Driving the digital enterprise with digital twins
Achieving the next frontier of speed, quality and agility
Dr. Pieter Dejonghe | November 21st 2018
“We are on the verge of transforming one of society’s most fundamental build blocks: manufacturing.”

Peter Diamandis, founder and chairman of the X Prize Foundation
Cofounder and executive chairman of Singularity University
Initiatives
We’re all saying essentially the same thing

- The Prime Minister’s Industry 4.0 Taskforce
- Made in China 2025
- Plattform Industrie 4.0
- Industrial Internet Consortium
- Made Smarter Review
- Smart Nation
- Alliance Industrie du Futur
- Robot Revolution Initiative
- Piano Industria 4.0
The top 5% of companies are dominating the economy by exploiting digital competencies.

Data is from 24 OECD countries.

The Best Versus the Rest: The Global Productivity Slowdown, Divergence Across Firms And The Role of Public Policy, OECD Productivity Working Papers
The Digital Factory transforms business models

<table>
<thead>
<tr>
<th>KUKA SYSTEMS do BRASIL</th>
<th>SIEMENS AMBERG</th>
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<tbody>
<tr>
<td>GREATER competitiveness and improved margins</td>
<td>IMPROVED CYCLE-TIME PRODUCTIVITY</td>
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<td>98% READINESS DONE VIRTUALLY</td>
<td>FLEXIBLE production</td>
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<td>&gt;1200 product variants configured-to-order and shipped within 24 hours</td>
<td>1 PART PRODUCED EVERY SECOND</td>
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<td>QUALITY LESS THAN 11 DPM (99.9989%)</td>
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<th>FIREWIRE</th>
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<td>IMPROVED SUSTAINABILITY</td>
<td>DATA-DRIVEN continuous improvement</td>
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<tr>
<td>FASTER PRODUCTION</td>
<td>REDUCED RISK</td>
</tr>
<tr>
<td>INDIVIDUAL -IZED product performance</td>
<td>FASTER TIME-TO-MARKET</td>
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Digitalize manufacturing. Democratize innovation.

Achieving the next frontier with configurable, flexible and personalized production.
The barriers to next frontier manufacturing

Virtual

- Fragmented digital infrastructure

Supply Chain
- Software
- Machine OEMs
- Materials
- Start-ups

Manufacturing Engineering
- Planning
- Process Definition

Production
- IT
- Automation
- Production Systems

Service

Real

- Change in mindset
- Ineffective closed loop
- Coupled logistics and production
- Single-purpose, inflexible, linear process
What if....

Customer Desire ↔ Design and Engineering ↔ Manufacturing Engineering ↔ Production ↔ Service

INTEGRATED digital infrastructure

EFFECTIVE closed loop

DIGITAL oriented mindset

FLEXIBLE logistics and production

MODULAR configurable production

Planning ↔ Process Definition
MANUFACTURING ENGINEERING
Engineering ↔ IT

Software ↔ Machine OEMs

SUPPLY CHAIN
Materials ↔ Start-ups

IT ↔ Automation
Production Systems

LOGISTICS

Start-up line

Single purpose, inflexible, linear process
Ineffective closed loop
Change in mindset
Coupled logistics and production
Fragmented digital infrastructure

EFFECTIVE closed loop

DIGITAL oriented mindset

FLEXIBLE logistics and production

MODULAR configurable production
Realize the full value of digitalization

Digital Twin Product

Digital Twin Production

Digital Twin Performance

Virtual product

Virtual production

Real product

Insights from performance

Continuous improvement

Verification

Validation

Commissioning

Specification

Ideal delivery

Real production

Automation

Collaboration Platform
Digitalize manufacturing to unify virtual and real production
Digitalize manufacturing to unify virtual and real production

The Digital Factory

Physics-based modeling and simulation
AI and Machine Learning
VR/AR
Additive Manufacturing
Mapping / Navigation
IloT and sensors
3D Laser Scanning
Advanced robotics
It’s time to rethink manufacturing.
Inventing new application fields with robots on demand

Integrate the digital twin and physical automation to mobilize robots equipped for performing precision jobs at any scale.

Mobile CNC robotic machining technology in aerospace manufacturing

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM
Department of Automation and Production Technology | Dr. Dirk Niermann
Technology Center CFK NORD | Stade - Germany
Inventing new application fields with robots on demand

Integrate the digital twin and physical automation to mobilize robots equipped for performing precision jobs at any scale.

SINUMERIK 840D sl

Digital Twin of SIMATIC S7-1500
Inventing new application fields with robots on demand

Integrate the digital twin and physical automation to mobilize robots equipped for performing precision jobs at any scale.
Transforming assembly quality and throughput

Integrate advanced robotics, sensors, programming and production system simulation to automate complex smart product assembly.
Transforming assembly quality and throughput

Integrate advanced robotics, sensors, programming and production system simulation to automate complex smart product assembly.
Additive Manufacturing is driving Innovation: Incremental progress isn’t competitive enough

**Status Quo**

- Shift from conventional design to innovative DFAM

**Product Transformation**

- Reimagine products
  - Reduce weight, material
  - Scan-to-product
  - Expand performance
  - Accelerate innovation cycles

- Reinvent manufacturing
  - Eliminate molding/castings/tooling
  - Eliminate/simplify assembly process
  - Reduce supply chains
  - Affordable low volume production

**Rethink Business**

- Individualization, personalization
- Zero inventory – on demand printing
- Design anywhere, Print anywhere.
- Increase competitiveness

**Manufacturing Transformation**

Shift from prototyping / experimentation to mainstream industrial production
Barriers to industrializing additive manufacturing

- Design software
- Simulation Software
- Print Preparation Software

- End-use part
- Finishing / Inspection
- Heat Treatment
- AM Process

- Conventional thinking
- Disconnected process chain
- Multiple file conversions
- Uncontrolled workflow
Reimagining design, production and service for greater business value

Connecting a digital thread across the complete product lifecycle

- 15% reduction in weight
- Equal or greater strength
- Less material waste
- On-demand availability

Post processing and inspection
Slicing, hatching printing
Prepare for printing

Validate Inc. process simulation
Adapt design Convergent Modeling™
Reinvent Manufacturing
Major 3D printing technologies supported in one system

Hybrid additive
Directed energy deposition

Multi-axis
Fused deposition modeling

Powder bed fusion
Laser material fusion

Productivity Simulation
HP Multi Jet Fusion

Multi jet fusion
Agent jetting/inkjet technology
Siemens PG Finspång: Reimagining designs for greater performance

Conventionally manufactured burner

- 13 machined parts, joined by 18 welds
- Thermal Barrier Coating (TBC) on front surface
- External pilot gas feed
- Standard lead time 26 weeks (excl. TBC)
- Weight: 4.5 kg

Additive manufacturing adapted burner

- 1 single part
- Pilot gas feed integrated in structure
- Optimized cooling, possible to remove TBC
- Standard lead time 3 weeks (excl. TBC)
- Weight: 3.5 kg
Accelerating introduction of next gen production concepts

Integrate mechanical and electrical design to generate PLC code automatically - and integrate automation hardware for the design and virtual commissioning of production systems.
Breaking through the screen barrier in production planning

Bring virtual simulation closer to reality with immersive and interactive VR experiences for work training.
Introducing AR in manufacturing operations for improved worker guidance and quality inspection

Overlay virtual and real data for augmented EWI and real-time 3D views of as-design and as-build products.
Gaining global visibility into production data and insights via manufacturing intelligence technologies on MindSphere

Impact production KPIs with actionable insights gained from analyses of real time global operation data.
Combining Digital Twins and IIoT to optimize logistic flows

Using an up-to-date digital twin of production to re-plan optimal solutions to incidents through multivariate simulations.

Model-based performance analytics
Realize the full value of digitalization

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