Industry 4.0 for Manufacturing & Assets
SAP Digital Manufacturing & Assets to increase Agility and Responsiveness

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June 6th, 2019
Four Eras of Digital Transformation – the Journey to Industry 4.0

Optimize and extend the value of current processes

Optimize existing processes for more efficiency or reliability

Extend current business processes beyond efficiency gains to capture new sources of value

Transform the company’s value chain or business model to capture new revenue streams
Why is digitalization important to Manufacturing?

Serve the customer
Enable digitally driven production to meet demand and make mass customization possible, giving customers exactly what they want and maintain costs.

Enable a smart factory
Intelligently integrate production with supply chain planning and logistics to deal with external impulses like short-term demand and supply fluctuations and the configuration of customer orders.

Differentiate with digital smart assets
Use digital capabilities like self-awareness of technical health and operational status or business system connectivity to maximize production line uptime and utilization.

Focus on high-value outcomes
Establish new production processes that ensure on-time delivery of high-quality products that exceeds every customer’s expectation.

- 40% Increase in operating efficiency
- 10% Reduction in operating costs
- 160% Increase in output
So, What is needed?

Customer Centricity

Center everything you do on your customers:
Enable product configuration with an agile manufacturing environment that adjust quickly to product variability through automation and rapid product line transformation.

Total Visibility

Provide a top floor to shop floor digital view of production:
Adopt Industry 4.0 principles throughout the plant and leverage intelligence from IoT sensors, machine learning and digital manufacturing insights to gain a real-time end-to-end view of production operations.

Business Innovation

Reinventing processes through analysis and automation:
Build intelligent products and establish feedback mechanisms to obtain operational performance and improve manufacturing processes to continually enhance quality.
How we Connect Digitally to Perfect Reality in Manufacturing
The Intelligent Enterprise
Key End-to-End Processes

**Source to Pay**
- Network & Spend Management

**Total Workforce Management**
- People Engagement
- Digital Core

**Design to Operate**
- Manufacturing & Supply Chain

**Lead to Cash**
- Customer Experience

Intelligent Suite

Intelligent Technologies
- AI
- Machine Learning
- Analytics
- IoT

Cloud Platform

Digital Platform

Data Management

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Digital Supply Chain – Manufacture

Business capabilities for Manufacturing

- **Connected manufacturing processes**: Break down manufacturing silos through single data model and connected and integrated manufacturing processes
- **Top floor to shop floor visibility**: End-to-end visibility on strategic, tactical and operational level
- **State-of-the-art business processes**: Leverage new technologies to identify and enable new business processes with highly flexible UI’s
- **Foster more efficient execution**: Improve throughput, increase quality, and reduce scrap
- **Advanced analytics and Machine Learning**: Leverage business and operational data points to analyze root causes of inefficiencies and predict failures in real time
Landscape Challenge
Managing assets from Multiple Suppliers on the Shop Floor

» Business Context
» OEE, Energy Management

» Multiple vendors
» Multiple machines
The Main Process Challenges for Manufacturing in the Digital Economy

Five Business Needs of “Connectedness”

1. Intelligent Visibility Across the Business
3. Complete E2E Supply Chain Integration
4. Predictive Service & Maintenance
5. Flawless Supplier Collaboration
SAP Digital Manufacturing Solutions
A complete portfolio of manufacturing solutions to support digitalization and Industry 4.0

SAP Digital Manufacturing Cloud
- Manufacturing Insights
- Manufacturing Network
- Predictive Quality
- Manufacturing Execution

SAP Manufacturing Suite
- SAP Manufacturing Integration and Intelligence
- SAP Manufacturing Execution
- SAP Plant Connectivity

SAP S/4HANA Manufacturing
- for Production Engineering and Operations
- for Planning and Scheduling
- Environmental, Health & Safety
Manufacturing Integration and Intelligence

Solution Details

- Key Performance Indicators
- Alert Management
- Overall Equipment Effectiveness Insights
- Individualized Dashboard Design
- Integration Capabilities
- Operational Visibility
- Enterprise Hierarchy
- Machine Data
SAP Manufacturing Integration and Intelligence

Overview

- **Extensible** manufacturing platform allowing rapid adaption to any manufacturing process
- Integration: Provide interoperability (in)between shop floor solutions and enterprise ERP (Production Planning (PP), Plant Maintenance (PM), Material Management (MM), Quality Management (QM))
- Intelligence: Visualize data from any of above sources to provide KPIs. Provide simple and efficient local User Interface and Dashboards
- Innovation: Powerful SOA-enabled business logic to cover for customer specific processes around planning, execution, maintenance and quality now including versioning of any Content
- Allows fast prototyping to achieve fast ROI
- Broad and extensive partner network and customer community
- Applicable to all manufacturing industries and utilities
Integration

- Aspen Tech IP21
- Wonderware InSql
- Wonderware Alarm Suite
- OSI Soft
- GE Fanuc Proficy Historian,
- Honeywell, Siemens through
- OPC UA or DA
- Citect
- Modbus
- IP21
- ODBC
- OLE DB
- OPC A & E
- OPC DA
- OPC HAD
- OPC UA
- File Monitor
- Socket
- SDK for additional Agents

Enterprise collaboration
- SAP ERP
- SAP CRM
- SAP SRM
- SAP PI

Process Integration Connector
- JRA/Jco, IDOC, RFC, BAPI, WS
- Event-driven execution control
- Mfg operations bus
- Message/event
- Monitoring

Business Logic
- Composites
- TCP/IP, HTTP, WS

Plant Connectivity
- Inspection/equipment testing
- Weigh scales
- Plant historian
- HMI
- MES
- SCADA/DCS
- Plant data collection
- RFID sensors/device integration
- Passive

Industrial Ethernet, field bus
- DCS
- PLC
- ...
Integration Scenario - PCo to MII to User
Event capture, validation, & delivery

PCo Monitors the Oxidizer Temperature Tag for violations and notifies MII if this occurs

MII Simultaneously notifies SAP EC and a Mobile Device of the Violation

Oxidizer Temperature Tag is defined in Shop-Floor Control System

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SAP Digital Manufacturing Cloud for insights
Digital systems for measurement and control in combination with real time business context

Key capabilities

- Analyze performance using dashboards filled with pre-defined, standardized key performance indicators (KPI) based on harmonized data
- Retrieve data from your shop floor, Execution systems and combine it with contextual information from your business sources like SAP ERP to build KPIs and Predictive models
- Leverage built-in machine learning algorithms in the analysis of quality defects
- Perform root cause analysis and drill-down at any level: global, plant or individual work center
- Customize your reporting and build individual dashboards or create formulas for customized KPI calculations
- Incorporate data from non-SAP sources using Analytical Model
Manufacturing Insights: Intelligent insights and analysis across global plant operations

SAP Manufacturing Integration and Intelligence (MII), SAP Digital Manufacturing Cloud for insights

- Adaption to any manufacturing process and global visibility and analytics for key performance indicators across a single plant or global operations
- Full integration to combined business and operational data from ECC, S/4HANA and the Manufacturing Suite for improved decisions
- Manage and view harmonized data acquired from disparate sources for better visibility into your plant operations
- Business logic orchestration to enable customer-specific processes for planning, execution, maintenance and quality
- Manufacturing Performance Management with OEE Energy Management to lower operational costs through an intuitive tailored Worker UI
SAP Digital Manufacturing Cloud for insights
Overall Equipment Effectiveness Insights

Manufacturing Insights provides real time insight in manufacturing operations with high fidelity data about the operations. This allows manufacturers to get insight while operations are running during a shift rather than after the fact when the shift is completed.

- Overall equipment effectiveness (OEE) analytics based on SAP ME and SAP MII-OEE
- Shift wise analysis of different losses
- Root cause analysis for all OEE losses (availability/quality/performance)
- OEE time element chart provides all losses in a single view

### Definitions

<table>
<thead>
<tr>
<th>Metric</th>
<th>Formula</th>
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</thead>
<tbody>
<tr>
<td>Availability</td>
<td>Net Production Time / Loading Time</td>
</tr>
<tr>
<td>Performance</td>
<td>Net Operating Time / Net Production Time</td>
</tr>
<tr>
<td>Quality</td>
<td>Value Operating Time / Net Operating Time</td>
</tr>
</tbody>
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### Key Calculations

- **Net Production Time** = Loading Time - Unscheduled Down
- **Net Operating Time** = Net Production Time – Speed Loss
- **Value Operating Time** = Net Operating Time – Quality Loss

![OEE Calculation Diagram](image-url)
SAP Digital Manufacturing Cloud for insights
Predictive Quality: Function flow

1. Identify Improvement opportunity
   - Identify product characteristics or quality KPIs which needs improvement

2. Select IT-OT data to be analyzed
   - Intuitively select IT-OT data associated with the production process to create analytical data model

3. Build and deploy predictive model
   - Guided steps to create and manage lifecycle of predictive model

4. Analyze and identify product quality influencers
   - Built-in analytics to analyze influence of selected IT-OT data

5. Proactive corrective action
   - Alerts generated by predictive model

Production / Manufacturing Process

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SAP Digital Manufacturing Cloud for insights

Predictive Quality

Key Capabilities

- Expose manufacturing big data (IT/OT data) in the pre-defined manufacturing semantics
- Intuitive workbench to Analyze & Correlate multi-tier data related to 3Ms of manufacturing
  - 3Ms = Machine, Material, and Method
- Simplify predictive model building and model life cycle management to keep pace with the operations
- Near real-time evaluation/scoring of predictive models and trigger corrective actions to the right people
Reimagine **intelligent asset management**: Optimizing equipment performance

**Traditional scenario**

- Time- or condition-based inspection and maintenance
- Unknown real-time risk of failure and performance
- No optimization of cost, risk, or performance

**A new world with SAP**

- Condition-health monitoring identifies failing equipment so it can be repaired before failure.
- Uptime improves consistency of equipment performance.
- Intelligent asset management enables optimization of cost, risk, and performance.

Using automated sensors to monitor equipment condition enables the maintenance plan to be created based on real-time asset health status and prediction of failure to optimize lifecycle performance.

**Top value drivers**

5% Improvement in return on assets
25% Improvement in first-time fix rate
15% Reduction in unplanned asset downtime

*Source: Average cross-industry benchmark – SAP Performance Benchmarking
THE FOLLOWING PREVIEW OF

MOUSE 'MAERSK OIL UNIQUE SAP EXPERIENCE'

HAS BEEN APPROVED FOR THE EMPLOYEES OF MAERSK OIL QATAR

www.maerskoil.com
SAP Intelligent Asset Management

State-of-the-art business processes
Leverage new technologies to enable new asset management business processes with highly flexible UI’s

Real-time insights
End-to-end visibility on strategic, tactical and operational level

Connected assets
Bring together information from operational and business systems using IoT for scalable transparency

The power of prediction and simulation
Drive smarter decisions, improve reliability, and reduce outages

Collaboration throughout the asset lifecycle
Share asset information, access one version of the truth, and collaborate on a cloud-based business network with integrated processes
FMEA Assessment
SAP S/4HANA Asset Management
Maintenance and Service Management

Plan maintenance activities with the right person providing the appropriate tools and resources

Schedule proactive preventive or condition-based maintenance tasks

Leverage integrated documentation for job execution and safety for a holistic view of asset status
Execute planned and unplanned maintenance tasks to help ensure optimal operations

Manage preventive and condition-based maintenance proactively

Increase equipment reliability and improve asset usage as well as safer maintenance processes

Manage asset information for work orders, maintenance, measurements, inspections, metering, and inventory
SAP Intelligent Asset Management
Asset Network and Collaboration

Enable secure asset information collaboration across your business network

Collaborate with manufacturers, operators, service suppliers, across the network on asset information

Provide one network channel for electronic handover of technical asset and maintenance data to OEMs, service providers, and procurement vendors

Improve data reliability, reduce master data maintenance, and maintain higher asset availability
Customer value examples from SAP Digital Manufacturing

**CATL**
World’s third biggest Li-ion battery manufacturer currently producing over 200,000 battery cells per day
- Integrated 1,000 shop floor machineries and enable business decision making based on real time process data
- Initially increased the average production volume per line by ~25% with stable quality; Initially increased the overall OEE by ~5% with the real-time monitor and analysis of the key resources
- Significantly increased the product quality
- Shortened the “Time to operation” of new lines, since production standards were setup and are mandate for the automation vendors to follow
- Reduced “idea to production” cycle time by integrating the production design to manufacturing processes

**Tyson Foods**
International leader in production of meat products growing rapidly through acquisitions
- Provide enterprise digital platform to support company growth
- Increase productivity and overall equipment effectiveness with focus on high machine availability and streamlined plant floor processes
- Real time visibility to plant operations
- Processed meat organization leading digital strategy with plant based investments that operate stand-alone
- Supports disconnected operations, allowing plant to operate when ECC is not available
  - Order Confirmations
  - Goods Movements
  - Results Recording

**Varian Medical Systems**
World leading manufacturer of medical devices and software for treating cancer and other medical conditions
- Digitized the entire design and manufacturing process end to end to reduce time to market & costs
- Automated paper-based processes for product design with electronic solutions
- Reduced design changes from months to days
- Improved quality leading to an enviable +99% uptime record for machines in the field
- FDA CFR 21 Part 11 Compliance with eDHR and repeatable processes
- Unified disparate systems in design and manufacturing to a single, trusted source of truth making relevant information available to decision makers at all levels without any delay

**Hanon Systems**
Korean Automotive Component Manufacturer of thermal & energy management systems with global operations
- Create consistent approach for managing cross plant analytics and key performance indicators for global manufacturing operations
- Improve decision support using real time analytics and end to end visibility of manufacturing data from planning through shipment
- Full integration and interoperability to SAP S/4 and SAP Manufacturing
- Accommodate Low & High automation production areas for consistent analytics
- Full order execution analytics driven by plant operations
- Deep integration into SAP planning & logistics to ensure high level of overall equipment effectiveness across plants
Three Machining Lines, One Engine Assembly Line

- 37 second Takt time per engine
- 6 engine configurations
- 5 plant connectivity / Kepware OPC server platforms / 20,000 tags
- 6000+ transactions per minute at full rate

Efficiency and Productivity through connected Automation
Complete Manufacturing Operations Visibility
Meeting variable customer demand with intelligent manufacturing

Digital Manufacturing and Industry 4.0

- **Adaptive manufacturing from digital transformation**
  - Real-time digital manufacturing insights on machine and environment

- **Improved efficiency**
  - Lowered risk through IIOT, 3-D visual work instructions and improved process controls

- **Re-imagined products**
  - Extended solution portfolio to enable integrated planning and configuration for smart manufacturing

Results

- Improved customer satisfaction
- Competitive advantage
- Higher profits

Industrial Battery Production

- **28** Lines of production
- **200,000+** Battery cells produced per day
- **1,000** Shop-floor machineries integrated
- **25%** Initial increase in average production volume per line
Intelligent Visibility into Processes and Verification Analytics
Big data applications for continuous process improvement

- Process Analytics from Historian Data
- Integration to LIMS results
- ERP Data for Business Context
- HANA Analytics Drive New Insights
- GMP Environment
- Empower EHS practitioners with live data to act in the moment
Thank you.

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