Digital Transformation: The paperless factory

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Content

ARC Advisory Group
Digital Transformation: Smart Manufacturing and Industrial IoT

1. Paperless design, engineering, compliance and asset management
2. Paperless manufacturing
3. Paperless supply chains

Outlook and recommendations
About ARC Advisory Group

Global Technology Strategy Consultancy

- Domains: Industrial Design and Operations
- Technologies: Automation, Instrumentation, IT, Industrial IoT (IIoT)
- Typical:
  - Market size and trends
  - Best Practices,
  - Benchmarking, Strategy
  - IIoT Reports, Studies, Blogs,
  - Speaking engagements
WHAT ARE WE TALKING ABOUT ???
**Smart Manufacturing**

- **Advanced Manufacturing: Advances in the physical and chemical processes**
  - Modular production
  - Additive manufacturing, advanced forming
  - ...
- **Smart Manufacturing Technologies: Digital Transformation**
  - Industrial Internet of Things (IIoT, including Cloud)
  - IT and Automation based technologies, e.g. analytics
  - ...

**Smart Manufacturing Initiatives**

- High Value Manufacturing Catapult
- Industrie 4.0
- Smart Manufacturing Leadership Coalition, etc.
A WINNING STRATEGY?
Smart manufacturing or Industrial IoT: A strategy for growth?

- Strategy for growth?
- Hype?
- Miss the train?
Manufacturing growth and competitiveness

Manufacturing growth, resilience, competitiveness, and growth are correlated with a high degree of technology intensity, technology/manufacturing complexity, quality, and are impacted by Smart Manufacturing.

Complexity index 2010 versus 1995

Impacted by Smart Manufacturing
THREE DOMAINS
Digital operations, asset lifecycle and supply chain management

- Advanced Analytics
- Predictive Maintenance
- Remote Monitoring Connected Services
- Business Process Execution
- Status, History of Products
- Connected Products
- Connected SCION
- Connected Production Assets
- Connected Products
- Business Ops
- Services
- Manufacturing
- Sales
- Supply Chain
- R&D
- Smart Logistics
- Smart Components
- Smart Product & Process Design
- And many more …
1. LIFE CYCLE
Model for Major ALM (or PLM) Processes

Past

Plan → Design → Procure → Build → Operate → Maintain → Retire & Recycle

Project Performance Management (PPM)

Design & Build

Handover

Funded Projects

Project Performance Management (PPM)

Asset Performance Management (APM)

Portfolio Mgt.

Asset & Project Portfolio Management (APPM)

New Facility Requests

Modification Requests

Operate & Maintain
Vision for Computer Integrated Engineering and Production

Dr. Thomas Tauchnitz, Sanofi Aventis, 2005

- Single repository for all engineering disciplines from front-end through operations and maintenance
- Integrated compliance management
- Manufacturing Operations Management and control systems synched with repository
- Generic, modular designs to maximise reuse

PLM suites for discrete industries are far ahead in cross-lifecycle integration
Software is available for all functions along the life cycle

Challenges are related to synchronization among systems, applications and organizations.
The reality: Asset Information Erosion

- Asset information is generally spread over applications, data bases and paper files
- Processes do not emphasize the synchronization of these sources
- Result is that information becomes inconsistent
- When external service providers are involved information becomes incomplete and more inconsistent
- Information is rarely handed over completely and electronically
- The cost of poor asset information is over 4% of CAPEX (NIST)
World class producers have low cost and high availability

Maintenance has an impact on reliability (McKinsey, 2009)

- World class oil and gas producers have 95-98% availability
- Make right decisions on savings
- Execute plans and processes flawlessly
- Can improve availability with several percent while reducing cost 25-30%

Precisely what ISO 55000 defines

- Good practices in defining asset management system
- Quality of governance is key
Implementation examples

Dr. Tauchnitz of Sanofi implemented his vision

- Developed engineering modules (multi-year effort)
- Internal collaboration required adjustment to processes and mutual trust
- Developed with Siemens first one-way then bidirectional interface with PCS7, from which NE150 was derived

Christoph Jauslin of Novartis implemented paperless integrated engineering globally

- Paperless engineering, handover, operations and maintenance
- Developed e-compliance, implemented by Siemens in COMOS
Expected benefits
- Manage information and processes for compliance
- Guarantee safe operation, maintenance and change with up to date “as built” information
- Single version of the truth
- Eliminate non-value adding work
- Reduce search time
- Stream-line work processes
  - Speed up management of change
- Improve collaboration
- Reducing engineering and contractor cost OR improved quality

Unexpected benefits
- Maintenance quality reduces cost in maintenance and production
- Cost of compliance constant despite more complex regulation
- Reduced on-boarding time
- Increased % as-built documentation
Asset information integrity as key enabler

Past

Plan → Design → Procure → Build → Operate → Maintain → Retire & Recycle

Current

Design & Build → Operate & Maintain

Project Performance Management (PPM) → Asset Performance Management (APM)

Handover

Asset Lifecycle Information Management

Funded Projects

Modification Requests

New Facility Requests

Asset & Project Portfolio Management (APPM)
2. MANUFACTURING
The Emerging Smart Production Environment

New or Changing …

- Software: Analytics, APS, MES/MOM, EAM/CMMS, LIMS, PAM, Security, etc.
- Mobility and enhanced worker connectivity
- Remote services; Product ‘as-a-Service’
- Smart sensors, assets, network connectivity, cloud
- Increased variety and changeovers

… All along with traditional automation and enterprise systems
Modular equipment, units and lines
Revolution in engineering, construction and production

Docking a modular plant

(Fine) Chemicals, Polymers and Pharmaceuticals
Standards for functions and integration well-defined

Functions for
- Production, quality, inventory, maintenance ops

Integration content

Paperless is feasible

Missing:
- Value chain interoperability
- M&A

IIoT implications for MES
- More generic specifications
- More real-time instantiation
Implications for standards

- Reference Architecture Industrie 4.0 investigates extension of the physical model of ISA-88 and ISA-95 standards.
Fast, world-wide production visibility and support

- SMLC: ALCOA Operational Intelligence
  - Global real-time smelter production data with real-time analytics
  - Internet

Source: Geoff Woods, ALCOA, live demo, OSIsoft UC, 2014
Impact on applications: IoT as MES add–on

Optimizing Manufacturing with IoT at Intel

- IoT solution in parallel with MES
  - Flat architecture
  - Processing at the ‘edge’
  - Controller connection to Cloud
  - Storage, analytics and predictions

- Complex partner network

- **Case 1: predictive combined asset and quality analytics: 9M$ benefits**
  - Reduce non-genuine off-spec (losses -25%)
  - Predictive maintenance (cost -20%)

- Two other cases with major benefits

- Lessons for other sectors
  - Incremental Industrial IoT application
  - Large data streams from ubiquitous sensing need large bandwidth
  - Data selection at controller level
  - Wide range of analytics applications possible

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Short-term gains possible by incremental steps

3. SUPPLY CHAIN
Traditional Supply Chain

Adaptive Production Logistic
- Industry 2.0 – 3.0

Actual:
- Product 1 in production

Plan:
- Starting the day after tomorrow product 2 will be produced for 7 days
- Raw material A is needed for product 1. In 3 weeks subsequent delivery is scheduled.

New Order Product 1

1) Delivery date?
2) Production Capacity: YES
   Raw material A: NO

Raw material A immediately?
3) Raw material A in 4 days

1+7+3 days

Delivery date:
In 11 days

Source: Poetter, Namur General Assembly 2013
Industrie 4.0: Cyber-physical systems, real-time operating networks

Adaptive Production Logistic - Industry 4.0

Actual: Product 1 in production

New Order Product 1

1) Delivery date?
Production capacity: YES
Raw material A: JA

2) Delivery date:
In 4 days (1+3 days)

Plan:
Starting the day after tomorrow,
Product 2 will be produced for 7 days.

I empty and can take over transportation immediately

Warehouse
Product A

I almost empty and can be refilled

Raw material A will be delivered tomorrow
(warehouse + truck)

Alternatively Product 1 can continue to be produced

Source: Poetter, Namur General Assembly 2013

VMI using cyber-physical systems

Requires real-time operating SCON!
From MRPII to Advanced P&S

- Manufacturing agility and supply chain speed will cause
- High Supply Chain volatility
- Traditional supply chain management will be insufficient
- Can be damped with near real-time predictive analytics

Statistical Forecasting

Rough Cut Capacity Planning

Sales and Operations Planning

Distribution Requirements Planning

Master Production Scheduling

Material Requirements Planning

Available to Promise

Infinite Capacity Scheduling

Collaborative Forecasting and Demand Management

Supply & Demand Balancing

Scheduling And Capable to Promise
From MRPII to Advanced P&S and Analytics

Statistical Forecasting

- Rough Cut Capacity Planning
- Sales and Operations Planning
- Distribution Requirements Planning
- Master Production Scheduling
- Material Requirements Planning
- Available to Promise
- Infinite Capacity Scheduling

Collaborative Forecasting and Demand Management

Supply & Demand Balancing

Scheduling and Capable to Promise

Volatility can be damped with near real-time predictive analytics

Towards Predictive Supply Chain Analytics and Network Optimization
Emerging SM / IIoT Architecture – SC Analytics

New IoT Analytics and Applications

Purdue Hierarchy

IIoT Hierarchy

Smart Machine

Emerging Option: Connect Assets Using New Technologies

XYZ Chemical
Maintenance

XYZ Chemical
Engineering

XYZ Chemical
Purchasing

XYZ Chemical
Corporate

Enterprise

Plant Operations

HMI / Workstations

Production Management

Wireless

Infrastructure (Networks...)

Fieldbus

Safety

Logic & Motion

Device buses

Discrete Control

Application Specific Appliances

Process Control

Local IoT Compute and Communicate module

Physical asset with sensors, actuators

IoT Smart Module

Application S/W

Analytics

Platform

Smart Devices

Client

Supplier

3rd Parties

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Shorten SCM implementation time dramatically

- SMLC Testbed General Mills
- Complex integrated solution requirement
  - Each implementation iteration takes years
  - Objective: reduce application building and integration to a few months.
OUTLOOK AND RECOMMENDATIONS
Mastering the 4th Industrial Revolution: Davos 2016

Great opportunities
- Consumer opportunities
- Economic growth opportunities
- Job opportunities for the highly skilled
- Mobility without physical relocation
- Barriers for entry shrink (investment to compete digitally is small)
- Digital transformation can go hand in hand with sustainability

Great challenges
- Rising inequalities, shrinking middle class
- Privacy and cyber security
- Skills transformation (every job will have digital components)
- Low Investment/Savings ratio
- Lack of physical interaction between people
Davos 2016: All stakeholders must take responsibility and contribute to make digital transformation a success

There has never been a time of greater promise, or greater peril

Professor Klaus Schwab
Founder and Executive Chairman
of the World Economic Forum
It’s not just a matter of technology

In the end, it all comes down to people and values. We need to shape a future that works for all of us by putting people first and empowering them.

Prof. Klaus Schab, Founder and Chairman of the World Economic Forum
Thank You.

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