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

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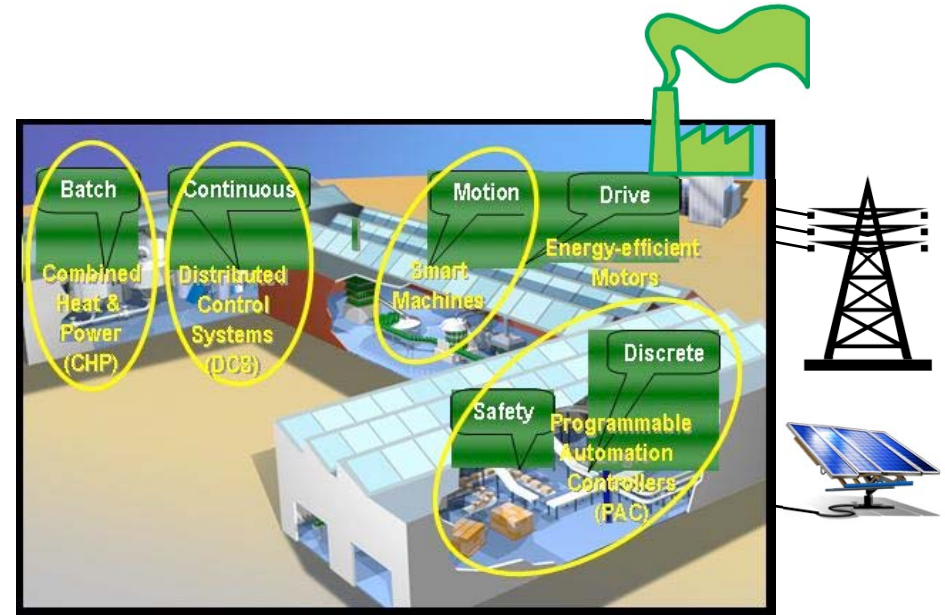
# Key Drivers As We Look Into The Future

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

# Industry trends and needs

Industry Sector	Trends
Aerospace	Metal → Composites
Automotive	Internal combustion → Fuel cells, batteries
Food & Beverage	Paper / Manual tracking → Automated track & trace
Life Sciences / Pharmaceuticals	Plant / chemical → Molecular / bio
Semiconductor	Crystal growth → Nano tubes

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

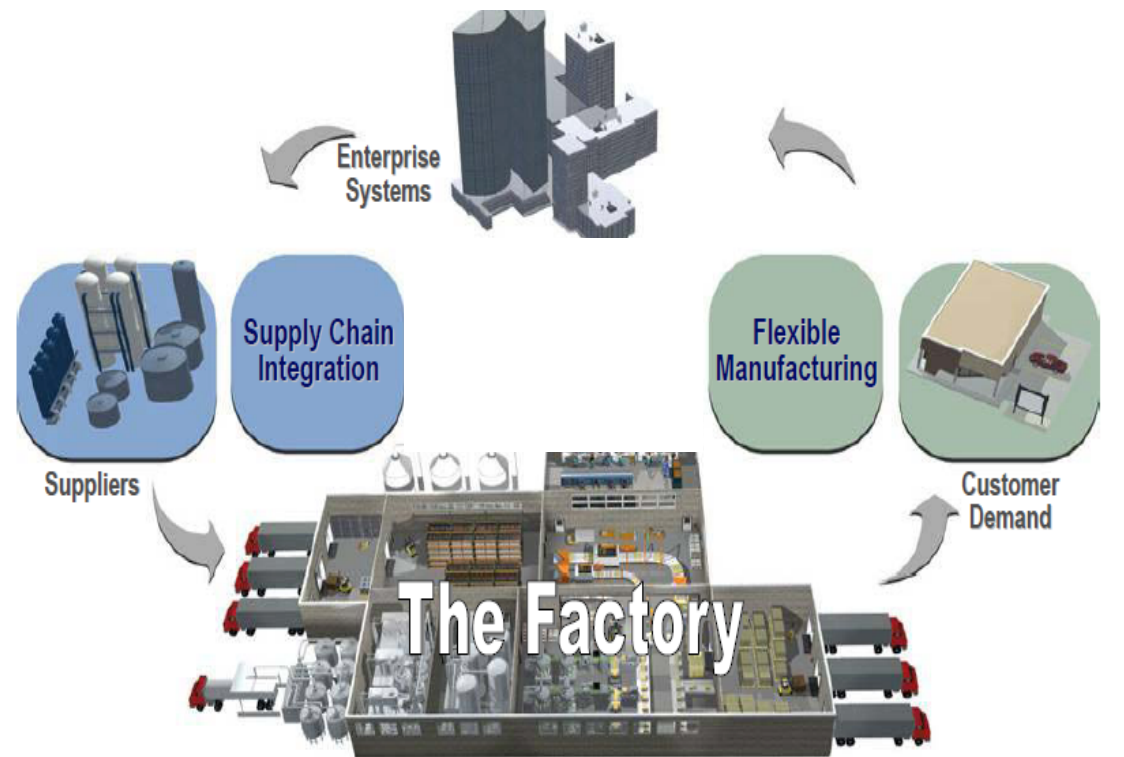


Need for increased integration of energy efficiency, demand response and emissions control **with production**

***Need to optimize production, energy usage and emissions simultaneously***

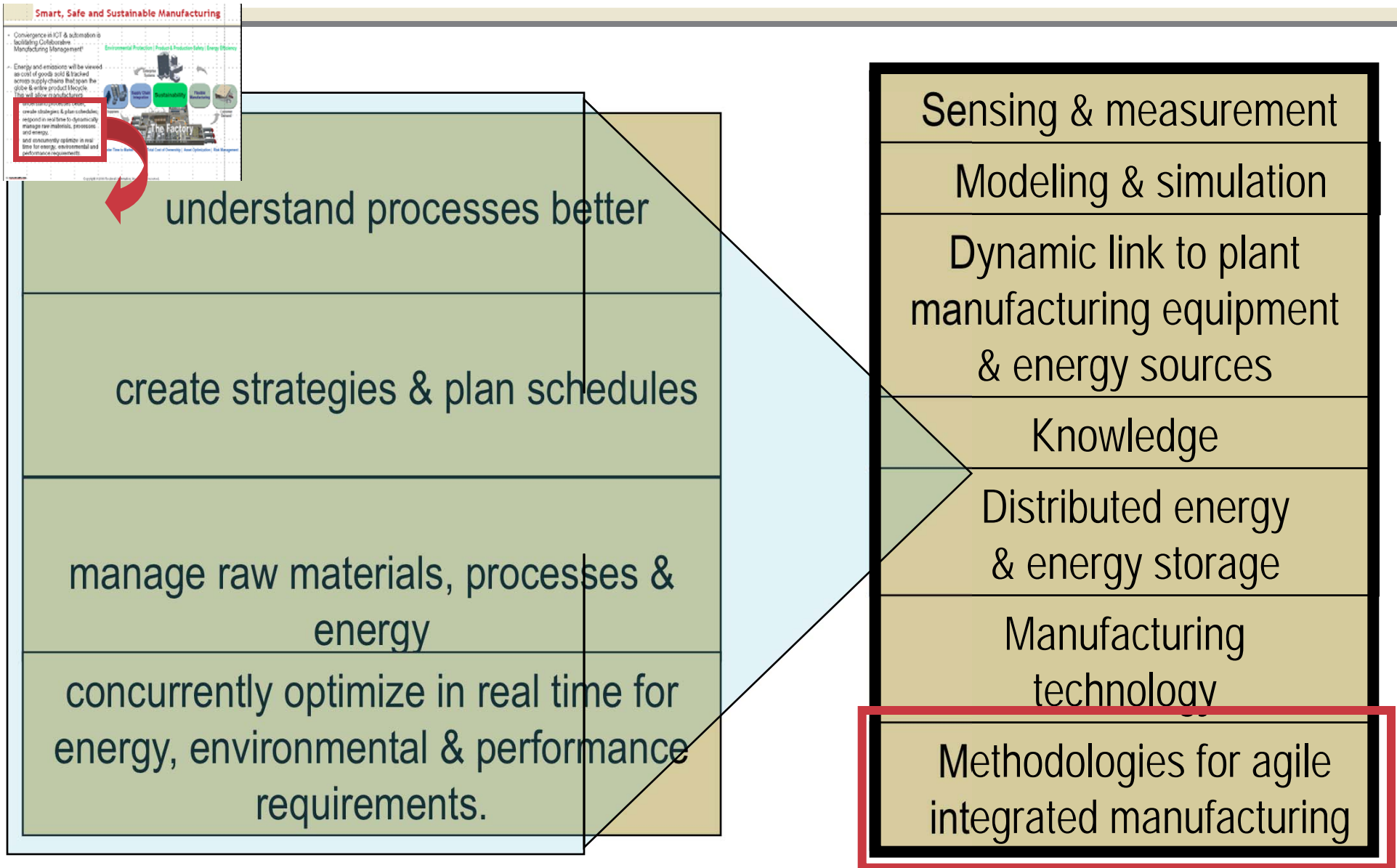
# Smart, Safe and Sustainable Manufacturing

- Convergence in ICT & automation is facilitating “Collaborative Manufacturing Management”<sup>1</sup>
- 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.



Faster Time to Market | Lower Total Cost of Ownership | Asset Optimization | Risk Management

# R&D Needs



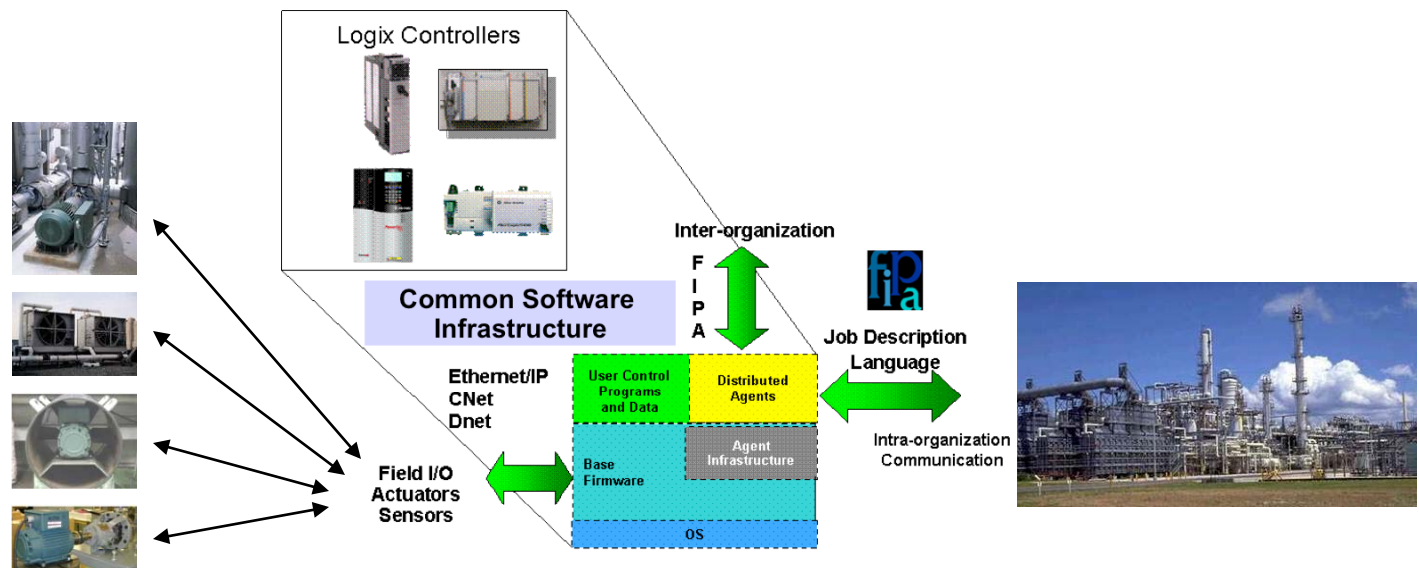


# Smart Distributed Power-aware Machines

- 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<sup>1</sup> – 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.



Self-organizing system



<sup>1</sup>"Prognostics and Control Integration with Dynamic Reconfigurable Agents", Fred M. Discenzo, Francisco Maturana, Raymond Staron, Pavel Stichy, Petr Slechta, Vladimir Marik, WSEAS Conference – 1<sup>ST</sup> WSEAS International Conference on Electroscience and Technology for Naval Engineering and All-Electric Ship, Vouliagmeni, Athens, Greece, July12-14, 2004



**Thank you!**

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