Production of the Future
Festo and Industry 4.0 – Next Level of Automation
Why?  When?  What?  How?

Quo Vadis Industry 4.0?

- Where we are now?
- What are the important technologies to be there?
- Results?

Beyond Industry 4.0?
Festo and Industry 4.0 – Next Level of Automation

Introduction Festo

The Industry 4.0 platform
- Overview
- Working results

Festo activities
- Interpretation of key features of Industry 4.0
- Research projects

Summary
Festo facts

• Turnover (Group): EUR 2.3 billion (2013)
• 16,700 employees in 176 countries
• Over 30,000 catalogue products
• Factory and process automation
• 2,900 patents world-wide
• R&D budget: more than 7% of sales
Innovation excellence

- Sustainable innovation management
- Over 20 Technology Engineering Centres world-wide
- Around 100 new products every year

Skilled enhancement of electromagnetic compatibility
Innovation down to the last detail
Pure innovation: virtual reality
Products for key industries

<table>
<thead>
<tr>
<th>Sector</th>
<th>Image</th>
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<tbody>
<tr>
<td>Automotive</td>
<td><img src="image_url1" alt="Automotive Image" /></td>
</tr>
<tr>
<td>Food &amp; Beverage</td>
<td><img src="image_url2" alt="Food &amp; Beverage Image" /></td>
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<tr>
<td>Electronic &amp; Light Assembly</td>
<td><img src="image_url3" alt="Electronic &amp; Light Assembly Image" /></td>
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<tr>
<td>Bio &amp; Pharma</td>
<td><img src="image_url4" alt="Bio &amp; Pharma Image" /></td>
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<tr>
<td>Water &amp; Waste Water</td>
<td><img src="image_url5" alt="Water &amp; Waste Water Image" /></td>
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Industry 1.0 - 4.0

1.0 Mechanical Production
Water-/steam power
End of 18th century

2.0 Mass production by divisioning of labour
Electric power
Beginning 20th century

3.0 More and more digitalised automation
Electronics / IT
Nineteen-seventies

4.0 Integrated automation
Cyber-physical systems
21st century

Source:
The vision of Industry 4.0 as part of a networked, intelligent world

• Industry 4.0 focuses on the production of **intelligent products**, **methods and processes**

• Cyber-physical systems enable the **intelligent factory**

• **Intelligent products** actively support the production process

• At its interfaces, the factory becomes part of an **intelligent infrastructure**

• Production is adapted to the **human rhythm**
Changing production over to Industry 4.0 will involve a long-term transition.

Yesterday
- Local automation technology

Today
- Communication-supported automation

Tomorrow
- Optimisation of entire product development and production processes using innovative software systems

The day after
- Self-optimisation of “Cyber Physical Systems” based on virtual models

Benefits remain to be proved

Source: Siemens Industry, Detlef Pauly
Structure of Industry 4.0 Platform

- **Steering Committee (SC)**
  - Member companies
  - Representatives of the 3 professional associations
  - SAC spokesperson
  - Guests: working group leaders

- **Scientific Advisory Committee (SAC)**
  - Professors from the relevant technical disciplines

- **Governing Board (GB)**
  - Board members from Steering Committee’s member companies

- **Secretariat (Sec.)**
  - Run jointly by BITKOM, VDMA and ZVEI

- **Community of experts**
  - Sends representatives to WG 1, WG 2, ..., WG n

- **Industrie 4.0 Platform**
  - Provides input on Platform’s strategy
  - Manages the platform in coordination with WG leaders
  - Supports and informs the community of experts
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SOA as seen by an Industry 4.0 Component

- Protected core, service offerings at the SOA interface based on standards

![Diagram showing SOA interface with nodes for Application A, Internet, Machine B, Service C, Sensors, Control Subsystem(s), Internal Communication, Internal Control(s), and Actuators. SOA interface is described as issues and accepts defined own service offerings.](\festo-draft-diagram.png)
Global manufacturing ICT convergence

- Industry 4.0: Convergence of Internet of service and Internet of things
Service oriented architecture – example for the internal structure

- Application A
- Internet
- Machine B

- SOA interface
  - Offers and accepts own defined ranges of services

- Service C

- RFID, QR ..
- Workpieces

- SPS + Remote IOs

- Remote IOs with int. PLC

- Integrated components/modules, (CPS)
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Summary
The challenges of the “Production of the future” have led to Industry 4.0

- Fast pace of technological change
- Customised solutions
- Innovative technologies
- Wide diversity of customers and markets
- Permanent pressure on costs
- Globalisation
- Increasing importance of product availability and prompt delivery
- Rising energy costs and environmental awareness
- Networking, flexibility and adaptability in production
  ➞ Autonomous, self-learning and knowledge-based systems
The factory of the future: a learning and adaptive production system

Understanding of the environment and requirements of a factory as a whole

Understanding of processes in the various sectors

Understanding of suitable automation systems, functions and solutions
Future production trends

Result of: MindCloud-Trends.pptx; Expertenansichten.pptx
Future production trends

Product trends
- Individualization
  - Individual products
  - Personalization
- Short product cycles
- ECO-Friendly
  - Natural materials
  - Customer demand for low environmental impact
- New materials and technologies
- Social Media

Production trends
- Customization
- Sustainability
- Digitalization & Networks
- Social Aspects

Result of: MindCloud-Trends.pptx; Expertenansichten.pptx
Smart Components for the Internet of Things

Integration of local “intelligence” and communication capabilities

Internet of Things
+ IP - capabilities

Cyber Physical Systems
+ internet communication
+ machine to machine Communication
  • wireless communication
  • semantic description

Embedded Systems
+ sensors, actuators
+ integrated intelligence

Physical Objects, Devices

Source: Forschungsunion Wirtschaft – Wissenschaft
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Summary
Smart Pneumatics in Industrial Applications

Learning Factory (Modular Production System)
- Modular, flexible manufacturing system
- Demonstration product: High-variant pick & place/assembly line
- High adaptivity
- Each module has its own controller "distributed intelligence"
- Superior "digital factory" system
- Complete realisation possible with in-house control technology!
AutoPnP – plug and play for automation systems

Within the project, software architectures are developed which
• allow scalability
• and modularity

This in turn allows adaptive production lines

Demonstrator “Convertible factory”
OPAK – open engineering platform for mechatronic components

- Functional planning by process planner
- Automatic translation into architecture and controller code
- Data processing and controller code on autonomous component
- Convergence to form complete control system
- Plug and Produce
Bionics can teach production technologies of the future

Festo is doing research to identify future production trends

→ for example:
Projects of Bionic Learning Network and Future Concepts
**Inspired by nature – The Bionic Learning Network**

The Bionic Learning Network is a cooperation between Festo and renowned universities, institutes and development companies with the goal to transfer nature’s strategy of efficiency to automation technology.

- Interdisciplinary core team
- Specialists from internal departments
- External development partners
- Universities and institutes
- Students and trainees
- Private inventors
Bionic Learning Network – Open Innovation

• **Creating networks** and discerning trends in research and development

• **Motivating people** to develop their ideas together with Festo

• Initiating **dialogue with customers** and partners

• Analysing customer **feedback** on innovative topics at trade fairs

• **Expediting product pre-development**

We want to provide impetus and initiate innovations.
# Production of the future – self-adapting and efficient

<table>
<thead>
<tr>
<th>Self-adapting components</th>
<th>Factory of the future</th>
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| ![Image](self-adapting-components.png) | - Individualised products  
- Small batch quantities  
→ Adaptability |

<table>
<thead>
<tr>
<th>Self-organization</th>
<th>Reduced complexity</th>
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<td><img src="self-organization.png" alt="Image" /></td>
<td><img src="reduced-complexity.png" alt="Image" /></td>
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<th>Communication</th>
<th>Learning</th>
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<td><img src="learning.png" alt="Image" /></td>
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</table>

→ Survival of the fittest  
- Adapt to changing environment  
- Be resource-efficient  

<table>
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<tr>
<th>Energy efficiency</th>
<th>Nature</th>
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<td><img src="energy-efficiency.png" alt="Image" /></td>
<td><img src="nature.png" alt="Image" /></td>
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Tomorrow’s production inspired by nature

Nature has perfectly adapted to its surroundings throughout millions of years of evolution.

- Energy efficiency
- Lightweight design
- Functional integration
- Communication and learning
Lightweight design

A bird can only fly since it is very lightweight.

If the moved mass is reduced, this directly decreases the energy consumption.

This is shown impressively by the SmartBird.

Lightweight design in automation applications will reduce materials and energy consumption.
Function integration
The dragonfly flies like a plane, helicopter or glider due to the fact that each wing is moved separately.
It can alter the angle of attack, the amplitude and the frequency of each wing separately.

New approaches in automation:
- More and more functions will get integrated into the smallest space
- Components will become smarter and more flexible
- Very high level of complexity under control by intuitive user interfaces
Human-machine interaction

Inspired by the elephant trunk, the Bionic Handling Assistant directly interacts with humans.

ExoHand demonstrates human-machine interaction by using haptic force feedback.

Human-machine interaction of the future will be safe.
Self-organization

Collective behavior and swarm intelligence are surviving strategies in nature.

With WaveHandling, intelligent components are self-organizing as soon as they are put together.

Intelligent components and self-organization will directly decrease setup times in the production of tomorrow.
Industry 4.0 - the Festo view

Real world and virtual reality continue to merge

A holistic, interdisciplinary approach

Technology
- Intelligent components
- Modularity
- Networked systems
- Innovative solutions for functional integration and microsystems

People
- Human-machine interaction
- Adaptive and intelligent technology
- Simple, intuitive operation

Qualification
- Training the new generation of workers
- Employee qualification
- Learning systems by Festo Didactic
### Summary: Opportunities presented by Industry 4.0 discussions

Industry 4.0 approaches are being implemented in practice in all cases where networking will lead to better control, organisation, efficiency etc. and a clear customer benefit can be identified.

<table>
<thead>
<tr>
<th>Action area</th>
<th>Customer benefit</th>
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<tbody>
<tr>
<td>Production</td>
<td>→ Economic, flexible, convertible production</td>
</tr>
<tr>
<td>Engineering Process</td>
<td>→ Fast commissioning of machines/installations</td>
</tr>
<tr>
<td>Energy management</td>
<td>→ Increasing resource efficiency</td>
</tr>
<tr>
<td>Logistical processes</td>
<td>→ More efficient control of procedures</td>
</tr>
<tr>
<td>Quality management</td>
<td>→ Analyses of causes of faults</td>
</tr>
<tr>
<td>Predictive Maintenance</td>
<td>→ Increasing machine availability</td>
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<td>...</td>
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</table>

→ The implementation of the **vision of Industry 4.0** is an **evolutionary process** which will progress at **different speeds** in factories and certain segments of industry.
Thank You for Your attention!