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RESEARCH REPORT

Unsettled Technology Domains for Rapid and Automated Verification of Industry 4.0 Machine Tools

Dr. Jody E. Muelaner

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Muelaner Engineering Ltd

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About the Author

Dr. Jody E. Muelaner is a chartered mechanical engineer with a background in metrology, aerospace manufacturing, and machine design. He now specializes in writing about technical topics in a way that the target audience can easily understand.

His writing has included technical reports for Rolls-Royce and Airbus, peer-reviewed journals, and UK Government reports, as well as magazine and websites. He has published several hundred articles and was awarded the SAGE Best Paper Award in 2010.

Starting out in machine design, Dr. Muelaner initially worked on sawmills, waste processing machinery, domestic appliances, and medical devices. After moving into metrology, his research focused on modeling and optimizing uncertainty in manufacturing systems, enabling right-first-time assembly, and the design of innovative laser instruments. He founded Muelaner Engineering Ltd in 2018 to provide consultancy and technical writing within advanced manufacturing and machine design. Dr Muelaner lives with his family in Bristol.

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Abstract

Currently, inaccuracies in machine tools are often not detected until after they have produced nonconforming parts, causing reworking or scrap. For high-value aerospace parts, a single rejected part is a significant cost. Low-value parts are often inspected less frequently, allowing many nonconforming parts to be produced before the issue is detected, also resulting in high cost.

The alternative to relying on part inspection is to run frequent tests on the machine itself, but established calibration and health check processes take between 20 minutes and several days. Emerging rapid and automated verification (RAV) processes enable machine tools to check their performance automatically in just a few minutes. These RAV processes can be performed frequently throughout the day, allowing machines to operate without human intervention for long periods of time. When an issue is detected, the machine may be able to recalibrate and then continue automatically. Where this is not possible, the machine stops and provides diagnostic information enabling the operator to efficiently get the machine back to production.

For many machines, especially smaller ones, artifact probing is the most cost-effective and easily implemented method. Combined with probing of roughing cuts, it can also verify spindle and dynamic errors at the micrometer level. Inertial measurement has a lot of potential to provide continuous monitoring during operations, and significant research efforts are therefore justified to validate and improve diagnostic capability. Noncontact triple-probing of spheres can provide highly accurate RAV while also enabling some compensation to be achieved in a very rapid way. This equipment is costly when dedicated to each machine for RAV but may be justified for very high-value machines and processes.

NOTE: SAE EDGE™ Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE™ Research Reports is to stimulate discussion and work in the hope of promoting and speeding resolution of identified issues. SAE EDGE™ Research Reports are not intended to resolve the issues they identify or close any topic to further scrutiny.

DR. JODY E. MUELANER
Muelaner Engineering Ltd

Edge Development Team

Dr. Andrew Francis, *GKN Aerospace*
Dr. Henny Spaan, *IBS Precision Engineering B.V.*
Guido Florussen, *IBS Precision Engineering B.V.*
Prof. Ben Hughes, *National Physical Laboratory*
Dr. Gregory W. Vogl, *National Institute of Standards and Technology*
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