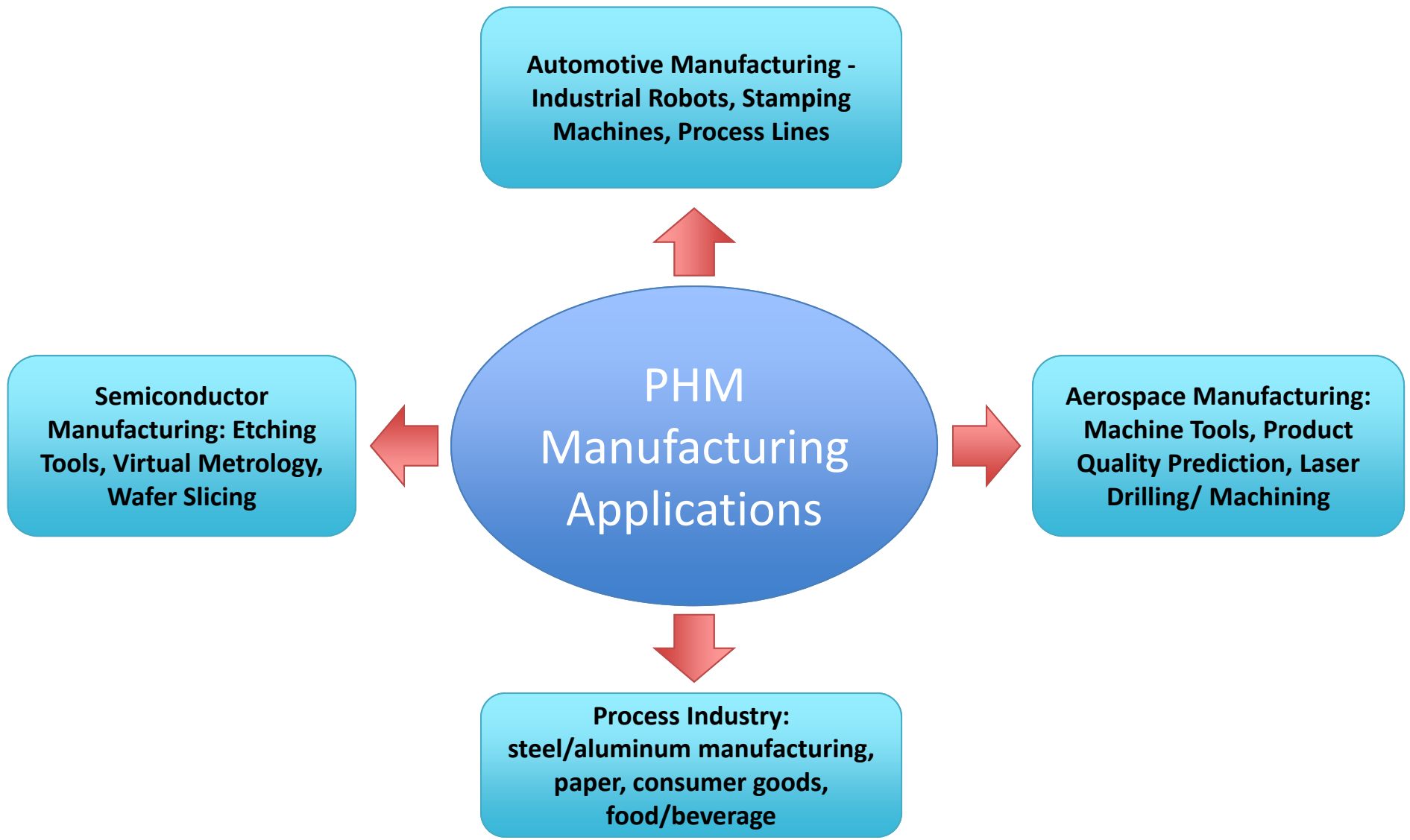








PHM4SMS Workshop Panel 1

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Overview of Manufacturing Sectors and Example PHM Applications



Example Machine Level PHM Applications for Automotive Manufacturing

			
Industrial Robots	Machine Tools	Stamping Machines	Centrifugal Air Compressor
Servo-motor torque monitoring	Non-intrusive performance monitoring	Process fault detection	Data-driven surge map modeling
Fleet-based health assessment	Tool condition monitoring		
	Spindle performance monitoring		
	Ball screw health assessment & life prediction		
	Bearing analysis & diagnosis		
	Mining for Alarm Correlation Patterns		

Past Success in Manufacturing Applications

- “ ... the IMS Center has generated over \$855M of economic impact to its members with a benefit cost ratio of 238:1.”

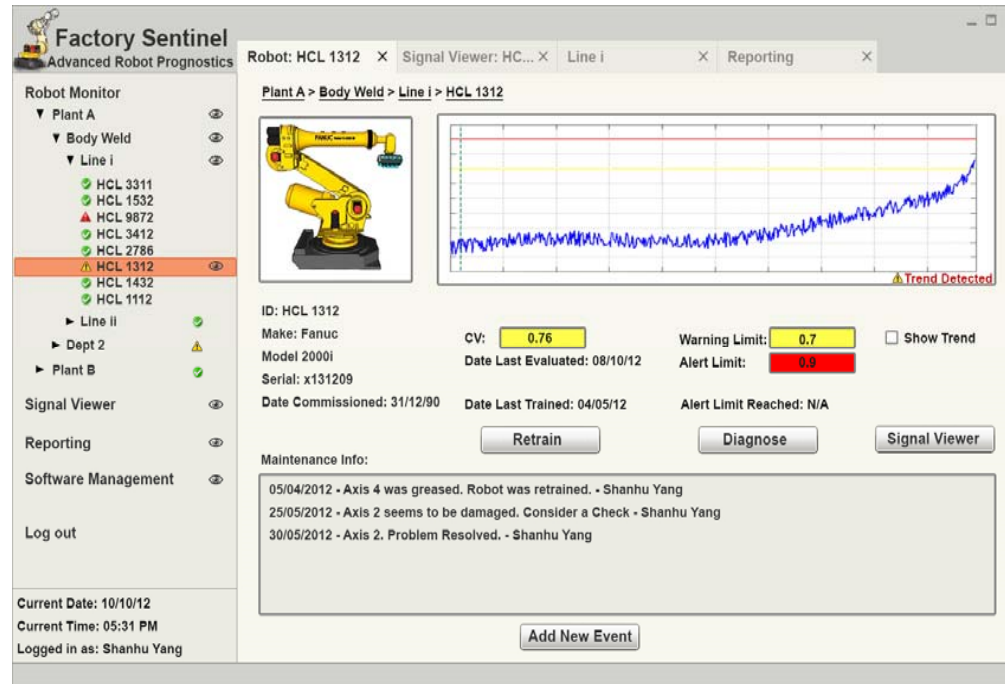
Gray DO, Rivers D and Vermont G. “Measuring the Economic Impacts of NSF I/UCRC Program: A Feasibility Study” (May 2012) Prepared for NSF I/UCRC under EEC-0631414. Accessed through: http://www.ncsu.edu/iucrc/PDFs/IUCRC_EconImpactFeasibilityReport_Final.pdf

- *Highlights from past case studies:*
- Toyota and IMS (2007): Data-Driven Surge Map Models and Surge Detection for Centrifugal Air Compressors
 - 6.5M saving estimated for extended application in whole factory
- Consumer Goods Manufacturer and IMS (2009): Autonomous Production Anomaly Detection Agent by Data Mining Methods
 - Dramatic improvement on product quality and millions in savings on downtime reduction
- Aerospace Manufacturer and IMS (2011): Machine Tool Health Assessment by Fixed Cycle Feature Text
 - Applied on multiple asset monitoring in two factories and severe machine breakdown was detected two weeks in advance.

Challenges

- Machine level PHM (Machine Tools)
 - Multitude of operating settings (different speeds, depths of cut, feed rates) – How to normalize these factors in order to have robust health monitoring methods.
 - How to deal with the human factors (how well was maintenance performed, how people operate the machine (from person to person and shift to shift)).
- Obtaining the right data to do diagnostics and prognostics
 - Many heterogeneous data sources from multiple places.
 - Obtaining information from machine controllers is easier now than 5 years ago, but can still be a barrier.
 - Maintenance records are incomplete, sometimes manually entered, and can be unstructured – This inaccuracy could make it more difficult to use historical data to develop and validate diagnostic and prognostic systems.
- System level / Production Line PHM Needs more Research
 - Many studies on machine or component level PHM; very few on multiple machines in a production line.
 - How to deal with changes in system configuration and units being replaced with respect to typical PHM approaches based on a baseline/reference condition.
 - Data driven models + system level interaction model could be needed.
 - Previous case study with consumer goods manufacturer used a data-driven method that could learn overtime; the approach worked very well but took 3 years to develop and implement.

Current and Future Perspectives



Video of robot health monitoring software:

<https://www.youtube.com/watch?v=wb7iiEblgHw&feature=youtu.be>

- For certain applications, I feel that the technology is mature enough (industrial robots, machine tools, rotating machinery).
- PHM applications at the process or system level require more R&D work, and creating a general approach for both machines and systems requires improvement in the science and also standards to help generalize the methods and approaches.