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Recent Advances of Industrial Big Data Analytics for Smart Product Service and Social Innovation

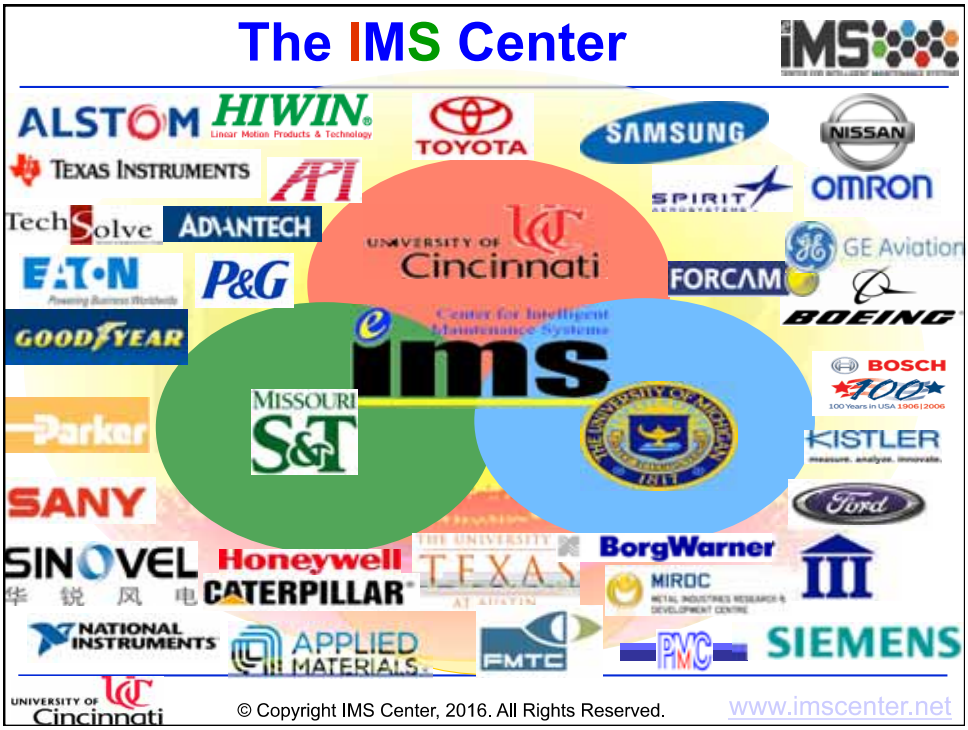
Jay Lee

Founding Director
NSF Industry/University Cooperative Research Center on
Intelligent Maintenance Systems (IMS)
Univ. of Cincinnati, Univ. of Michigan, Missouri Univ. of S&T, and Univ. of Texas Austin
www.imscenter.net

Outline

- Changing Role of Data and Value Creation
- Industrial Big Data Analytics, CPS, and Social Innovation
- Examples
- Conclusions

The IMS Center



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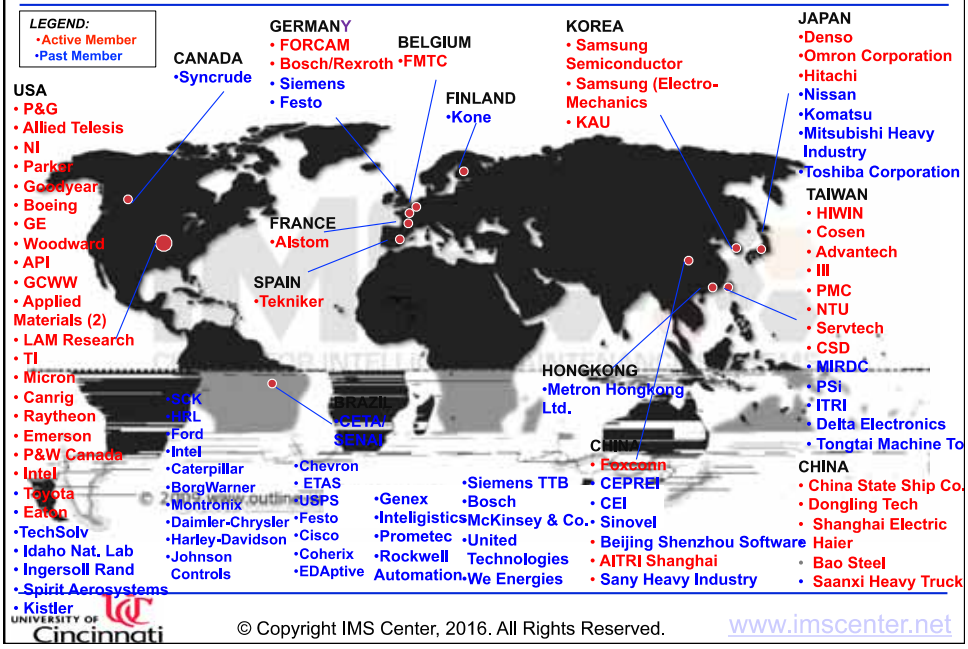
Global Industry Partners (80+)



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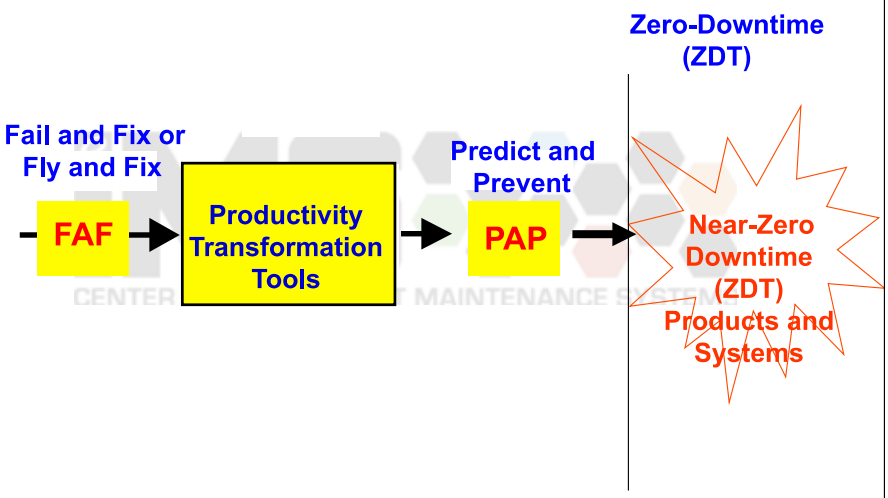
IMS Vision and Grand Challenges



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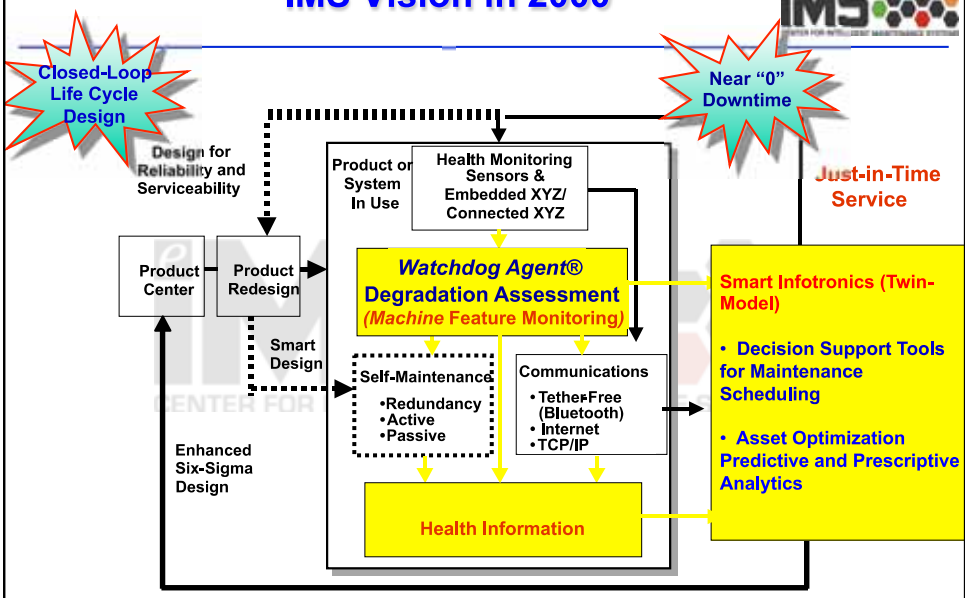
IMS Vision in 2000



NSF I/UCRC IMS Vision in 2000 www.imscenter.net

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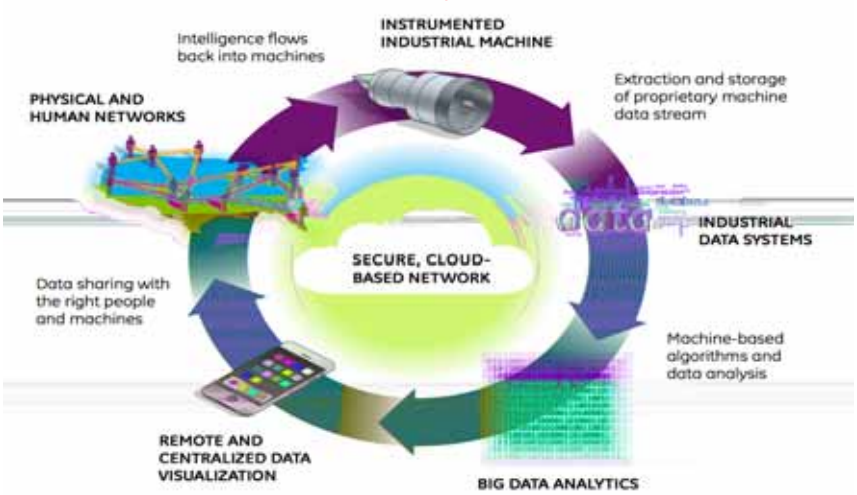
GE Industrial Internet System

IMS Adventure in 2001 → *Catalyst*→ GE Venture in 2011



Ref: GE Industrial Internet

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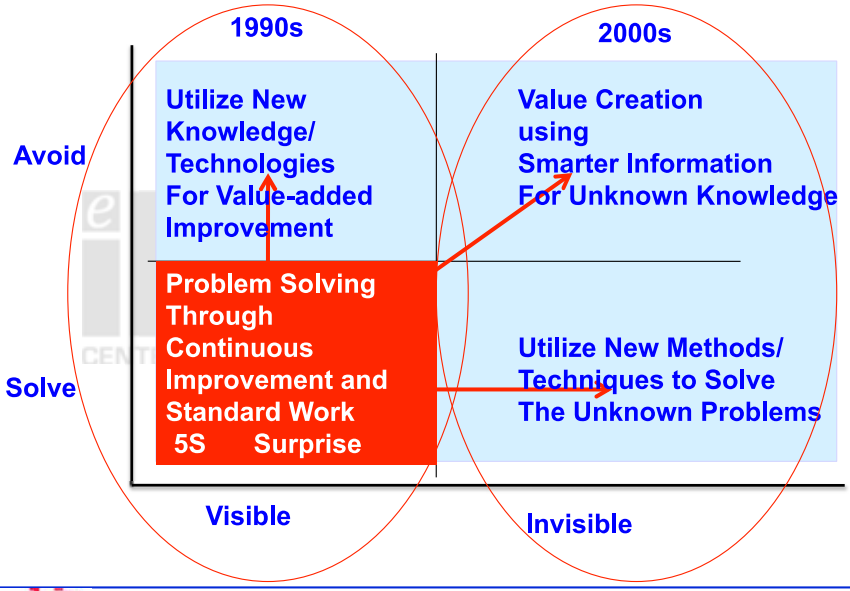
Competitiveness Transformation Strategy



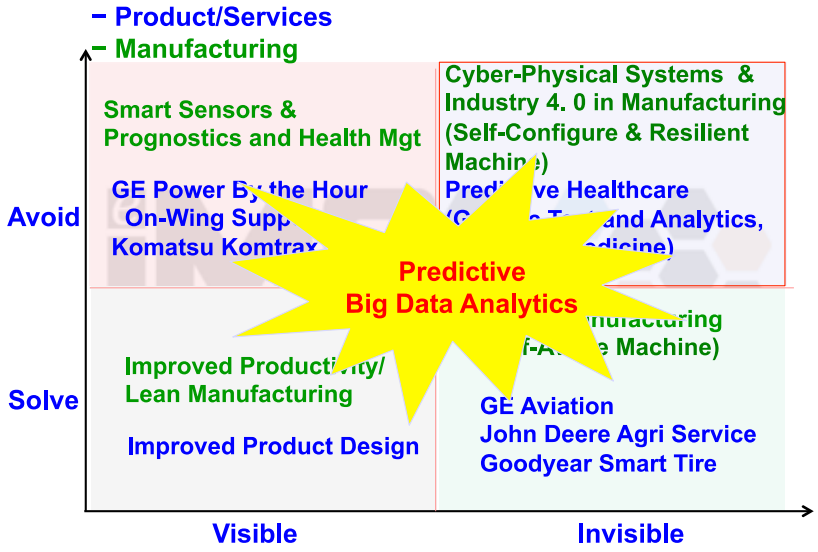
Industrial Big Data in 1990s

- GM OnStar®
- UTC Otis Elevator REM®
- GE Medical InSite®

Industrial Big Data in 2000s

- John Deere Agir Service® 2002
- Komatsu Komtrax® 2002-2005
- GE Aviation OnWing Support® 2005
- Alstom Train Tracer® 2006
- Goodyear FuelMax® 2008

Product/Manufacturing Evolution



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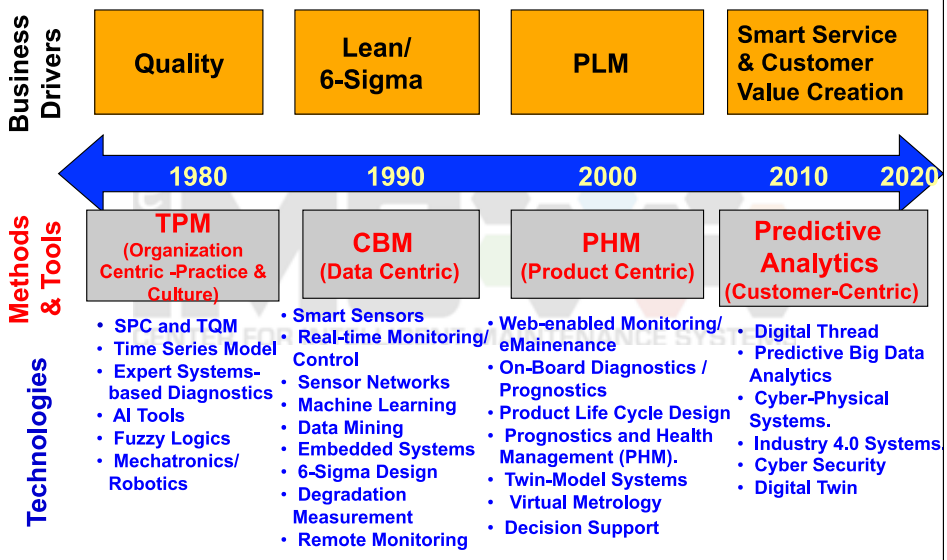
Industry Transformation



Value of Predictive Analytics

- Apply Data Analytics to large amounts of data of a variety of types to uncover hidden patterns, unknown correlations and other useful information from industrial and manufacturing systems and integrate with business automation software for improved productivity and innovation.

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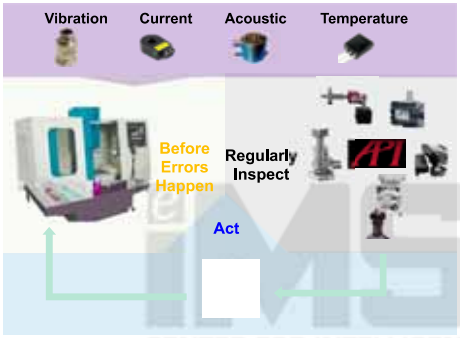
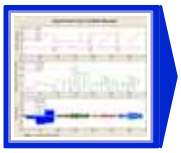
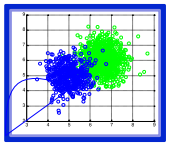
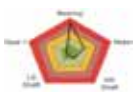
Watchdog Agent® → Self-Aware Machine



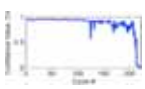




Health Map



Risk Radar Chart



Degradation (Confidence Value)

(Image courtesy: http://www.huazhongcnc.com/en/Product/CNC-M/473.aspx http://www.apisensor.com/index.php/products-en/machine-tool-calibration-en/vec-en)

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6Cs in Big Data System

1. Connection --RFID, Wireless, Sensor Networks
2. Cloud – Computing and Data on Demand
3. Cyber— Model and Memory
4. Content/Context – Relationship and Reference
5. Community -- Relationship and Sharing
6. Customization – Service and Value

Challenges of Industrial Big Data

1. Broken
2. Bad
3. Background

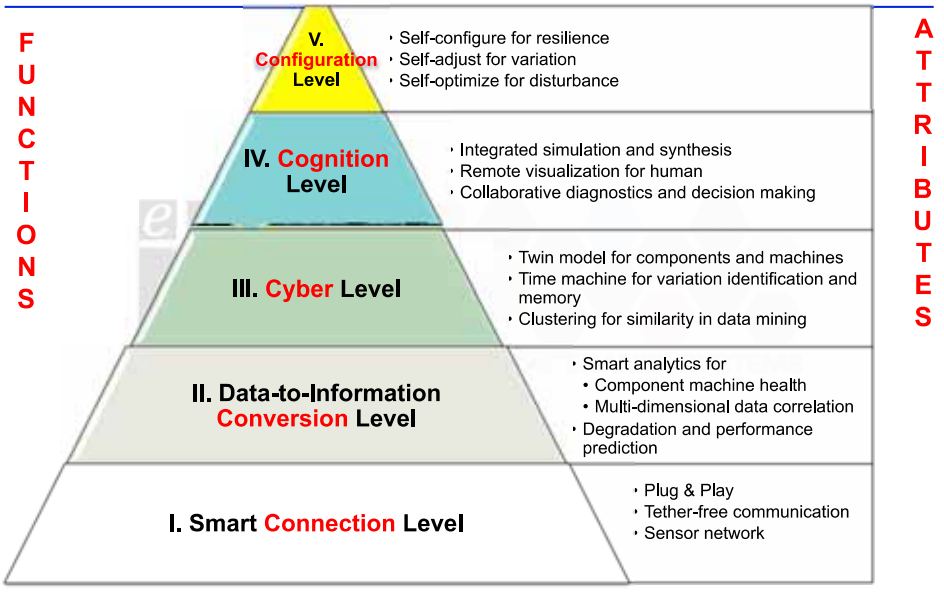
Jay Lee. Industrial Big Data Book (2015)

What are Cyber-Physical Systems?

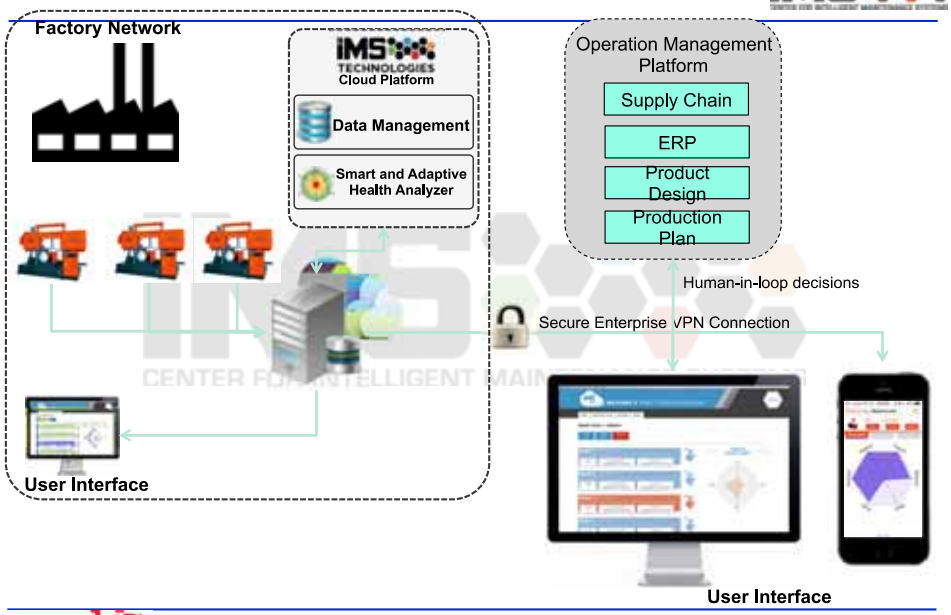
- **Physical**
  - natural and human-made systems governed by the laws of physics and operating in continuous time
- **Cyber**
  - computation, communication, and control that are discrete, logical, and switched
- **Cyber-Physical Systems**
  - systems in which the cyber and physical components are tightly integrated at all scales and levels

Ref: NSF CPS Program, 2007

Architectures for 5 Levels (5C) of CPS



APP Based PHM Platform Diagram



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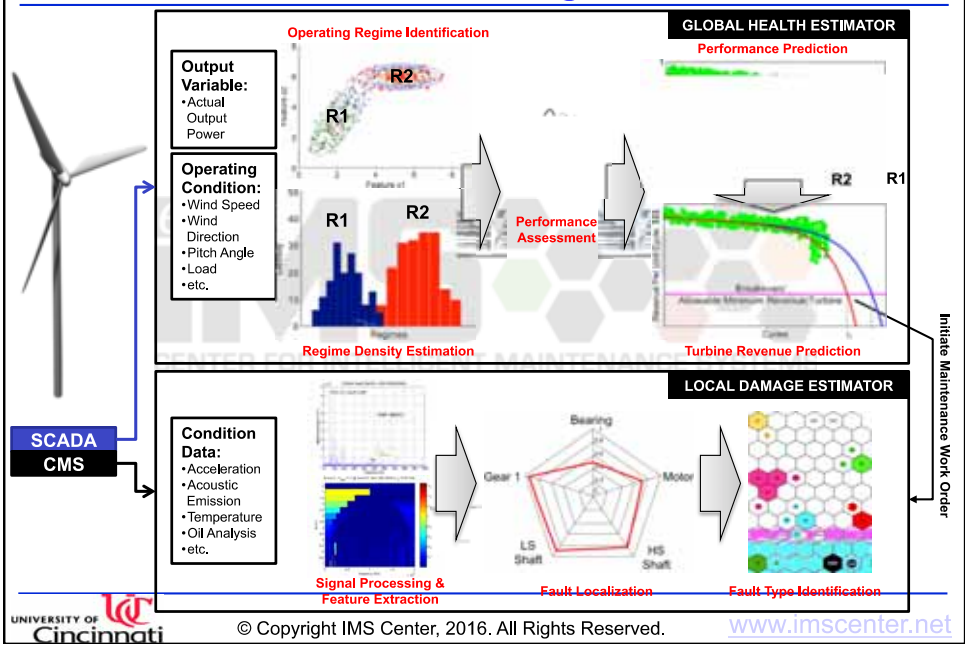
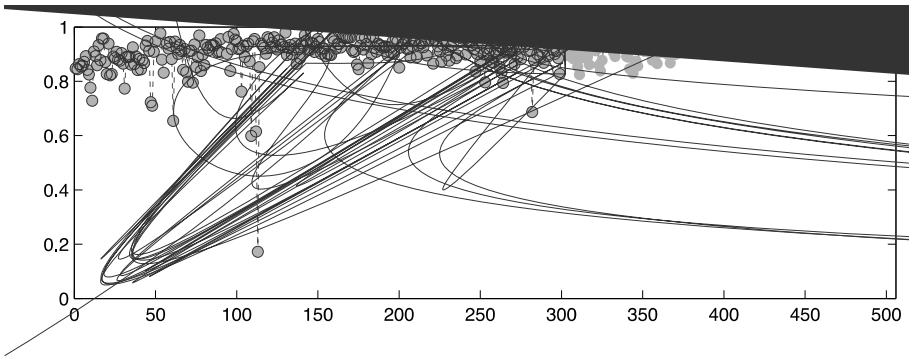
Smart Wind Turbine Prognostics



Fleet Cluster-based Health Analytics

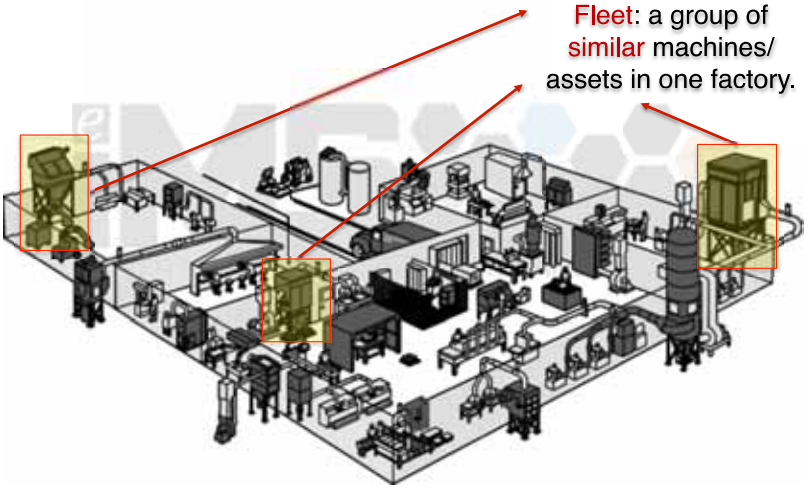
Data was prepared similarly with unit-specific modeling method.
Daily wind speed measurements were used for regime similarity evaluation, power curve data was used for health metric evaluation.



Rethink the "Fleet Systems"

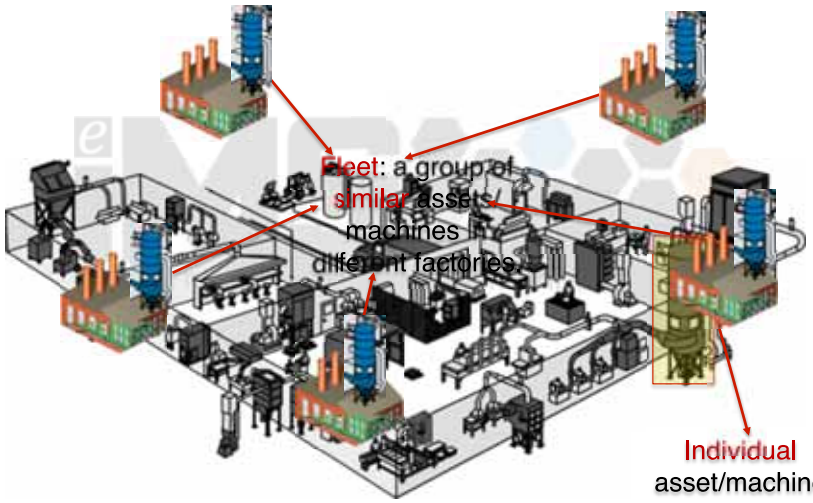
What is a fleet? (1/2)

- Scenario 1: For manufacturing, in **one factory**, there are equipment/ assets of the same type. These similar assets are referred to as a fleet.



What is a fleet? (2/2)

- Scenario 2: Assets/machines of similar type that are experiencing similar working conditions, while **located at different factories**, can also be considered as a fleet – focus of this research.



Smart ECU to Save Lives

Smart Wearable Systems for Sports and Peer-to-Peer Personal Healthcare

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Application Example

- New Sensor technology allows long-term studies with consistent electrode placement, unlocking previously unattainable connections between muscle activity and any number of factors (mood, weather, time of day, sleep, etc)
- Develop conformable force-measurement device to make set-up completely wearable, allowing for in-the-field analysis of fatigue.
- Apply methods and technology to other muscles of interest within the body (such as leg-foot interactions)

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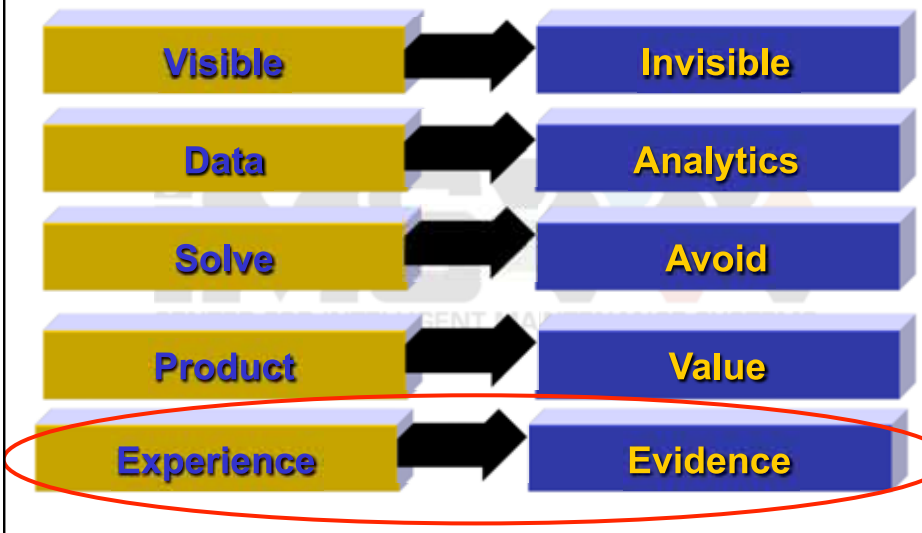
Transformation



IMS Major Impacts

1. IMS is the "*Catalyst*" of GE Industrial Internet and Fanuc ZDT Technologies.
2. Ranked the highest Economic Impacts (1:270) by NSF Economic Impact Study Report in 2012.
3. Won PHM (Prognostics and Health Mgt) Data Challenges Competition for 2008 (1st and 3rd) ,2009 (1st, 2nd, 3rd), 2010 (3rd), 2011 (1st and 3rd), 2012 (3rd), 2013 (3rd, 4th, 5th). 2014 (1 st). 2015 (4th)
4. NSF ICorps Award (2012) for New Company Spin Off Predictronics.
5. 5 Spin-off Companies (U.S., Japan, Taiwan, China)
6. NI for IMS License Trials in 2011 & NI LabView Watchdog Agent® Toolkit Official Global Licensing in 2015.

Thank You !

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