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**

<table>
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<tr>
<th>Productivity improvements</th>
<th>New operational processes</th>
<th>People process optimization</th>
<th>Lower risks, such as reduced warranty cost by (10%) and improved compliance through 100% component and process traceability</th>
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<tr>
<td>such as lower maintenance costs (up to 60%), or lower capital appropriations (25%)</td>
<td>resulting in lower labor cost (30%) with improved OEE (5%–10%) and reduced scrap levels (30%–50%)</td>
<td>leading to 10% to 30% higher productivity in the form of higher outputs and lower costs</td>
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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
Business model, change

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
Information on project

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
Digital world
SAP Leonardo
Physical world

Digital twin

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

$  £  "As designed"
1 0 1 0 0 1 1

$  "As built"
0 1 0 0 1 0 1

$  "As maintained"
1 0 1 0 0 0 1

$  "Performance"
0 1 0 0 0 0 0

Vending machine
DCS/PLC
Auto
Chemicals

Sensors
Navigation
LIMS/Inspection/ equipment testing

Robots
CNCs
Engine
Batteries

Pumps
AGVs
Motors
Transmission

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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

![Diagram showing SAP solutions and integration](image-url)
Digital manufacturing with SAP for industrial IoT

» Business context
» OEE, energy management

» Multiple vendors
» Multiple machines

API SYSTEMOsiSoft
SIEMENS
Festo
BECKHOFF
ABB
Yaskawa
Kawasaki Robotics
Emerson
Schneider Electric
Kepware
Honeywell
Rockwell Automation
Bosch
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)

People

SAP S/4HANA

Enterprise Management – the digital core

–

R&D

Supply chain planning

Manufacturing

Sales

Aftersales service

From processes to networks

New business models

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

SAP Leonardo IoT Foundation

SAP Cloud Platform / SAP HANA platform

Products

Procurement

Supply chain planning

Manufacturing

Logistics

Sales

Aftersales service

R&D

SAP Leonardo IoT

Edge

Applications powered by SAP Leonardo

✔️ Network log. hub

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✔️ Asset intelligence network

SAP Leonardo IoT

Foundation

SAP Cloud Platform / SAP HANA platform

Products

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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

Connect top floor and shop floor

SAP connectivity
Partner connectivity
Customer connectivity
Machine orchestration

Manufacturing engineering
Digital manufacturing insights
Distributed manufacturing

Manufacturing planning
Manufacturing execution
Predictive maintenance
Predictive quality

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SAP for Manufacturing solution portfolio

Innovation strategy

**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

MONITOR

DESIGN

PLAN

RESPOND

PRODUCE

DELIVER

OPERATE

**ERP**
- Production plan
- Bill of materials (BoM)
- Variant management
- Production steps

**SAP MES (SAP Manufacturing Execution and SAP MII)**
- Production details management
- Detailed and flexible
- Production step routing
- Shop-floor controls for each step
- Mapping of ME production details to PLC control parameters (recipe)

**PLC (machine)**
- Sensor detects material carrier
- Requests control parameters from ME

**SAP Connected Manufacturing – architecture**
- Serial numbers
- Quality results per lot
- Order confirmation
- Inventory update, equipment usage
- Log parametric data
- Tolerance checks
- Return “conformance” or “nonconformance” decisions
- Mapping of ME production details to PLC control parameters (recipe)
- Machine reports completion and requests next operation

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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
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/throughput, 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

Key performance indicators
- Quality
- Cost
- Delivery
- Productivity
- Safety

Manufacturing performance indicators

Manufacturing activity indicators
SAP Digital Manufacturing Insights

System landscape

SAP ERP or SAP S/4HANA

SAP HANA (SAP MPM)

SAP Digital Manufacturing Insights

SAP Cloud Platform

Big Data infrastructure

Direct via smart data integration

Flat file integration
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
- SAP Distributed Manufacturing
  - Outsourced collaboration for 3D printing

Quality issue management
- CAPA-based issue resolution

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Thank you!

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