Industry 4.0 – a new paradigm in German manufacturing

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Fraunhofer IOSB-overview

CEOs:
Prof. Dr.-Ing. Jürgen Beyerer
Prof. Dr. Maurus Tacke

Core competencies:
Optronics
System technology
Vision technology

Business units:
Automation
Energy, water, environment
Automated Visual Inspection
Defence
Security

Key figures:
Budget 2012 41 Mio. €
Total staff 405
Scientists and engineers 267
Students 130

Cooperation with:
KIT Faculty for computer science, Institute for anthropomatics, Chair for interactive realtime systems
Realtime IT for complex manufacturing processes
Service offering of the Business Unit “Automation”

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<th>Production monitoring and MES</th>
<th>MES-level</th>
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<td>Adaptive information technology</td>
<td>Vertical integration</td>
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<td>Process and condition monitoring</td>
<td>Life cycle</td>
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<td>Field device-level</td>
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Qualification and training for experts and executives

**Image Description:***
- **MES-level**
- **Vertical integration**
- **Life cycle**
- **Information model**
- **Horizontal integration**
- **Field device-level**
1. Starting point for our work in information technology: monitoring & control system for Daimler in press, body, paint, trim shop

The integrated monitoring & reporting system for Daimler consists of:
- ProVis.Agent® for monitoring & control,
- ProVis.Visu® for real-time visualization,
- ProVis.Paula® for web based reporting.

In the Bremen plant ProVis.Agent monitors app. 450 PLCs of app. 2.000 machines/facilities in body, paint and trim shop.

In the Woeth plant (commercial vehicles) we have delivered ProVis.Agent incl. online body tracking, central shift calender, integration of EMOS (Durr-monitoring system, paint shop).

The web based reporting system for manufacturing and machine data based on content management system WebGenesis®, data amount Daimler Bremen:
1 TByte raw data/35d, 2.000 facilities, app. 1.600 users.
2. What does “Industry 4.0” mean?

1st industrial revolution: mechanisation of the textile industry
- end of 18th century

2nd industrial revolution: assembly line, era of mass production
- 20th century

3rd industrial revolution: numerical/programmable controllers, automation
- 1970ies

4th industrial revolution: based on cyber physical systems
- today

Sources:
- Getty Images
- Fraunhofer IOSB, BU Automation, 2012
2. Industry 4.0 and the future factory

Functions (examples):
- communication, negotiation
- interpretation, configuration
- visualization, simulation
- capacity balancing
- APP-store for MES-functions

CPS 'manufacturing cloud'

- Specifications, delivery dates, amounts
- Delivery dates
- Product specification, geometry, kinematics, BOM, work plan
- Product specifications, work plans, BOM, orders, deadlines, Material availability, long term capacities
- Material, capacities, delivery dates, amounts
- Manufacturing equipment and self description, geometry, kinematics, logic
- Machine and equipment suppliers
3.1 Aspects of Industry 4.0: Interoperability in information technology for manufacturing

- software embedded in field devices, which are connected by the field bus, e.g. in sensors, actuators, drives, valves, etc.;

- the control software of machinery and equipment, e.g. programmable logic controllers (PLCs);

- the software managing the equipment, e.g. SCADA, manufacturing execution systems – MES, etc.

GOAL: standard interface (USB-mechanisms) for the factory
New facility identified!
3.1 Required components for plug-and-work methodology

MES 1
MES 2
MES m

Plug-and-produce middleware

MES 1
MES 2
MES m

Encoder
Decoder

Facility 1
Facility 2
Facility n

Digital factory

Encoder

Presentation © Fraunhofer IOSB, BU Automation, 2012
3.1 Developed and patented methodology

Producer or MES-supplier

MES-systems

Decoder: allows specific access/navigation to the data model

Plug-and-work middleware: XML-based Data model (here CAEX) as global name space of an OPC-UA-server

Plug-and-work middleware: XML-based Data model (here CAEX) as global name space of an OPC-UA-server

Machine supplier

Encoder ("driver"): interprets incoming data to CAEX-data model

Self description of a single facility/machine

various description formats

Data from Digital factory

Material flow data, layouts, shift model, etc.
3.1 Example for plug-and-work benefits

Potential for savings at MES-/Monitoring-systems or HMI; example ProVis.Agent®

Assumptions:

Invest monitoring system: 500,000 €

Monitored PLCs per system: 250
Efforts per PLC for Image-, IO- and facility engineering: 2-5 days

=> Total engineering efforts: app. 500 days
Cost per day engineering: 500 €

Total cost engineering: 250,000 €

Potential for savings by plug-and-work: app. 80% 200,000 €
3.1 Example for plug-and-work effects

Example of a demonstrator:
- TS1: test station
- DT1: turn table
- TB1: transport belt 1
- TB2: transport belt 2
+ various variables and values

completely! generated from self description of facilities including topology information from layout planning

Next step:
- test with real facility at Daimler Woerth
3.2 Aspects of Industry 4.0: Gesture interaction

- Technology: gesture recognition and man-machine-interaction instead of keyboard, mouse, touch-screen
- Multi-user/multi display interaction
- Benefits: time saving, for gestures can be recognized directly on the object, e.g. quality inspection
3.3 Aspects of Industry 4.0: machine builders of the future

Development of machine sales in Germany and China
(Source: VDMA: Maschinenbau in Zahl und Bild 2012)

<table>
<thead>
<tr>
<th>Year</th>
<th>Germany</th>
<th>China</th>
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<tbody>
<tr>
<td>2003</td>
<td>154</td>
<td>77</td>
</tr>
<tr>
<td>2007</td>
<td>215</td>
<td>209</td>
</tr>
<tr>
<td>2011</td>
<td>221</td>
<td>563</td>
</tr>
</tbody>
</table>

Examples for product services for today's customers
(Source: Fraunhofer ISI, Modernisierung der Produktion: Nutzen statt Produkte kaufen)

- **Availability guaranty**
  - Currently in use: 12%, Pilot project: 4%
- **Optimization contracts during operation**
  - Currently in use: 7%, Pilot project: 2%
- **Pay-on-production**
  - Currently in use: 3%, Pilot project: 1%
- **LCC guaranty**
  - Currently in use: 3%, Pilot project: 1%
3.3 Aspects of Industry 4.0: machine builders of the future

Average share of components/competencies in today’s machines
(Source: VDMA – Forum IT@Automation)

13% of machine builders: „Products consist less than 50% of hardware“
3.4 Aspects of Industry 4.0: machine builders of the future

- IT-based services lead to new business models
- For machine builders also software will become a product
4 Conclusions

- Internet and mobile devices from the office are also used on the shop floor
  - iPads, smart phones, Ethernet factory wide;
  - Security and availability are required

- Degree of software in conventional mechanical products increase
  - Organizational structure and process organization will change towards
    software development, tests, etc.; opportunities for new business models

- The separate disciplines industrial engineering, automation and IT merge
  - Increasing demands concerning interdisciplinary cooperation;
    new degree programs, lifelong qualification, new ways of cooperation

- Supplier structure / different software vendors do not support integrated use of IT
  - Interoperability and standards are overdue

- Risk of data-, information- and functional ‘overkill’
  - Assistant functions, role based access, new GUls, semantic search, etc., required

- ‘Automation of automation’
  - Configuration and parameterization instead of programming
Testing platform – Industrial IT Lab

• R&D-platform „IT-based automation“
• All IT-processes from the sensor up to the control room
• Multi-vendor equipment

Supported by:
For further information please join us:

19. and 20. September 2012