Autonomous Factories 4.0: Industrial Use Cases and the Role of AI

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Innovalia Group

Digital Transformation (DTx)

Digital Innovation Hubs (DIH)

Digital Maturity

HMI

Cybersecurity

Software Quality & Safety

Quality Control Products & Services

Zero Defect Manufacturing Platforms
SOLUTIONS FOR EVERY SECTOR
Products

Systems

Sensors

Software

Accessories
More performance  
Lower cost

Horizontal Arm Systems  
Bridge type Systems  
Gantry Systems  
Portable Systems
Optical sensors

High Speed Scanning

Obtain high accuracy 3D pointclouds of your parts for reverse engineering, virtual metrology and automatic inspection.

OptiScan 1040-L

OptiScan 1015-L / HR
Captures and analyzes point clouds allowing the inspection and measurement of any type of part.
Machine Check
Accessorie

More performance
Lower cost

Use your machine to its full

Higher usability
Higher savings on non-quality
Better adaptation to our machines
Higher measurements accuracy
Accessories

YOU can make it
WE can hold it

Checking fixtures
Positioners
Calibration Tools
Project No: 780732

Duration: 36 months

Start date: January 1st 2018

Partnership: 50 partners, 16 countries

Strategic Objective: ICT-15-2016-2017 (Big Data Lighthouse)

Total Eligible Cost: 18,925,990.00 €

EC Contribution: 14,983,566.26 €

Project Web Site: www.boost40.eu
Autonomous Factory 4.0
Factory 4.0

Europe leads the world’s smartest factories (5 +2 / 9)

**Bayer Pharmaceuticals Division (Garbagnate, Italy):** digital twin-based scheduling programme for quality-control lab.  
**Bosch Automotive (Wuxi, China):** Advanced data analytics are helping the company to “deeply understand and eliminate output losses, simulate and optimise process settings, and predict machine interruptions before they occur.”  
**Haier (Qingdao, China):** ‘Order-to-make’ mass customisation platform and a remote, AI-supported intelligent cloud platform for predictive maintenance.  
**Johnson & Johnson DePuy Synthes (Cork, Ireland):** IoT technology to create digital twins of physical assets for advanced machine insights, lower operating costs, and machine downtime reductions.  

**Phoenix Contact (Bad Pyrmont/Blomberg, Germany):** ‘Customer-driven digital twinning’ has involved creating digital copies of each customer’s specifications, cutting production times by 30 percent.  
**Proctor & Gamble (Rakona, Czech Republic):** The factory has developed a Web-based analytics model for supply chain improvements, speeding up time to market, and increasing inventory efficiency and customer satisfaction.  
**Schneider Electric (Le Vaudreuil, France):** Operators have increased visibility into operations, maintenance, and energy use, leading to energy cost reductions of 10 percent and maintenance cost reductions of 30 percent.  
**Siemens Industrial Automation Products (Chengdu, China):** A new platform for flexible production takes customer orders and immediately allocates resources and schedules production time, leading to 100 percent compliance and 100 percent traceability.  
**Fast Radius/UPS (Chicago, US):** Industrial-grade 3D printing is helping to tackle demand for fast-turnaround times and mass customisation of products, while a centralised, proprietary operating system drives real-time analytics and orchestrates design, production, and global fulfilment.
By 2020, 40% of All Digital Transformation Initiatives, and 100% of All Effective IoT Efforts, Will Be Supported by Cognitive/AI Capabilities.
Factory 4.0 – Impact of Data-driven AI Transformation
A Vision for the Autonomous Factory 4.0

Smart Factory

Digital Factory

Autonomous Factory
The Industry 4.0 digital platform stars are.....
The advantage of being digital, is that we can always play not to be, however being the opposite is completely impossible.  

4.0  

.............. the manufacturing process and the business value
Industry 4.0 Business Value

New business models

- Speed
- Flexibility
- Quality
- Efficiency
- Security
Industry 4.0 manufacturing processes
Adding software to a broken process doesn't make you digital. The biggest challenge is reimagining the process, not writing software.

“...the key to digital transformation is re-envisioning and driving change in how the company operates. That’s a management and people challenge, not just a technology one.”
Factories 4.0 – Industrial manufacturing process evolution

- **Plug & Produce Modular Assembly Cells**
  - Flexible operations
  - Mass customisation

- **Autonomous Transportation & Logistics**
  - Components move
  - Machines move
  - Products move
Factories 4.0 – Industrial manufacturing process evolution

Safe human-robot collaboration

Human-robots-machines come together as needed for mission-oriented tasks

Digital twin – Real factory synchronised operations

Real-time digital and physical actuation

Continuous Production Planning Adaptation for Zero Defect Manufacturing

Human in the loop - Augmented Virtual Decision Support
Factories 4.0 – Industrial manufacturing process evolution

BE in CPPS
Smart Products > Intelligent Processes > Digital Business

- Connected Worker Services
- People
- Services
- Things
- Connected Sensing Gauges
- Cognitive Production Control
- Cybergauge
Factories 4.0 – Industrial manufacturing process evolution

- 75% Reduce time to production decision
- 90% Reduce time to set quality controls
Factories 4.0 – Industrial manufacturing process evolution

Cost

• 185-200 new references per year.
• 500-600 references are in production simultaneously.
• Checking fixture development cost: 5,000 € (simplest) - 25,000-30,000 € (most complex). → Average cost: 12,000 €.
• Checking fixtures have to be available in the production plant during the production life of the part, usually about 4 years.

Time

Measurement process is manual, done by quality engineers and manually-uploaded on PC.

Quality

Until quality ok, production batch not valid.
### Factories 4.0 – Industrial manufacturing process evolution

<table>
<thead>
<tr>
<th>Business Objective</th>
<th>BPI results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost reduction for checking fixtures</td>
<td>25%</td>
</tr>
<tr>
<td>Total Costs reduction</td>
<td>40%</td>
</tr>
<tr>
<td>Measurement time reduction in development phase</td>
<td>90%</td>
</tr>
<tr>
<td>Measurement time reduction in production phase</td>
<td>75%</td>
</tr>
<tr>
<td>Reduced requirement of skilled works on non-value adding operations</td>
<td>50-75%</td>
</tr>
<tr>
<td>Storage and easy access of historical values</td>
<td>90%</td>
</tr>
<tr>
<td>Increase of available shop floor surface (fixtures)</td>
<td>50-75%</td>
</tr>
</tbody>
</table>
Factories 4.0 – Industrial manufacturing process evolution
Factory 4.0 Architecture
Reference Architecture for Manufacturing Industry 4.0 (RAMI 4.0)

Smart production

Smart supply chain

Smart product
From Industry 4.0 towards data-driven AI operations
Industry 4.0 Big Data Transformation
99%

Manufacturing Data Value is Lost
Link between Platforms & Things

It’s all about sharing data!

OPEN CONTEXT DATA
- Traffic
- Weather

FIELD VIEW (FACTORY)
- Actors
- Sensors
- Machines

INTERNATIONAL DATA SPACES ASSOCIATION

VALUE CHAIN
- Production
- Consumer

PLANNING, EXECUTION, CONTROL (MULTI-SIDED PLATFORMS)
- IOT Clouds
- Domain specific platforms
- Marketplaces
- Broker
Industrial Data Space: Data sovereignty for data-driven AI services
Industrial Data Space: Data sovereignty for data-driven AI services
FIWARE for Smart Industry: Building the right industrial context for smart services with OSS.
Industrial Data Space Foundations

- Same Rules
- Certification
- Data Access & Usage Control
Factory 4.0 migration pathways: How do we get there?
Digital Migration Paths for Factories 4.0

**Hyperconnected Factories**
Networked enterprises in complex, dynamic supply chains and value networks

**Autonomous Factories**
Optimised and sustainable manufacturing including advanced human-in-the-loop workspaces

**Collaborative Product-Service Factories**
Data-driven product-service engineering in knowledge intensive factories

**Small-Scale Digital Factories**
Mission-focused digitalisation for SME-driven sustainable manufacturing
Autonomous Factories 4.0
Transformation: Digital Capabilities
Autonomous Factories 4.0
Transformation Pathway

<table>
<thead>
<tr>
<th>Migration path</th>
<th>Digital Platform Capability</th>
<th>Shopfloor Automation Capability</th>
<th>Manufacturing Equipment Capability</th>
<th>Manufacturing Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level II</td>
<td>Monolithic</td>
<td>Line-Based Production</td>
<td>Smart IIoT</td>
<td>Smart Manufacturing/Production</td>
</tr>
<tr>
<td>Level III</td>
<td>Connected</td>
<td>Automated Line</td>
<td>Plug &amp; Produce</td>
<td>One Stage – Semi Autonomous</td>
</tr>
<tr>
<td>Level IV</td>
<td>Distributed</td>
<td>Off-line AI Data Interop</td>
<td>Automatic Awareness</td>
<td>Multi Stage – Semi Autonomous</td>
</tr>
<tr>
<td>Level V</td>
<td>Modular</td>
<td>Analytics Real-time</td>
<td>Safety &amp; Security Machine Learning</td>
<td>Semi-Autonomous Production</td>
</tr>
</tbody>
</table>
Digital Transformation Project Profile

**Investment**
Average digital transformation project investment goes from 50K€ to 100K€.

**Duration**
Over 60% of enterprises consider the optimum Industry 4.0 project duration between 9 and 12 months.

**ROI**
55% of enterprises expect a ROI of Industry 4.0 actions below 2 years.

**Competitiveness**
Productivity improvements 20%.
A Digital Shopfloor Alliance for Factory 4.0 Transformation

Rely on the DSA network of experts, trusted components and service platforms to build a digital shopfloor matching your automation performance.

**DSA profiling**
Engage with your DSA expert, select your digital shopfloor profile and assess the ROI of your digital shopfloor strategy.

**DSA certification**
Customise and apply the DSA "validation & verification" framework to ensure safe operation of your module/ reconfigurable manufacturing cell or collaborative robotic workplace.

**DSA integration**
Find and select a suitable DSA integrator to support you in the safe and secure deployment of your digital shopfloor services.

**DSA-ready products**
Benefit from certified HW components and software solutions and infrastructures to reduce the ramp-up time of your digital shopfloor services.
Low Deployment Cost

Fast Return of Investments

Easy Configuration & Operation

Reliable Solutions

Incremental deployment

Open Systems

Digital Shopfloor Alliance Value Proposition
Autonomous Factory 4.0 Services Framework

Augmented interaction & planning

3 Types of knowledge generation

Edge control, stream perception & actuation

Smart memory
Factory 4.0
Big Data
Pilots
FACTORIES 4.0

10 Lighthouse
Automotive (6)
Machine Tool (2)
White Goods & Appliances (2)

3 Replication
Textile
Ceramics
Elevation / AERO

Lighthouse Factory 4.0
Replication Factory 4.0
High Added Value Products

(Electric) Connected Car
Smart Washing Machine
Smart Connected Shaver
Machine Tool & Automation
Manufacturing Processes 4.0

- Light metal Casting
- Augmented Manual Assembly
- ZDM (Hot) Stamping & Hydro-forming
- Autonomous Assembly Islands
- Predictive Maintenance Service
- Autonomous (Intra) logistics & warehouse
- High-precision Lot-size-1 Machining
- Mass-manufacturing Injection Molding 4.0
- Adaptive Welding
- Spare Part Customer Service Management
High Performance Big Data Algorithms & Platforms

- Hybrid Twin Engineering Analytics
- Real-time Simulation Based Planning
- Data Lake Operational Analytics
- Distributed Production Scheduling
- Rule-based Fault Detection & Prediction
- Edge-powered Engineering Analytics
- Hybrid Predictive Production Planning
- IoT Stream Operational Analytics
- 3D Industrial Lake Visual Production Analytics
- In-memory Demand Forecasting
AI for Autonomous Zero Defect Manufacturing
One Day at the M3 Digital Factory
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One Day at the M3 Digital Factory

Thomas
Product Designer

TIME SAVING
ERROR MINIMIZATION
TRACEABILITY
One Day at the M3 Digital Factory

Model Based Design

QIF
STEP 242

... CATIA
One Day at the M3 Digital Factory

Mats
Industrialization Prototypes

HIGH DEFINITION
FAST FLEXIBILITY
One Day at the M3 Digital Factory

Part 034834-20180614
One Day at the M3 Digital Factory

Irina
CNC Production

IN-PROCESS INTEGRATION PROGRAMABLE
One Day at the M3 Digital Factory

MH Check

Irina

CNC Production
One Day at the M3 Digital Factory

In-machine metrology

Part 034844-20180622
One Day at the M3 Digital Factory
One Day at the M3 Digital Factory

Leo y Lily

Quality Control

DATA QUALITY
CERTIFICATION
PRODUCTIVITY
One Day at the M3 Digital Factory

Optiscan + Touch
PTB-NIST Certification
Multi-CAD/Multi-alignment
Off-line programming
Virtual Metrology
GD&T
Simulation
QIF – DMIS
Reporting flexibility
Automation

Program ISC-20180614
One Day at the M3 Digital Factory

Amelia y Harry
Process Engineers

RELIABILITY
TIME SAVING
SERVICE
One Day at the M3 Digital Factory

Fixture Tech
One Day at the M3 Digital Factory

Olivia
Production Engineer

PROCESS
VISIBILITY
EASY TO USE
DECISION
SUPPORT
One Day at the M3 Digital Factory

Olivia
Production Engineer
One Day at the M3 Digital Factory

Carlos
Maintenance

BIG DATA
REAL TIME
CONNECTIVITY
One Day at the M3 Digital Factory

Elisabeth

Production

Maintenance

Carlos

Monitoring

Carlo

Maintenance
One Day at the M3 Digital Factory

Alice
Product Manager
One Day at the M3 Digital Factory
One Day at the M3 Digital Factory

Enterprise

Model Based Design
Assisted Reality & Engineering Services
Analytics
Workspace
Business Management Services

Plant Network: Wireless or Wired Ethernet

Factory

Digital Twin Planning Services
iPlanning
iProgramming
Analytics
Simulation Services

Workcell Network: Deterministic Ethernet, ROS, IDS / Orion Context Broker

Workcell / Production Line

GFX
Software
Context Perception & Model Building Services
Data Assembler
Box
Control & MES Services

Vision Interface (30 Hz), IIoT Interface
Real-Time Control Interface (125-1000 Hz)

Field Device Network (Time Sensitive Network): Real-Time Ethernet, Digital IOs, Camera Link, P&P

Field Devices & Product

Fog / Cloud

Big Data & High Performance Computing Infrastructure
One Day at the M3 Digital Factory

Thomas  
Leo  
Lily  
Olivia  
Carlos  
Amelia  
Harry  
Alice
The advantage of being intelligent, is that we can always play stupid, however being the opposite is completely impossible.
The advantage of being digital, is that we can always play not to be, however being the opposite is completely impossible.
Thanks!

Any questions?

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