

# Intelligent Maintenance Systems (IMS)

*A CISE-funded Center*

University of Cincinnati, Jay Lee, Director, 513.556.2493, jay.lee@uc.edu

University Michigan–Ann Arbor, Jun Ni, 734.936.2918, unni@umich.edu

Missouri University of Science & Technology, Jagannathan Sarangapani, 573.341.6775  
sarangap@umr.edu

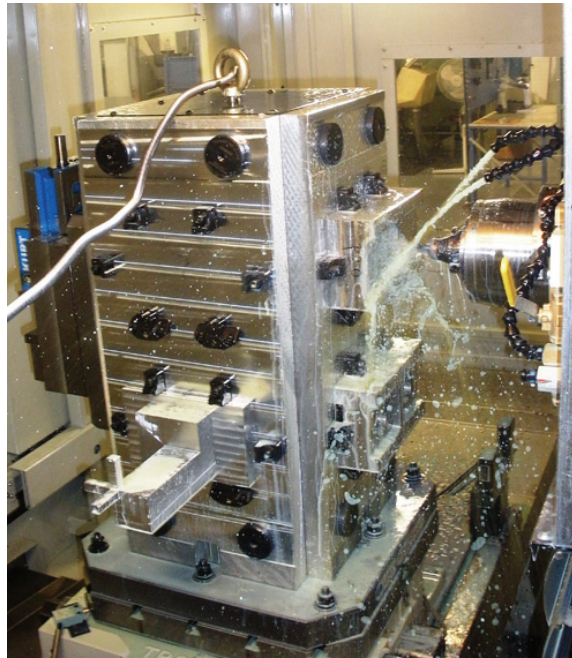
Center website: <http://www.imscenter.net/>

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## Prediction and Prevention of Hydraulic Hose Failure

Researchers at the Intelligent Maintenance Systems (IMS) have developed a system for predicting and preventing failure of hydraulic hose systems. There are no commercial products for this purpose in the marketplace. Previously, there have been only a few studies of hydraulic hose prognostics. IMS has developed a smart sensor with embedded prognostics algorithms that can be easily attached to the hose. It monitors the degradation of hose behavior and alerts the potential failures, and further request early repair or replacement autonomously.

The technology has many critically important industrial applications. Across the board, end users of systems that rely on hydraulic hoses will be able to attain dramatic improvements in machine uptime and provide safety. There will also be important reductions of environmental and human safety consequences related to hose failure. Smarter, stronger and safer hydraulic hose systems will provide significant benefits to customers involving many applications.



**Economic Impact:** The developed IMS prognostics tools have been implemented in many IMS sponsors' production including P&G, GM, and Boeing. The economic impacts of this work exceed \$100M.

For more information, contact Jay Lee, 513.556.2493, jay.lee@uc.edu.

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## Watchdog Agent for Assessing Equipment Performance



The Watchdog Agent™ is deployable to embedded data acquisition devices and monitoring data acquisition platforms on industrial equipment. Since machine or process breakdowns severely limit their effectiveness, methods are needed to predict products' life expectancy. Information about the remaining life of products and their components is crucial for their disassembly and reuse, which in turn leads to a more efficient and environmentally friendly usage of product and resources. Development of the Watchdog Agent by researchers at the Intelligent Maintenance Systems (IMS) center answers the aforementioned needs. The Watchdog is essentially software that can be applied to just about any product or system for which it would be beneficial to predict when and why the product or system is going to fail, from a simple valve to a complex system. Watchdog Agent™ assesses and predicts the process or equipment performance based on the inputs from the sensors mounted on it. Performance-related information is extracted from multiple sensor inputs through signal processing, feature extraction and sensor fusion techniques. Historical

behavior of process signatures is utilized to predict their behavior and thus forecast the process or machine performance. Researchers developed the Watchdog Agent toolbox to include tools for a wide variety of applications including EV smart battery, wind turbine, automotive systems, machine tools, etc. These tools can then be customized to meet the needs of the particular industry or processes involved. Most of previous systems are limited to few tools. In today's competitive market, production costs, lead-time and optimal machine utilization are crucial values for companies. The watchdog agent's continuous assessment and prediction of product's performance enables collaborative product life-cycle management in which products are followed, assessed and improved throughout their life-cycle. Watchdog software has been used in test-beds for Harley-Davidson, Tongtai Machine, TechSolve, and it is in the process of being applied at Omron, Toyota, General Electric and other companies. In its now commercial form, prognostics engineers are able to leverage the research to enhance asset reliability and management of wind turbines and mining equipment.

**Economic Impact:** The combined economic impacts to IMS company members exceeded \$100M. By improving the monitoring, diagnostic, and prognostic capabilities of industrial equipment, production processes become more reliable and more cost effective because the equipment has less downtime, lasts longer, and costs less to maintain. This benefits consumers, industry and the national economy.

For more information, contact Jay Lee, 513.556.2493, [jay.lee@uc.edu](mailto:jay.lee@uc.edu).