

## Proceedings for Panel: *PHM for Manufacturing*

Aim: To summarize for the wider community the issues identified by the panelists and the audience and identify collective priorities and recommendations for way(s) forward in a concise format for the panel chair to complete and submit

### Panel Summary

The future industrial internet of things (IIoT) will realize the connectivity of machine tools and online diagnostics and prognostics for improved product quality and asset utilization. But the question remains: How do we get there? Machine tools are vital for the production of high-value parts, and these machines will still be mechanical in nature, thus subject to wear and performance changes. One vision of IIoT is a future with maintenance systems with self-diagnostic capabilities that enable equipment to achieve and sustain near-zero breakdown performance. Parts should be produced with no unplanned downtime while reducing manufacturing costs and maintaining or increasing part quality. But how to do so? Manufacturers need smart machine tools with online abilities to assess their own health, so that production isn't halted but enhanced. Through identification of current health and early signs of problems, smart machine tools with prognostic and health management (PHM) systems will give manufacturers the trusted information they need to optimize production. Currently, manufacturers are implementing their own PHM programs based around various sensors including MEMS accelerometers. This panel will bring together a diverse group of speakers from industry and academia to discuss online sensor-based solutions to transform machine tools into smart machine tools for the future IIoT. Discussion will focus around sensor-based PHM solutions for spindles and linear axes, which are the main elements of machine tools that affect part quality. However, another goal of the panel is to spur discussion to explore the potential impact of these relatively new approaches to other industries of interest to the PHM Society, such as transportation vehicles and energy production assets.

### Speakers/Presentations with links

1. Sreerupa Das (Lockheed Martin)
2. Jaydeep Karandikar (Oak Ridge National Laboratory)
3. Mark Walker (D2K Technologies)
4. Lou Zhang (Machine Metrics)

## Summary of Key Issues from 20-30 minute open discussion

### Speakers (from their talks):

The quality of PHM insights depends on operational data, both historical and current, and operational data requires monitoring the health of spindles, axes, and cutting for process capability. This leads to the future of smart machine tools, which are designed to collect data from assets and surroundings. Machine optimization is the next step, in which both the capability of the machine and part quality are modeled, so that corrective actions can be recommended for optimized and defect-free machining. But these smart machine tools must be connected before being maintained or optimized. Manufacturers should connect their machines, gathering data in robust pipelines that can be scaled, and then worry about preventative maintenance. The industrial internet of things (IIoT) with PHM solutions will minimize downtime/disruption of manufacturing pipelines, increase efficiency, and lower costs. Furthermore, the manufacturing industry is moving towards cloud-based solutions. The result is an IIoT of smart machine tools with cloud-based solutions and optimized manufacturing, but optimized for what? Optimization and decision-making should also include enterprise manufacturing intelligence, which is enabled by increased access to enterprise data. A top-down approach is needed in which local intelligence is enhanced with enterprise/stakeholder awareness.

### Audience:

#### Prioritization of Issues Following open discussion and ranking

There were about 40 audience members at the start of Q&A.

Questions included: How to include requirements in PHM design? How realistic is cyber security with the Cloud? How to do PHM with lack of data? Will companies share PHM data publicly?

#### Recommendations for Way Forward

There was no discussion of prioritization or a way forward, as in a workshop setting, because this panel session had 25 minutes after the panelists presentations that was filled with Q&A.