All rights reserved.

Printed with permission by Curran Associates, Inc. (2021)

For permission requests, please contact American Society for Precision Engineering (ASPE)
at the address below.

American Society for Precision Engineering (ASPE)
P.O. Box 10826
Raleigh NC 27605-0826

Phone: (919) 839-8444
Fax: (919) 839-8039

www.aspe.net

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

ASPE 2020 Annual Meeting

Oral Sessions

Session 1

Precision Manufacturing

Tuesday, October 20, 2020, 10:00 AM - 11:35 AM

Session Chair:

Stephen J. Furst (Smart Material Solutions, Inc.)

1. **Creating Production Machinery for the 4th Industrial Revolution**..... *
- Shore, P. (Loxham Precision)

2. **ILCentric – A New Approach in Centering Optics for High-end Applications**..... *
- Wentz, C.T.; Goetzen, G.G. (Innolite GmbH)

3. **A Study of the Micro-Structure of Diamond Turned Surfaces and the Generation
Diffraction Color** 11
- Hashimoto, T. (AMETEK Precitech Inc.) (Keio University); Roblee, J.W. (AMETEK Precitech Inc.);
Yan, J. (Keio University)

4. **Tool Point Receptance Variation with Spindle-holder-tool Selection**.....15
- Schmitz, T.L. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory)

5. **Modeling and Simulation of Modulated Tool Path (MTP) Turning Stability**21
- Copenhaver, R.W.; Schmitz, T.L. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory)

6. **An Investigation of Magnetic-Field Assisted Mass Polishing for Precision Manufacturing of
Optical Freeform Surfaces**..... 27
- Cheung, C.F.; Wang, C.J.; Loh, Y.M.; Ho, L.T. (The Hong Kong Polytechnic University)

Session 2

Precision Design

Tuesday, October 20, 2020, 1:00 PM - 2:05 PM

Session Chair:

Richard M. Seugling (Lawrence Livermore National Laboratory)

1. **Balanced Design Effort for Contamination Control in Precision Semiconductor
Measurement Equipment**..... 32
- Hijkoop, E.G.; Verbaan, K.; Martens, B.; Kouters, M.H.M. (NTS-Group)

2. **Design of an Ultra-precise Oscillating Blade Microtome based on Vibration Cancellation**.....38
- Fu, X.; Chen, J. (The University of Hong Kong); Yang, J.; Chang, S.; Boas, D.A (Boston University);
Chen, S. (The University of Hong Kong)

3. **Optomechanical Spherical Manipulator with an Adjustable Center of Rotation**43
- Smelt, K. J. (DEMCON); de Jong, J. J. (DEMCON) (University of Twente); Blok, C.A. (DEMCON);
Brouwer, D.M. (University of Twente)

*No abstract included

4. **Efficient Modeling for the Design of a Large-stroke Fully Flexure-based 6-DOF Hexapod** 47
 Nijenhuis, M.; Naves, M.; Hakvoort, W.B.J.; Brouwer, D.M. (University of Twente)

Session 3

Controls and Mechatronics

Wednesday, October 21, 2020, 7:30 AM - 9:05 AM

Session Chair:

Chinedum E. Okwudire (University of Michigan)

1. **Decoupled, Open-Loop, Multi-DoF Rotation of an Under-Actuated, Spherical Permanent Magnetic Dipole Actuator** 52
 Hamer, T.T. (Massachusetts Institute of Technology); Chabot, J. (MIT Lincoln Laboratory); Trumper, D.L. (Massachusetts Institute of Technology)
2. **Magnetic Levitated Linear Scan Module with Nanometer Resolution.**58
 Goos, A.; Ehrle, R.; Geissler, D.; Gloess, R. (Physik Instrumente (PI) GmbH & Co. KG)
3. **Vibration Mitigation on Precision Ball-Screw Feed-Drives Through Data-driven Tuning of Trajectory Pre-Filters**63
 Dumanli, A.; Sencer, B. (Oregon State University)
4. **Combined Servo Error Pre-compensation and Feedrate Optimization Using Sequential Linear Programming**69
 Kim, H.; Okwudire, C.E. (University of Michigan)
5. **Oversampling Sensors for Precision Positioning Applications**74
 Bhushan, B.M.; Lenhard, A.; Trumper, D.L. (Massachusetts Institute of Technology)
6. **Study on Improvement of Reversal Motion of NC Moving Table by Friction Force Compensation**
 80 Inomata, Y. (Kanazawa Institute of Technology Graduate School); Morimoto, Y.; Hayashi, A. (Kanazawa Institute of Technology)

Session 4

Micro/Nano Technologies

Wednesday, October 21, 2020, 1:30 PM - 3:05 PM

Session Chair:

Michael A. Cullinan (The University of Texas at Austin)

1. **Role of Precision Engineering in Pushing the Performance Limits of Nanoscale Additive Manufacturing**..... 84
 Kim, H.; Saha, S.K. (G.W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology)
2. **Ceramic Two-Photon Printing of High Aspect Ratio Microstructures**89
 Cortes, J.; Mettry, M.; Worthington, M.; Chandrasekaran, S.; Panas, R.M. (Lawrence Livermore National Laboratory (LLNL))
3. **Towards 3D Part Fabrication Using a Micro-Scale Additive Manufacturing Tool**.....93
 Behera, D.; Roy, N.; Cullinan, M.A. (The University of Texas Austin)

*No abstract included

- 4. **Polarization Based Optically Variable Devices Fabricated by Elliptical Vibration Texturing96**
Wang, J.; Yang, Y.; Guo, P. (Northwestern University)
- 5. **Design, Fabrication, and Signal Propagation Characteristics of Micro-Mechanical Logic Elements 100**
Sun, F.; Panas, R.M.; Bekker, L.; Mancini, J.A.; Pascall, A.J. (Lawrence Livermore National Laboratory (LLNL))
- 6. **Multi-Focus Random-Access Pump-Probe Microscopy Based on Compressive Sensing 102**
Lu, W.; Chen, B.; Chen, S. (The Chinese University of Hong Kong)

Session 5

Metrology Systems

Thursday, October 22, 2020, 10:00 AM - 11:40 AM

Session Chair:

Jonathan D. Ellis (Clerio Vision)

- 1. **Lessons Learned by the Precision Engineering Community for Application on Future Astronomical Systems..... ***
Arenberg, J. (Northrop Grumman Aerospace Systems)
- 2. **Nanopositioning and Nanomeasuring Machines for Cross-scale Measurement with Sub-nanometer Precision and Nanofabrication* ***
Manske, E. (Technische Universität Ilmenau (TUI))
- 3. **Moonshot Metrology..... 107**
Liebers, M.; Arneson, H. (Professional Instruments Company)
- 4. **Phase-shifting 3D Imaging of Rotating Milling/drilling Tools 113**
Guo, X.; Lee, C. (Texas A & M University)
- 5. **Spindle Metrology for a High Resolution X-ray Microscope 117**
Knapp, B. R. (Professional Instruments Company); Preissner, C. (Argonne National Laboratory); Oss, D. (Professional Instruments Company)

Session 6

Measurement Errors & Uncertainty

Thursday, October 22, 2020, 1:00 PM - 2:35 PM

Session Chair:

Richard K. Leach (University of Nottingham)

- 1. **Comparison of Optical and Contact Surface Topography Measurement, Including Uncertainty. ***
Leach, R.K.; Thompson, A; Su, R (University of Nottingham); Murakami, H (University of Kitakyushu); Cui, X. (Dalian University of Technology); Senin, N. (University of Nottingham) (University of Perugia)

*No abstract included

2. Trends in Geometric Error of X-ray Computed Tomography Instruments Observed at Different Locations in the Measurement Volume 122
Jaganmohan, P. (National Institute of Standards and Technology) (University of North Carolina at Charlotte); Muralikrishnan, B; Shilling, M. (National Institute of Standards and Technology); Morse, E.P. (University of North Carolina at Charlotte)

3. Software Based Accuracy Improvement of 5-axis Machine Tools by Compensation of Rotary Axis Errors.....*
Spaan-Burke, T.; Spaan, H. (IBS Precision Engineering)

4. Development of a New Standard for the Performance Evaluation of Single Axis Linear Positioning Systems 128
Vogl, G. W. (National Institute of Standards and Technology (NIST)); Fesperman, R.R. (Corning Inc.); Ludwick, S. J. (Aerotech Inc.); Klopp, R.W. (Exponent Inc.); Grabowski, A. (Physik Instrumente (PI) GmbH & Co. KG); Lebel, J. (Renishaw Inc.); Miller, J.A. (University of North Carolina at Charlotte); Brown, N. L. (ALIO Industries Inc.); Belski, E.; Duncan, N. (Aerotech Inc.); Hennessey, C.W. (ALIO Industries Inc)

5. Flatness Measurement of Large Surfaces Applying Improved Sequential Three-point Method 134
Yamada, S.; Uda, Y.; Shimada, S. (Osaka Electro-Communication University)

*No abstract included

Poster Sessions

Tuesday, October 20, 2020, 12:00 PM - 1:00 PM

Thursday, October 22, 2020, 12:00 PM - 1:00 PM

Controls and Mechatronics

1. **Success and Failure in Friction Identification, Compensation, and Simulation for Precision Motion Stages** 138
Belski, E.; Duncan, N.; Ludwick S.J. (Aerotech, Inc.)
2. **Modern Angle Measurement Sensors with Classical Comparisons**..... *
- Dowski, E. R. (Ascentia Imaging, Inc), Claytor, N. (Fresnel Technologies)
3. **Rotation Measurement During Nanoindentation** *
- Fan, C.; Smith, S.T. (University of North Carolina – Charlotte)
4. **Vibration Reduction in Milling Process on Highly Flexible Workpiece** *
- Hong, T.; Lee, J. (Korea Institute of Industrial Technology (KITECH)); Kim, K. (Korea Polytechnic University); Kim, H. (Korea Institute of Industrial Technology (KITECH))
5. **Study on Compensation Filter for Velocity sensor in Active Vibration Isolation System**..... *
- Kim, K; Choi, J.; Jang, C. (Korea Polytechnic University)
6. **Design of the Small Scale Testbed to Investigate the Capsule Train Dynamics** *
- Lee, J. (Korea Railroad Research Institute)
7. **A Study on the Compensation Algorithm to Reduce Delamination on Hole Surface During Robot Drilling for CFRP** *
- Lee, J.; Kim, H. (Korea Institute of Industrial Technology)
8. **Development of a Spherical Motor Manipulated by Four Wires**..... *
- Sasaki, B.; Honda, S. (Tokyo Metropolitan University)
9. **Magnetic Levitation Fine Stage with Pitching Moment and Gravity Compensation System**.... 143
Takahashi, M.; Ogawa, H.; Saegusa, T. (Hitachi Ltd.)
10. **Shape-Changeable micro Channels Generated by fabricating additional Manufacturing for Micromanipulation System**..... *
- Yoshinaga, S. (Kogakuin University); Tomie, K. (Nagaoka Institute of Design); Masaki, D. (Kogakuin University)
11. **Semi-active Secondary Suspension Control of Capsule Train with MR Damper by Using HILS System** *
- You, W.; Abebaw, B.; Lee, J.; Lee, C.; Lee, G. (Korea Railroad Research Institute)

*No abstract included

Metrology & Characterization

12. **Comparing Surface Roughness Evaluation Techniques and the Effects of Processing Parameters on the Additively Manufactured AlSi10Mg Surfaces** *
- Frederick, C.; Bhattad, P.; Saharan, A.; Dehoff, R. (Carl ZEISS)
13. **Milling Force Measurement Using a Low-cost, Constrained-motion Dynamometer** 149
- Gomez, M.; Schmitz, T. L. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory)
14. **Portable Microscope System for Real-time Aerosol Measurement**..... 155
- Gu, S.; Chen, B.; Wen, C.; Chen, S. S. (The Chinese University of Hong Kong)
15. **Uncertainty Evaluation by Monte Carlo Method on the Effective Tool Length in a Precision Machine Tool**..... 160
- Horvath, N.; Gomez, M. (Oak Ridge National Laboratory)
16. **Optical Gear Inspection Using a Triangulation Sensor and an Areal Evaluation** 166
- Hosseinpour, A.; Peng, Y.; Goch, G.; Ni, K. (University of North Carolina at Charlotte); Guenther, A. (ETH Zurich (Eidgenoessisch Technische Hochschule))
17. **Curved-edge Displacement Sensor for Spindle Dynamic Identification** 170
- Lee, S.; Kim, J.; Lee, C. (Texas A&M University); Vogl, G.W. (National Institute of Standards and Technology)
18. **High-Throughput Nanomechanical Property Mapping** *
- Nowakowski, B.; Hintsala, E. D.; Stadnick, B. (Bruker Nano Surfaces); Chen, Y (University of North Carolina at Charlotte); Hangen, U. (Bruker Nano Surfaces Germany); Stauffer, D.D. (Bruker Nano Surfaces)
19. **In-line Interferometer for Surface Topology Inspection of Printed Electronics** *
- Spaan-Burke, T.; de Vries, J.; van der Nolle, R.; Daneshkhah, B.; Felius, M.; Spaan, H. (IBS Precision Engineering)
20. **High-precision Metrology with High-resolution Computed Tomography (or 3D X-ray Microscopes)** 174
- Villarraga-Gómez, H. (Carl Zeiss Industrial Metrology, LLC); Kotwal, N.; Ninov, V (Carl Zeiss X-ray Microscopy, Inc.); Omlor, L. (Carl Zeiss, Inc.); Mishra, A.; Johnson B. (Carl Zeiss X-ray Microscopy, Inc.); Zarnetta, R.; Weib, D.; Kimmig, W.; Krenkel, M. (Carl Zeiss Industrielle Messtechnik GmbH); Graf vom Hagen, C. (Carl Zeiss XRay Microscopy, Inc.)

*No abstract included

Micro and Nano Technologies

21. **The Role of Visualization and Error Correction in Very Large Area, Tip-based Topography Measurement** 179
Connolly, L. G.; Natinski, E. (The University of Texas at Austin); Khusnatdinov, N.; Jones, C.; Mizuno, M.; Meissl, M.; Choi, J.; LeBrake, D. (Canon Nanotechnologies); Cullinan, M. A. (The University of Texas at Austin)
22. **Development of a Micro Spur Gear Utilizing Extra Fine Wires** *
- Honda, S. (Tokyo Metropolitan University)
23. **Feedback Sensing and Dynamic Operation of the Lightfield Directing Array** 185
Panas, R.M.; Corral, P.; Hunter, S.; Paul, P. (Lawrence Livermore National Laboratory); Scott, J.; Piedrahita, M. (219 Design)
24. **Design and Fabrication of Connected Chains of Mechanical Logic Bits**..... 188
Sun, F.; Bekker, L.; Panas, R.M.; Pascall, A.J. (Lawrence Livermore National Laboratory); Farzaneh,

Precision Design

25. **Damping Characteristics of Fluidic Pressure-fed Mechanism in Dynamic Systems and Control**..... 189
Chun, H.; Kim, J. (Texas A&M University); Kim, H. (Korea Institute of Industrial Technology); Lee, C. (Texas A&M University)
26. **Design of a Large Size, Eigenfrequency Optimized XY Stage for Wafer Positioning Based on Compliant Mechanisms** *
- Hosobuchi, K.** (Hitachi High-Tech Corporation); Gräser, P.; Manske, E. (Technische Universität Ilmenau)
27. **Basic Study of Temperature Prediction Model for Machine Tools** 194
Kanabe, H.; Ikushima, S.; Kusuyama, J.; Nakao, Y. (Kanagawa University)
28. **Optical Displacement Measurement by Image Correlation** *
- Lambert, N.** (Los Alamos National Laboratories); Patterson, S. (University of North Carolina at Charlotte)
29. **Experimental Investigation on Effect of Shaft-bore Cooling Structure on Thermal Stability Against Heat Generation Due to Aerostatic Bearings** 199
Wakiya, S.; Yamazaki, S.; Kusuyama, J. (Kanagawa University); Fedorynenko, D. (Tohoku University) Nakao, Y. (Kanagawa University)

*No abstract included

Precision Manufacturing

30. **Design of an Air Bearing Slide for High Dynamic Response** 204
Arneson, C. (Professional Instruments Company)
31. **4R Blockhead Air Bearing Spindle Performance Vs. Inlet Pressure** 207
Arneson, S.O.; Arneson, D.A.; Oss, D.D.; Liebers, M.J. (Professional Instruments Company)
32. **Novel Large Capacity Oil Hydrostatic Rotary Ultra Precision Bearing** *
Arneson, H.D.; Oss, D.D.; Arneson, C. (Professional Instruments Company)
33. **Machining Characteristics of Rock by Wire-Sawing in Vacuum at High Cutting-load** 210
Furutani, K.; Okamura, H. (Toyota Technological Institute); Okada, T. (Japan Aeronautical Exploration Agency); Saiki, K. (Osaka University); Ohue, H. (Tokusen Kogyo Co., Ltd.)
34. **Physics-based Modeling of Metal Cutting to Predict and Control Part Quality** *
Heigel, J.C.; Saini, N.; Roth, T. (Third Wave Systems)
35. **Design of Force Sensor for Ultra-Precision Single-Point Diamond Turning** *
Odedeyi, P.; Hatefi, S.; Oyetayo Ayenumelo J.; Abou-El-Hossein, K. (Nelson Mandela University)
36. **Comparison of Manufacturing Methods for Turbine Blade Fir-tree Roots** 214
Ozaner, O. (TUSAS Engine Industries, Inc.) (Gazi University)
37. **Captured Powder Damping in Additive Manufacturing** 222
Schmitz, T. L.; Betters, E.; West, J. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory)
38. **Stability Analysis with Uncertainty for Twist drilling** 228
Schmitz, T. L.; Gomez, M. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory); Karandikar, J. (Oak Ridge National Laboratory); Shim, J.; Ro, S.; Hwang, J. (Korea Institute of Machinery & Materials)
39. **Laser Assisted Diamond Machining of BK7 Glass** *
Shahinian, H.; Bodlapati, C.S.; Navare, J.; Kang, D.; Mohammadi, H.; Ravindra, D.M. (Micro-LAM Inc.)
40. **Laser Assisted Diamond Machining of 6061 Aluminum**..... *
Bodlapati, C. S.; Navare, J.; Kang, D.; Mohammadi, H.; Ravindra, D. M.; Shahinian, H. (Micro-LAM Inc.)
41. **Investigation of Tool Protective Effect and Surface Deterioration Resulting from Builtup Layer Formation in Micro Scale Machining of Inconel 718** 235
Song, X.; Takahashi, Y. (Chuo University); He, W. (University of Shanghai for Science and Technology); Ihara, T. (Chuo University)
42. **Polishing of Epoxy Resin Surface of CFRP Mirror for Space Telescopes**..... 241
Igawa, T.; Takino, H. (Chiba Institute of Technology); Utsunomiya, S. (National Astronomical Observatory of Japan)

*No abstract included

Precision Manufacturing

43. **Effects of Surface Roughness on Fatigue Life for Stainless Steel AISI 304 Parts Finished by Turning** 246
Takino, H.; Ogata, T. (Chiba Institute of Technology)
44. **Comparison of Dynamic Stiffness in Tombstone Materials** 250
Betters, E.; West, J.; Schmitz, T. L. (University of Tennessee, Knoxville) (Oak Ridge National Laboratory)
45. **Efficient Error-bounded Hermite Curve Fitting Algorithm for Linear Segments** *
Zhang, Y. (Tsinghua University)
46. **Pollutant Removal on Sol-gel Film of Optical Surface by Non-dielectric Barrier Discharge Plasma Cleaning in Low Pressure** *
Zhang, P. (Harbin Institute of Technology)

*No abstract included