Distributed Power-aware Machinery as a Foundation for Next Generation Sustainable Manufacturing

Dr. Fred M. Discenzo, Dr. Ram Pai, Dan Carnahan, P.E.
Rockwell Automation
November 3, 2009
## Key Drivers As We Look Into The Future

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Energy &amp; Waste</td>
<td>Effective utilization of resources to reduce waste and energy consumption, while optimizing production.</td>
</tr>
<tr>
<td>2 Safety &amp; Security</td>
<td>Inherent Security and Safety of human, physical and intellectual capital across the connected supply chain.</td>
</tr>
<tr>
<td>3 Social Responsibility</td>
<td>Assessment and availability of information on Carbon and GHG emissions across the Product Life Cycle.</td>
</tr>
<tr>
<td>4 Harmonized Standards</td>
<td>Supply chain integration with availability and automated interpretation of digitized global standards across interoperable systems.</td>
</tr>
<tr>
<td>5 Globally Linked Enterprise</td>
<td>Global communication supporting a fabric of enterprises capable of exchanging and making decisions on information in real-time across the globe.</td>
</tr>
</tbody>
</table>
## Industry trends and needs

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>Metal → Composites</td>
</tr>
<tr>
<td>Automotive</td>
<td>Internal combustion → Fuel cells, batteries</td>
</tr>
<tr>
<td>Food &amp; Beverage</td>
<td>Paper / Manual tracking → Automated track &amp; trace</td>
</tr>
<tr>
<td>Life Sciences / Pharmaceuticals</td>
<td>Plant / chemical → Molecular / bio</td>
</tr>
<tr>
<td>Semiconductor</td>
<td>Crystal growth → Nano tubes</td>
</tr>
</tbody>
</table>

Opens up opportunities to reduce energy intensity (& emissions) through innovations in manufacturing processes

Need for increased integration of energy efficiency, demand response and emissions control with production

**Need to optimize production, energy usage and emissions simultaneously**
Smart, Safe and Sustainable Manufacturing

• Convergence in ICT & automation is facilitating “Collaborative Manufacturing Management”\(^1\)

• Energy and emissions will be viewed as cost of goods sold & tracked across supply chains that span the globe & entire product lifecycle. This will allow manufacturers
  – understand processes better,
  – create strategies & plan schedules,
  – respond in real time to dynamically manage raw materials, processes and energy,
  – and concurrently optimize in real time for energy, environmental and performance requirements.

\(^1\) : www.arcweb.com Copyright © 2009 Rockwell Automation, Inc. All rights reserved.
R&D Needs

Sensing & measurement
Modeling & simulation
Dynamic link to plant manufacturing equipment & energy sources
Knowledge
Distributed energy & energy storage
Manufacturing technology
Methodologies for agile integrated manufacturing

Understand processes better
Create strategies & plan schedules
Manage raw materials, processes & energy
Concurrently optimize in real time for energy, environmental & performance requirements.
Smart Distributed Power-aware Machines

- Leverages the growing trend toward distributed intelligent devices – employ open standards for interoperability (e.g. FIPA)
- Systems dynamically re-configure (i.e. self-organize) to meet production requirements in a safe, reliable manner while minimizing energy requirements
- An example framework supporting dynamic reconfiguration is autonomous agents\(^1\) – based loosely on a biological analogy – e.g. ants, bees, geese
- Provides a basis for managing increasing complexity, unknown disturbances, and energy cost fluctuations. Real time response achieves superior performance levels in energy utilization, waste reduction, and sustainable production.

\(^1\)"Prognostics and Control Integration with Dynamic Reconfigurable Agents", Fred M. Discenzo, Francisco Maturana, Raymond Staron, Pavel Stichy, Petr Slechta, Vladimir Marik, WSEAS Conference – 1st WSEAS International Conference on Electrotechnology and Technology for Naval Engineering and All-Electric Ship, Vouliagmeni, Athens, Greece, July 12-14, 2004

Copyright © 2009 Rockwell Automation, Inc. All rights reserved.
Thank you!