Innovations for Digital Manufacturing

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Why IoT and digital manufacturing are important …

- Reimagining new business processes to simplify process variability
- Rapid introduction of innovation and creating new business models
- Higher level of automation and changes in how people will work
- Enabling the “market of one” delivering individualized products

Business value benchmarks

**Productivity improvements**
- such as lower maintenance costs (up to 60%), or lower capital appropriations (25%)

**New operational processes**
- resulting in lower labor cost (30%) with improved OEE (5%–10%) and reduced scrap levels (30%–50%)

**People process optimization**
- leading to 10% to 30% higher productivity in the form of higher outputs and lower costs

**Lower risks**,
- such as reduced warranty cost by (10%) and improved compliance through 100% component and process traceability

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SAP Leonardo IoT – innovation portfolio

Line-of-business (LoB) digital supply chain
(Business process view)
- Digital business planning
- Digital response and supply
- Digital logistics
- Digital product innovation
- Digital manufacturing
- Digital operations

SAP Leonardo IoT
("Things" view)
- Connected products
- Connected assets
- Connected fleet
- Connected infrastructure
- Connected markets
- Connected people

Efficiency-led models

New business models
Digital transformation impact

Business processes

Business models

Work environment
Customer satisfaction
Competitive advantage
Higher profit

Smart manufacturing
Real-time insights on machine and environment

Improved efficiency
Lowering risk, through 3D visualization of work instructions and change orders

Reimagined products
Extending the solution portfolio to enable configuration for precision manufacturing
Three machining lines, one engine assembly line

- 37-second takt time per engine
- 5 plant connectivity / Kepware OPC server platforms / 20,000 tags
- 6,000+ transactions per minute at full rate
Integrated enterprise
Facility health reports scope

- Bottleneck analysis by line and by constraint operation
- Downtime by state by operation and by machine
- State trend by operation and by machine
- MTBF and MTTR showing downtime in minutes and scheduled time minus downtime
- Top X fault trend by machine and operation
- Top fault by occurrence and time
- Run at rate (JPH capability)
- Over cycle analysis (engine assembly line only)
- OEE (including bottleneck station)
- Quality rate
- Hour counts by station and by process
- Part through station, including cycle time
- Right first time – without rectification
- First time through after rectification

Process and product quality reports scope

- By unit
- By operation station
- By process
- By engine type
- By adaptor plate/platen
- By on/nok/all
- Parameter requirement
- Linked to facility health analysis (complete engine birth certificate)
- Linked to tightening server – tightening spindle selectable (all/multi-selectable)
- Linked to cold test
- Linked to hot test
- Linked to leak test
Integrated mining and steel
Real-time visibility across operations
Manufacturing intelligence
Increases productivity

65% to 80%
Improved overall equipment effectiveness
Work environment, change

Reduced costs

Improved productivity

Higher quality

**Role expansion**
Working across disciplines to design and manufacture smart products

**Process change**
Collaboration, networking

**Business model**
Customer centricity
Industry 4.0
Building blocks

End-to-end integration, IT–OT convergence

User experience – wearables – augmented reality

Distributed manufacturing – additive manufacturing

End-to-end transparency – intelligent analytics – Big Data
Digital manufacturing
Linking the physical world to the digital world

Business world
- General ledger
- Procure to pay
- Order to cash
- Engineer to order
- Configure to order
- Make to stock
- Inventory controls
- Costing
- CRM
- SRM
- Materials

Digital world
- "As designed"
- "As built"
- "As maintained"
- "Performance"

SAP Leonardo
- Vending machine
- DCS/PLC
- Auto
- Chemicals
- Sensors
- Navigation
- LIMS/inspection/equipment testing
- LEDs
- Robots
- CNCs
- Engine
- Batteries
- Pumps
- AGVs
- Motors
- Transmission

Digital twin

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Accelerate the enterprise success
Higher productivity due to simplification

How to accelerate and grow productivity and profitability in complex business environment?
How to run business and production seamlessly integrated?

Need for **smart simplification**

1. **Top floor to shop floor**
2. **Customer to operations**
   - Simplify
   - Harmonize
   - Reduce

Accelerate the enterprise success
Higher productivity due to simplification

SAP ERP
SAP Integrated Business Planning
SAP Manufacturing Execution
SAP Plant Connectivity to automation

Consumer/customer
Business networks
Digital manufacturing with SAP for industrial IoT

» Business context
» OEE, energy management

» Multiple vendors
» Multiple machines

Digital manufacturing

SAP Manufacturing Execution

SAP Manufacturing Integration and Intelligence

SAP Plant Connectivity

Shop-floor automation systems
Digital manufacturing with SAP
Five scenarios of “connectedness”

1. Shop floor to top floor
2. Machine to machine
3. E-commerce integration
4. Machine/operations cloud
5. Direct replenishment
SAP Leonardo and digitalizing business: The big picture

UI layer (SAP Leonardo IoT Bridge)

Enterprise Management – the digital core

R&D

Supply chain planning

Manufacturing

Logistics

Sales

Aftersales service

Procurement

People

From processes to networks

New business models

SAP Leonardo IoT Foundation

SAP Cloud Platform / SAP HANA platform

Applications powered by SAP Leonardo

Network log. hub

Connected goods

Track & trace

Digital manufacturing

Vehicle insights

Predictive maint.

Asset intelligence network

SAP Leonardo IoT Edge

Networks

Connected goods

Digital manufacturing

Vehicle insights

Predictive maint.

Asset intelligence network

Products

Things/Physical layer

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**Digital manufacturing with SAP**

**Digital manufacturing** wires the world of machines with business processes

- Shop floor to top floor (vertical)
- Machine-to-machine (horizontal)
- End-to-end integration
- Business partners
- Easy connectivity

Build on an **open IoT-ready platform** supporting **Industry 4.0 manufacturing**

- Following the OPC UA standards
- Enabling a manufacturing network
- Connecting partners along the supply chain
- With flexible deployment options
Continuous innovation

Rapid innovation through side-by-side extensions in the cloud

Side-by-side with SAP S/4HANA innovations

**Planned innovation not yet available, subject to change**
SAP Manufacturing Execution
Main differentiators

SAP Manufacturing Execution – what is it?
- Shop-floor execution system for the discrete industries

Main differentiators
- ERP integration built in
- Ability to control production of every single unit (lot size 1)
- Easy interaction with shop-floor automation layer
- Unit-level tracking and tracing/genealogy
  What operation, tool, or machine was used, where parts came from, …
- Comprehensive nonconformance management including in-line sampling and ability for visual test and repair
- Process interlocking
- High flexibility and extensibility; pure SOA-based architecture
- High usability with browser-based user interface
- Role-specific access and personalized dashboards for operators
- Flexible production process modeling without additional programming
- Active community of partners and customers
SAP Connected Manufacturing – architecture
The connected plant in the extended supply chain

**ERP**
- Production plan
- Bill of materials (BoM)
- Variant management
- Production steps
- Serial numbers
- Quality results per lot
- Order confirmation
- Inventory update, equipment usage

**SAP MES** (SAP Manufacturing Execution and SAP MII)
- Production details management
- Detailed and flexible
- Production step routing
- Shop-floor controls for each step
- Log parametric data
- Tolerance checks
- Return “conformance” or “nonconformance” decisions

**Plant Connectivity**
- Mapping of ME production details to PLC control parameters (recipe)
- Mapping of ME production details to PLC control parameters (recipe)

**PLC (machine)**
- Sensor detects material carrier
- Requests control parameters from ME
- Machine reports completion and requests next operation

**MONITOR**
- DESIGN
- PLAN
- RESPOND
- PRODUCE
- DELIVER
- OPERATE
SAP Manufacturing Integration and Intelligence (SAP MII)

Main differentiators

SAP Manufacturing Integration and Intelligence – what is it?

- **Extensible** manufacturing platform allowing rapid adaption to any manufacturing process

Main differentiators

- **Integration**: Provide interoperability between shop-floor solutions and enterprise ERP (production planning, plant maintenance, materials management, quality management functionality)
- **Intelligence**: Visualize data and include KPIs from any of the above sources
  - Provide simple and efficient local user interface and dashboards
- **Innovation**: Powerful SOA-enabled business logic to enable customer-specific processes for planning, execution, maintenance and quality
  - Fast prototyping to achieve fast ROI
  - Broad and extensive partner network
  - Applicable to all manufacturing industries and utilities
SAP Overall Equipment Effectiveness Management with SAP MII
KPI management with prebuilt business process execution

Solution highlights

- Single, common framework for all plants
- Enterprise-wide repository of operational data
- Cross-plant performance comparison
- Combined with business context
- Broader business implications of performance loss
- Framework for performance capability and production improvement
Energy monitoring and analytics with SAP MII
Enterprise operations management

Provide **real-time visibility** to energy consumption across the enterprise – **insight to action** – energy, fuel, steam, and water use is optimized in line with production schedules and energy contracts.
SAP Digital Manufacturing Insights
Unlocking the benefits with insights into digital manufacturing
SAP Digital Manufacturing Insights – role-based insights to enable intelligent decisions

- Set up manufacturing KPI governance in line with corporate objectives
- Review and benchmark revenue, cost, delivery performance, quality & customer satisfaction across manufacturing plants
- Expedite decisions
- Monitor and analyze manufacturing performance indicators
- Improve adherence to production schedule through real-time production insights and expedited actions
- Gain continuous improvement of yield/through put, product quality, vendor quality through advanced analytics (predictive, statistical process control …)
- Achieve advanced algorithm-based insights pointing to causes
- Analyze and review prioritized causes and their impact and initiate corrective actions

CXO

Key performance indicators

- Quality
- Cost
- Delivery
- Productivity
- Safety

Manufacturing performance indicators

Plant and unit heads

Manufacturing activity indicators

Supervisors
SAP Distributed Manufacturing
Unlocking the power of additive manufacturing
SAP Distributed Manufacturing
SAP Distributed Manufacturing:
Design collaboration to optimize part design for 3D printing

Design collaboration
- Allows both parties to collaborate on lightweight VDS viewing file (CAD original automatically converted when uploading) – no need to send large CAD originals back and forth
- Possibility to chat based on embedded screen-shots
- Design can be approved, added to part, and converted into STL file

Provides CAD design (converted when uploading into VDS viewing file)
Clarifies his questions on design; manufacturer can provide updated design file
Approves design and converts CAD file into printable STL file (added to collaboration)
Digital manufacturing with SAP – Industry 4.0 meets IoT

**SAP Manufacturing Execution**
- Enforced execution
- Work instructions
- Machine integration
- Data collection
- Track and trace
- “As built” record

**SAP Manufacturing Integration and Intelligence**
- Real-time dashboards
- Manufacturing analytics
- Simplified user interface
- Shop-floor visibility
- OEE
- Energy management

**Quality networks**
- Global batch traceability
  - Genealogy minimizes quality escapes

**Cloud-based offerings**
- SAP Digital Manufacturing Insights
  - Cloud-based performance management

**Quality issue management**
- CAPA-based issue resolution

**SAP Distributed Manufacturing**
- Outsourced collaboration for 3D printing
Thank you!

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