Australia

Digital Transformation

Confluence of Factors

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Major User and Automation Challenges

- Improve Plant Safety
- Reduce Asset Downtime
- Increase Efficiency
- Improve Human Reliability
- Remote Monitoring and Diagnostics
- Cybersecurity
  - Secure Web Access
- Reduce development Engineering, and Implementation Costs
- Plant Floor to Enterprise connectivity
- Provide multidisciplinary control: discrete, motion, process, drives, and safety

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Plant of the Future: Characteristics

“A well managed plant looks silent and boring” – Peter Drucker

THE FACTORY OF THE FUTURE WILL HAVE ONLY TWO EMPLOYEES, A MAN AND A DOG.
THE MAN WILL BE THERE TO FEED THE DOG.
THE DOG WILL BE THERE TO KEEP THE MAN FROM TOUCHING THE EQUIPMENT.
- WARREN G. BENNIS

Plant of the future characteristics

- Agile and flexible
- Supply chain synchronization
- Optimum asset utilization
- Business and Plant Systems synchronization
- Optimization based on economics
- Autonomous operations
- Nearly unmanned operation
- Event Prediction Mitigation
- Intervention by exception
- Integrated control, electrical, and safety
  - Adaptive, flexible, distributed, fault tolerant, expandable
- Information-Driven (evidence-based decision)
- Connected, networked, access anywhere
- Right information, content, context
- Asset Performance Management
- Monitored and optimal control
  - Optimized operating performance
  - Predictive and Prescriptive Alerts
  - Highly integrated operations and maintenance
- Security by design
- Suppliers become long-term partners
- Provide solutions
# Next Generation Automation System Requirements

<table>
<thead>
<tr>
<th>Attribute</th>
<th>From</th>
<th>To</th>
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<tbody>
<tr>
<td>System Architecture</td>
<td>Hierarchical, Proprietary</td>
<td>Interoperable</td>
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<tr>
<td>Communication</td>
<td>Proprietary</td>
<td>Common Objects</td>
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<td>Performance</td>
<td>Weekly or monthly</td>
<td>Real-time KPIs</td>
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<tr>
<td>Safety &amp; Security</td>
<td>Specialized</td>
<td>Integral</td>
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<tr>
<td>Work Process</td>
<td>Operator dependent</td>
<td>Automated</td>
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<tr>
<td>Business &amp; Plant Systems</td>
<td>Loose Coupling</td>
<td>Tightly Integrated</td>
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<tr>
<td>Flexibility &amp; Scalability</td>
<td>Monolithic</td>
<td>Modular</td>
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<tr>
<td>Maintenance</td>
<td>Preventative</td>
<td>Predictive, RCM, Prescriptive</td>
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<tr>
<td>Optimization</td>
<td>Process and unit</td>
<td>Plant wide &amp; Supply Chain</td>
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<tr>
<td>Access</td>
<td>Tethered</td>
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<td>Applications / Control</td>
<td>Centralized</td>
<td>Distributed</td>
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<tr>
<td>Software</td>
<td>Specific</td>
<td>Migration</td>
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</table>
Digital Transformation Drivers

Workforce Challenges
- Human Factors
- Mobility

Cloud
- Big Data & Analytics
- IoT

Apps
- Safety and Security
- Smart Sensors
- Wireless

New Technology
- COTS
- Modularization
- 3D Visualization
- 3D Printing
- Cognitive Automation
- Robots/Drones

Virtualization

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Cyber Security

OT domain

Network intrusion + Open from the inside
- Stolen plant data:
  Information leakage / Intrusion of malware

Information leakage - Data falsification

Data falsification

Adjacent domain

Intrusion from adjacent domain

Infection by maintenance PC connection

Infection by USB memory connection

Remote operation - System malfunction

Infection by charging portable devices

Network intrusion - Uncontrollable by network load increase

Controller

Operation PC

Control & Information System
Sensors and Smart Devices

Nano chemical sensors for emissions monitoring, fuel-leak and fire detection

Sensor Fusion
- Nano sensors
- LOW COST Intelligent Sensing
- Ubiquitous connectivity

- As instruments, devices and equipment become smarter and generate data it is a challenge to collect and use all of this data
- Historians will expand to collect a wider variety of data
- There will not be single “Über system” that contains all information
- Standard information models are required to allow massive and disparate types of data to be used
- Access to actionable data, when and where needed
- System of sensors working together

Low energy, self-powered sensor networks for monitoring, operational KPIs, and remote operations
Passive Wireless Sensing Technology

Passive Wireless Sensor Tag

- Intrinsically safe -- don’t carry battery with ultra-low power reading from RF
- Small and flexible -- able to be embedded into the objects or infrastructure in lifetime
- Suitable for harsh environment and rotating Assets
- Rotating equipment monitoring using thin film, temperature, pressure, strain, and combine with vibration to measure equipment condition

Benefits

- More touch and feel, faster response time
- Access to process data anywhere, anytime, any device
- More accurate picture of operations
Mobility and Wearables
Modularization

• Modular approach in new types of process automation systems that incorporate programmable forms of I/O and standard (COTS) (cabinets/field junction boxes).
• Reduces custom engineering costs
• Each module fully automated and reusable

Picture is Bayer’s Process Equipment Container Unit installed at INVITE from f3factory.com
Immersive Virtual Reality

Source: Omega Simulation Co., Ltd. (http://www.omegasim.co.jp/contents_e/solution/)
Robots:
• Assist workers
• Machine learning to perform new tasks
• Work in hazardous areas
• Future: work without direct operator supervision

Drones and ROVs:
• Surveillance and observation
• Safety and security
• Interrogate hard to reach places
• Observe
• Sense and warn of hazards
Cloud for Collaboration

Data + Applications

Plant/Enterprise 1

Plant/Enterprise 2

Plant/Enterprise 3

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Digital Transformation Terms

- **Smart Manufacturing**
- **Industrie 4.0**
- **Smart Factory**
- **Digital Manufacturing**
- **IIoT**
- **The Internet of Things**
The Internet of Things (IoT) - The internet of things represents a network of physical objects of things embedded with electronic software, sensors and connectivity to exchange data with business processes – *Internet of Things Global Standards Initiative*

**Industrial Internet of Things (IIoT)** – is a subset of IoT that focuses on connecting different devices (both old and new) and equipment (both old and new) used in a manufacturing environment. IIoT enables them to communicate in ways that was not possible before. By collecting data from any device, organization can leverage the data collected to improve efficient and business performance. Some consider IIoT as an enable for Smart Manufacturing

**Digital Manufacturing** - Digital Manufacturing connects different parts of the manufacturing life-cycle through digital data that conveys design intent and process information. Digital Manufacturing focuses more on manufacturing and less on higher level business decisions
**Industrie 4.0** – Industrie 4.0 has its origins in a German government initiative that refers to the fourth industrial revolution. Industrie 4.0 promotes the concepts of cyber-physical systems (CPS) that monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. CPS communicate with each other and with people throughout the value chain.

Image by: Christoph Roser, https://commons.wikimedia.org/w/index.php?curid=47640595
Smart Factory - Refers to the manufacturing concept that relies on interoperable systems; modelling and simulation; intelligent automation; multilevel cyber security; and networked sensors. Smart Factories use data and information throughout the entire product life cycle to create flexible manufacturing processes. Access to information is extended beyond the enterprise to suppliers, customers and other concerns to optimize the supply chain.

Smart Manufacturing - “Smart Manufacturing is the endeavor to design, deploy, connect and manage enterprise manufacturing operations and systems that enable proactive management of the manufacturing enterprise through informed, timely (as close to real-time as possible), in-depth decision execution. “Smart Manufacturing – The Landscape Explained”, MESA.org, 2015 Systems

Where is the real value?

By themselves, none of these represent any value. The value is in the solution approach that enable new product innovation, product related services, improved production processes, greater agility and flexibility, enhanced sustainability, and improved supply chain management.

Digital Transformation - The digital transformation is about digitizing companies to discover new business processes and practices that can transform businesses.
Digital Transformation

Disruptive Innovation

Aging system, outdated business models

Step change in business results

Connected Enterprise, Customers, Suppliers, Partners, Employees, Products, Services, Etc.
Digital Transformation

New Products and Services:
• Potential to change industry structure, boundaries and even create new industries
• Creates new opportunities and competition
• Typical applications: monitor, control, optimization and autonomy

• Example
  • Farm Performance Management
    • John Deere revenue declined 5%; to combat decline JD turned to software and services that deliver information to aid farmers in the field
    • An array of different types of farm equipment can be connected to each other and to other systems
    • Interact with environment and with each other to form a system of systems
      • Geolocation aware and coordinates activities with other types of equipment
        • Automated tiller injects fertilizer at specific depths and intervals
        • Coordinates with planters to seed in optimal locations
        • System of systems:
          • Connect farm machinery to irrigation systems and soil and nutrient sources with information on weather, crop prices, and commodity futures to optimize overall farm performance.
Digital Transformation

• Examples:
  • Joy Global
    • Mining equipment manufacturer
      • Monitors multiple products, operating conditions, safety parameters, and predictive service indicators for entire fleet of equipment
      • Connects products, operations, supply chain, services through sensors, digitization, network and information services
      • Uses big data, cloud, and advanced analytics to deliver optimized performance in real time
      • Increase asset utilization by 50% to 70% and production by 60%
  • Zipcar
    • Real-time access to vehicles when and where people need them
Digital Transformation

• Examples:
  
  • Uber (5 years) and Lyft
    • P2P business model, don’t own any cars (booking approaching $10 billion annually)
      • **Service** matches vehicles, drivers with passenger through P2P dispatching
      • Fast, convenient and easy to pay by customers
  
  • Tesla vehicles have sensors and connectivity to monitor its health and call for service. It can autonomously download software to take corrective action or send out a notification to customer to schedule a convenient time for a service tech to pick up the vehicle and take it to a Tesla repair facility
  
  • Philips lightbulbs flash if it detects and intruder
Process Automation & IIoT Integration

- Process Automation and IIoT Integration by CCC

CCC: Complementary Collaborative Coupling

Digital Transformation Standards

Applications
Analytics
ERP
MES

Cloud Computing

The Internet

Real time control
Applications
HMI
Storage
Gateway

On premise or to cloud

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Digital Transformation: Convergence of IT and OT

Typical characteristics
• Corporate functions like finance
• Interact through PC, tablet, etc.
• Focus on transactional information
• COTS hardware and standard Apps
• Short lifecycle
• Protect and limit access to information

Typical characteristics
• Physical assets used for production
• Interact through equipment, automation and HMI
• Focus on real-time process control
• Proprietary hardware, custom Apps, and heterogeneous environment
• Operate the plant, protect asset, people and environment

• Support IT and Plant Personnel to Increase Productivity and Maintainability
  • Enable change in business processes
  • Standardize processes and supporting tools resulting in fewer applications to learn and support
  • Support industry standards
  • Repeat deployment, maintenance and life-cycle management

• Provide Applications that LeverageScarce Technical Resources
  • Capture and maintain critical knowledge for workforce transition and training
  • Create “On-demand knowledge” that provides timely decision support through the visualization and analysis of accurate information
  • Facilitate collaboration by integrating data, applications, and workflow
Digital Transformation Opportunities

Enterprise
• Real-time performance management
• Benchmarking
• Support for continuous improvement programs
• Capture spot market opportunities
• New revenue streams
• Sustainability

Production
• Improved flexibility and responsive operations
• Greater agility
• Improved reliability through predictive maintenance
• Improved worker productivity, throughput
• Higher energy efficiency
• Improved material usage
• Improved environmental
• Improved safety

Design & Engineering
• Design for connectivity
• In-service performance feedback for improved design
• Operating ecosystem
• Product innovation
• Greater product variety

Services
• Remote monitoring, services
• Predictive maintenance
• Field service optimization
• New business models/services

Supply Chain Management:
• Product tracking
• Reduced costs
• Monitor incoming raw material quality
• Resilience to supply disruptions
• Lower supply chain costs
• Better Inventory optimization

Customers
• On-time delivery
• Improved quality
• More consistent quality
• Responsive to changes
• Remote monitoring and maintenance of products
• Product as a service opportunities
• Performance as a service opportunities
• Vendor managed services
Why the Need for Standards?
Smart Manufacturing spans a broad scope of systems in the manufacturing business including supply chain, product design, plant design, engineering, and operations management.

Source: ARC Advisory Group
Digital Transformation Lifecycle Considerations

Product Lifecycle Management
- Defines the process of managing all information about the product from concept, to production, sale, use, service, and disposal
- *Smart products can be customized at nearly any time of production process*
- *Smart products can participate in the production process and provide information about its use in the field*

Standards focus areas
- Modeling practice
- Product Model and Data Exchange
- Manufacturing Model Data
- Product Category Data
- Product Lifecycle Data Management

Currently most of the standards apply to integration of a single product, like CAD or an single interface between phases
Asset Lifecycle Management

- Defines the activities necessary to obtain, install, commission, operate, maintain and dispose of an asset
- Operate and Maintain is typically the longest phase
- Assets are typically designed to manufacture a family of products
- Degree of flexibility is key decision when acquiring an asset
- *Smart Manufacturing assets are designed to be reconfigurable through software to make different products based on market needs*
- *Smart manufacturing assets have embedded monitoring capabilities for self-diagnostics and provides health status updates*

Standards focus areas:
- Production system model data and practice
- Production system engineering
- Production system maintenance
- Production lifecycle data management
Supply Chain Management

- Deals with the activities involved in obtaining raw materials, converting them into saleable goods, and delivering them to the customer
- Tracks all of the raw material and products
- *Smart supply chain collects copious amounts of data about raw material and finish goods.* The data collected includes amounts and locations. The information is used by planners and partners to ensure supply meets demand.

Standards focus areas
- Process modeling and reengineering
- Performance measurements
- Best practices
Operations

- Core function of Smart Manufacturing
- All the lifecycle converge in the “make” area of operations
- Smart operations span autonomous, self-aware, and self-correcting machines as well as unencumbered information flow from the plant floor devices up to enterprise systems and everywhere in-between

Standards focus areas:
- Enterprise level
- Manufacturing Operations Management level
- SCADA level
- Device level
Standards based architecture to support sustainability and interoperability

Source: ARC Advisory Group
Move to Federated Systems

Point-to-Point
Easy and Cheap

- Non-Scalable
- Each individual connection is seductively low cost
- Together a mass of connections results in support high costs

Database Centric
Expands Easily

- Separates data from its Source
- Monolithic Data Store
- Creates Redundant Data
- Central Point of Failure
- Creates Synchronized data not data synchronization

Federated Systems
State of the Art

- Distributed and Scalable
- Functionally Rich – Driven by information models
- Event-Driven
- COTS
- More flexible

Common Information Infrastructure
Digital Transformation Standards Gaps

Gaps
- Limited lifecycle coverage
- Standards spanning many phases typically focused on limited set of functions
- Within the operations lifecycle, communications standards exist but limited interoperability among systems
- Existing standards don’t address CPS based automation
In general the benefits of standards many fold.
• Reduce suppliers costs and extends their support
• Users realize productivity improvement by eliminating custom applications that are difficult to maintain.
• Improves interoperability
• Standards provide “how-to” guides for designers, builders, and operators
• They help communications between internal and external stakeholders

With regards to Digital Transformation standards:
• Enhance manufactures ability to collect, transform, disseminate, use and respond to information quickly
• Spur the development and adoption of new technology and manufacturing methods
• Fundamental building blocks that allow information to flow easily and cost effectively throughout all levels of manufacturing and beyond.
Digital Transformation Steps

• Top management must not only support but drive digital transformation
• Form a task group. The group should be comprised of production, information technology, development specialist etc.
• Create a common understanding of the digital transformation, smart manufacturing, digital manufacturing, or IIoT concepts identify other expertise within your organization that can help realize these concepts.
• Start by thinking about what you want to monitor immediately and why do you is it worth monitoring. What devices and equipment needs to be connected. Who will use the information. How will the information be used? What infrastructure do you need and who will maintain it? Also think about security.
• The real value of smart manufacturing is developing new ways of doing business that create a step change in performance. Think about creative ways to leverage information that was previously inaccessible.
• Hold brainstorming sessions and workshops to flush out new ideas
• Pick a few ideas that have the greatest potential and elaborate concepts, create business models and determine market potential or business value.
• Develop details proposals and plans for implementation
Operational Technology (OT)

Yokogawa is known for:

- Highly available operation (24/7)
- Avoiding unplanned outages and abnormal situations
- Long-term performance sustainability
- Innovative MAC services

Industrial Internet of Things (IIoT)

Yokogawa also provides:

- Flexible & predictable operation
- Flexible & multipoint sensors
- KPI-based production and (self-)optimization
- Collaborative cloud-based solutions
- Knowledge sharing

Yokogawa also provides:

- New customer values beyond the plant
- Cross-site management
- Business to Business management
- Service-based business platform (DaaS/SaaS)

Digital Transformation Today: Project Collaboration

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<th>Feed</th>
<th>Design</th>
<th>Configuration</th>
<th>FAT</th>
<th>SAT</th>
<th>Commissioning</th>
<th>Operation</th>
</tr>
</thead>
</table>

Control System project phases can move to cloud environments

- Less travel
- Easier integration of geographically dispersed project members
- Workflows automation can improve project management
- Easier to manage projects
Cyber Security

Our Solution:
Plant Security Consulting & Lifecycle Services to minimize risk and increase corporate value

Our Capability:
Security Competence Laboratory

Professional Consultants
19 GICSP engineers (as of March 2016)
*Global Industrial Cyber Security Professional
Digital Transformation Today: Example Pokemon Go!

- Most popular downloaded and top grossing gaming app
- Uses a mixture of AR, Smartphones, location tracking and cameras
- Transforms gaming experience from computers, consoles, and monitors to mobile
- New business model: free to download, pay to speed up progress
- Charge retail establishment to become sponsors (attracting customers)
- Nintendo’s market cap increased more than 25%, a jump of $9 Billion
Digital Transformation Today

- Augmented Reality
- Mainstream IT technologies
- Native and server based Apps
- Role & Task oriented Apps
- Bringing together previously unassociated data
- Right Information at the Right Time with the Right Context
Data Analytics Answers More Questions

New Insights

Known Info

Descriptive
- Why/How did it happen?
- Slice and Dice, Hypothesis Testing

Predictive
- What should we do now?
- What-if Analysis, Simulation

Prescriptive
- What’s the best we can do?
- Optimization, Data Mining

Past
- What happened?
- Reports

Present
- What’s happening?
- Dashboards, KPIs

Future
- What will happen?
- Extrapolate, Predict

KPIs

Machine learning for predicting asset failures

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Today we have looked at exciting trends in the automation industry now we want to use these new technologies to drive things further through Co-Innovation.

- **Create**
  - Collaborate with Customers, Partners and Organizations to Create Ideas for Innovative Methodologies, Tools and Solutions

- **Prove**
  - Check Internal and External Markets for Applicability
  - Develop Proofs of Concept for Innovative Ideas that have Potential Mutual Benefits

- **Co-Innovate**
  - Prepare a Development, Implementation and Marketing Approach to Bring the Best Ideas to Market
Co-innovating tomorrow™

Thank You