Five Technologies That Will Drive The Future Of Industrial Automation

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Outline

• Manufacturing Trends

• Technology and Architecture Trends

• How Will Technology Trends Transform Industrial Automation?

• Q & A
Scientists from the RAND Corp have created this model to illustrate how a “home computer” could look like in the year 2004. However the needed technology will not be economically feasible for the average home. With teletype interface and the Fortran language, the computer will be easy to use.
Prediction in 1968 of the year 2001

Space travel - common place

Computers – Big single computer, possible erratic behavior

Arthur C. Clarke
Stanley Kubrick
Supply Chain Integration and Flexible Manufacturing Are Driving The Integration of Factories With Business Enterprise Systems
## Manufacturing Trends and Drivers

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
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<tbody>
<tr>
<td>Mass Production</td>
<td>Mass Customization</td>
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<tr>
<td>Discrete Supply Chain</td>
<td>Supply Chain Synchronization</td>
</tr>
<tr>
<td>Loosely Coupled Design &amp; System</td>
<td>Integrated System</td>
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<tr>
<td>Local</td>
<td>Global</td>
</tr>
<tr>
<td>Physical Assets</td>
<td>Functional Assets</td>
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<tr>
<td>Lowest Procurement Cost</td>
<td>Total “System” Cost</td>
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Many Common Drivers for OEMs and End Users
What Do Manufacturing Companies Want?

Major Food Company

• (INTEGRATION) IT and factory control becoming integrated
  – Rolling out ERP (focus on supply chain integration)
  – Regulatory Mandates: Walmart and FDA

• (COST) Into “second wave” of driving productivity of manufacturing plants
  – Looking to save about $750M / year
  – Plants are efficient today; however, significant annual waste still exists

• (FLEXIBILITY) Moving to new, “healthier” products will require new processes and smaller batches
  – Rapid re-configuration of automation equipment
  – Walmart’s competitors demanding “customized” products

Long-term vision: flexible and integrated manufacturing – “customized trail mix” for every consumer
Outline

- Manufacturing Megatrends

**Technology and Architecture Trends**

- How Will Technology Trends Transform Industrial Automation?

- Q & A
The Five “Key Technologies” For Industrial Automation
Trends Impacted By Information Technology Evolution

• Integrated Control, Safety, Security, and Information
  – Information-Enabled Control Platforms with Integrated Safety and Security

• Ethernet
  – Industrial Ethernet Becomes the Dominant Network

• Adoption of World-Wide Web Software Standards
  – WWW Data Exchange and Software Integration Standards for Industrial Automation
Outline

- Manufacturing Megatrends

- Technology and Architecture Trends

How Will Technology Trends Transform Industrial Automation?

- Q & A
The Five “Key Technologies” For Industrial Automation

- Software
- Plant (Enterprise)
- Line (Manufacturing Solutions)
- Machine (Factory)

- Control / Diagnostics
- Communications
- Electronics
- Materials
- Software Integration / Web Services

- Advanced Control
- Prognostics
- Autonomous Systems
- Wireless
- Commercial Electronics
- On-Machine
- Alternate Materials
- Nanocoatings
- High Reliability Software
- RFID
Advanced Control

- **Increased production** - shortened average cook cycle duration by 10%

- **Increased efficiency** – New control algorithm enabled stabilizing water content in the cheese to the maximum allowed. The manufacturer produces more cheese for the same cost.

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Trend toward application-specific advanced control methods that optimize performance and energy efficiency
Customer’s Problem: Pump Life Unloading Rail Cars

Customer’s Problem: Pump Life Unloading Rail Cars

• Bearings, pump cavitation, vibration monitoring
• Spectral signature analysis, Neural Networks
• Motor condition monitoring

Growing trend towards prognostics and remote monitoring of machinery, e.g., nonstop, operator-free operation
Next Generation Control Systems Architecture: Autonomous Control Systems

Today

- Difficult to expand
- Faults stop operation
- Manual recovery
- Minimal redundancy
- Hierarchical

Future

- Easy to expand
- Fault-Tolerant
- Self recovery
- High redundancy
- Distributed

Autonomous Systems (Modular, Adaptive Systems)

Flexible Automation

Competitive Differentiation

Flexible Automation

Fixed Automation

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Looking at the Evolution of Agent Technology

Highly distributed & heterogeneous

- Small applications with high-complexity nodes
- Initial proof-of-concept and conceptualization

(1998-2000)
- Large systems with low-complexity nodes
  - Agent firmware integrated with Logix OS

(2000-2006)
- Development environment and optimized firmware
- Heterogeneous systems with diverse complexity nodes
  - Survivability
  - Reduced manning

(Future)
- Intra & Inter Autonomous Control (WWW)

Water / Waste Water
- Optimum configurations
- Dynamic rerouting of packages
- Multi component multi objective control
- Process optimization

Survivability
- Reduced manning

Optimum configurations
- Dynamic rerouting of packages

Commercial Deployment

Agent population size
Autonomous Control Systems Application: Shipboard Automation

Agent Based Solution Developed

Agent based prototype developed

Navy Requires Highly Survivable System

Demonstrate on the Navy’s Land based Simulator

- Test and debug automatically generated agents
- Test Agent Behavior for different configurations

Potential future applications: Automated, self-adjusting manufacturing lines to optimize throughput

- Test Reconfigurable Shipboard Automation Architecture
The Five “Key Technologies” For Industrial Automation

- Machine (Factory)
  - Control / Diagnostics
  - Advanced Control
  - Prognostics
  - Autonomous Systems
  - Wireless
  - Commercial Electronics
  - On-Machine
  - Nanocoatings

- Line (Manufacturing Solutions)
  - Software Integration / Web Services
  - High Reliability Software
  - Alternate Materials
  - Materials

- Plant (Enterprise)
  - Software
  - Machine (Factory)
  - Line (Manufacturing Solutions)
  - Communications
  - Electronics
  - On-Machine
  - Nanocoatings
  - Advanced Control
  - Prognostics
  - Autonomous Systems
  - Wireless
  - Commercial Electronics
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  - Nanocoatings
Wireless Industrial Applications

Wireless Ethernet, Self-Powered Wireless Sensors

RFID

Source: Milwaukee Journal Sentinel  2/8/03
Future Of Wireless: Self-powered Wireless Sensors

- Low-power radio
- Energy harvesting technology
  - Energy harvesting from machine vibration and other “parasitic” means
  - Efficient and reliable generation and supply of energy to power nodes

Self-powered, wireless sensors and sensor networks for production metrics, machine health monitoring and remote asset monitoring

http://www.millennial.net
Key Considerations for Deploying Wireless in Industrial Automation

- Potential interference
  - Existing wireless, legacy radios, microwave ovens, cordless phones, emerging radios, process, fusion lighting
- Achieving proper coverage
  - Antenna placement, reliable bandwidth, minimize radios, channel usage (3D), redundancy
- Environmental compatibility
  - Indoor/outdoor, temperature, contaminants, wash-down
- Guaranteeing security
  - IEEE 802.11i, 802.1x, TKIP, AES, RADIUS
- Minimizing cost
  - Installation, power, communication, enclosures

Customer Value Propositions
Example: Rotating Machinery Monitoring
- Lower cost (wiring)
- Ease of expansion
- Mobility
Is RFID Revolutionary?

Bar Code Technology

“Static”

Fixed amount of information

Deeply embedded in existing processes

RFID Technology

- Dynamic -- information can be added or deleted at every step in the supply chain
- Can store significantly more information

Process Transformation

Revolutionary

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RFID For Track/Trace, Genealogy

Phase 1
Case and Pallet Tagging
• Read tags
• Program / Print Tags on cases/pallets
• Provide traceability in supply chain
• Integration with MES / ERP

Phase 2
Product / Parts Tagging
• Read Tags
• Program / Print Tags
• Apply real-time control
• Production interlocking
• Integration with MES / ERP

Provide Traceability In Supply Chain With RFID Embedded In Packaging Material Such As Cardboard, Plastic Caps, Cartons
The Five “Key Technologies”
For Industrial Automation

Plant
(Enterprise)

Line
(Manufacturing Solutions)

Machine
(Factory)

Software
Integration / Web Services

Software

High Reliability Software

Materials
Alternate Materials
Nanocoatings

Electronics
Commercial Electronics
On-Machine

Communications
Wireless
RFID

Control / Diagnostics
Advanced Control
Prognostics
Autonomous Systems

Control / Diagnostics
Impact of Software/IT on Manufacturing

The Value Chain

Supply Chain Integration

Batch Size of One

The Product Lifecycle

CAD-To-Part

Warranty Cost Reduction

Opt. Asset Management

Data-Information Integration

Factory

Enterprise

Suppliers

Customers

Design

Support

The Enterprise

The Product Lifecycle

The Value Chain

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Customer Problems Today (Information Architecture):

- **High cost**
  - Too many servers
  - Custom code
  - Upgrades difficult
  - Multiple copies of data

- **Difficult to Operate & Maintain**
  (training, personnel)
  - Too many custom interfaces
  - Lack of standards

- **Lack of Integrated Security**
  - Distributed (decoupled) security
  - No device level security

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**Software -**
*Customer Problems Today with Information Architecture*
Summary: Impact of The Five Key Technologies On Manufacturing

- **Flexible Automation**
  - Reconfigurable Control Systems
  - Agent-Based, Autonomous Cooperative Systems
  - Wireless Systems

- **Integration**
  - Information-enabled automation
  - Adoption of WWW standards

- **Optimum Asset Utilization And Lowest Cost**
  - Advanced Control
  - Self-Diagnostics and Maintenance
  - Health, Safety, and Environmentally Responsible Systems

Modern Manufacturing Systems Will Be Modular, Adaptable, Smart, and Efficient
Five Technologies That Will Drive The Future Of Industrial Automation

Questions

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