The role of industry 4.0 – Towards turnkey manufacturing solutions

Prof. Jürgen Fleischer, KIT
Prof. Bin SHEN, Tongji University
Prof. Weimin ZHANG, Tongji University
Agenda

1. Industry 4.0 - Introduction
   
2. Industry 4.0 @ AMTC - Demonstration line
   2.1 Presentation of the demonstration line
   2.2 Material flow and information flow
   2.3 Workpiece carrier and automation
   2.4 Smart assembly and quality assurance

3. Next steps: Set up of a Sino-German cooperation platform
Industry 4.0 – Introduction
Production today

Serial flow line manufacturing

Agile manufacturing system

Flexible manufacturing system

Productivity

Flexibility
Industry 4.0 – Introduction

Vision

Serial flow line manufacturing

Agile manufacturing system

Flexible manufacturing system

Industry 4.0

Industry 4.0 – High flexibility combined with high productivity

Productivity

Flexibility

1 2 3 4

1a 2a 3a 4a

1b 2b 3b 4b
Industry 4.0 – Introduction

Challenges

- Low setup time
- Low storage
- Direct link between manufacturing and assembly
- Reduction of waste through integrated QA

Flexible manufacturing system

1. 
2. 
3. 
4.
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Introduction
Presentation of the demonstration line

Goal:
- Demonstration line for the production for batch size 1+ with i4.0 technologies

Actual production

New production with with i4.0 technologies

Pictures: Stricker N. wbk 2013
Introduction
Presentation of the demonstration line

Goal:
- Demonstration line for the production for batch size 1+ with i4.0 technologies

Expected results:
- Autonomous manufacturing with real time control
- Accelerated troubleshooting during production processes
- Networking of machines with OPC UA
- Smart automation of machines, operations and handling equipment
- Data collection during manufacturing to improve the global process
- Highly reduced inventory in the production

Demonstration product:
Bosch-Rexroth hydraulic valve
Introduction
Presentation of the demonstration line

Approach:
Valve spool
Valve block
Additional parts

Workpiece carrier
Clamped valve block
Valve spool
Additional parts

Zero point clamping

Conveyor

Logistic
Cloud
Control

Information and material flow are transported on the workpiece carrier
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Material Flow

Step ① - Workpiece carrier:
- Loading of the valve parts at the Supermarket
- Identification through RFID
- Clamping of the valve block
- Transport of valve spool

Step ② - Transportation system TS2
- Registration via RFID
- System status via OPC-UA
- Docking of transport vehicle

Step ③ - Transportation system vehicle
- Hand driven vehicle
- Docking into reference position @Baoji and @TS2 via zero-point-clamping

Step ④ - Baoji
- Docking of transport vehicle
- Workpiece (spool) handling via robot
- Registration via RFID
- Machining status via OPC-UA

Step ⑤ - DMU
- Clamping of workpiece carrier via Zero-Point Clamping
- Loading by hand
- Registration via RFID
- Machining status via OPC-UA

Step ⑥ - Assembly
- Registration via RFID
- Assembly status via OPC-UA
Information Flow

Active Cockpit
- PC with OPC-UA Client

LAN

Workbench
- IndraControl L45 with OPC-UA Server

DMG DMU 65
- Integrated OPC-UA Server

Baoji lathe
- IndraMotion with OPC-UA Server
- XM21 with OPC-UA Server

TS2
- XM21 with OPC-UA Server

Schunk LWA Robot
- Robot Control Unit

Concept highlight: unified communication via OPC-UA
Concept – Services

Server:
- Each machine or station is equipped with its own OPC UA Server
- The OPC UA server provides live information about the station available
- The OPC UA server provides methods that allow control of the station

Client:
- Counterpart to the server is an OPC UA client
- The OPC UA client is on a computer in the local Ethernet network, it can access the information from the stations and control the production process
- The OPC UA client is live information to the Active Cockpit further, for the visualization and monitoring of the production process
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Workpiece carrier
Function Structure

Clamped valve block
Valve spool
Additional parts

Zero point clamping

Data transfer from the reader (client) to server

OPC-UA
RFID Reader
RFID
Transport palette
Transport vehicle
Milling table

ABB Robot
Robot Module
Automated Handling
Assembly Center
Additional Parts
All additional parts are easily accessible

Valve Spool

BAOJI lathe chuck
The Schunk robot is able to pick up the Valve spool

Valve Block
DMU milling machine
Valve block positioned and clamped on workpiece carrier

Zero Point Clamping
Positionning for transport or clamping for milling
Work piece carrier concept

- Additional parts
- Clamped & positioned valve block
- Alignment pin
- RFID
- Robot gripping system Vero S
- Opening cylinder
- Lubricant-proof case
- Zero-point clamping system
- Valve spool
**Work piece carrier**

**Transport on TS2**

1. Entrance Point for new WPC onto TS2 Conveyor Belt
2. Loading/Unloading of WPC from WT2
3. Unloading of WPC onto Assembly Workbench
4. Assembly Workbench
5. Supermarket/WPC Mounting station

Legend:
- WPC – Workpiece Carrier
- Exit/Entrance for WPC on TS2
- Cross Transfer Section
Automation Concept for BAOJI

Automation of Baoji with the robot LWA 4D from Schunk

Automation steps:
- Docking of the vehicle
- Opening of the valve spool compartment
- Handling of the valve spool from WPC to Baoji chuck
- (Turning)
- Handling of the valve spool from Baoji chuck to WPC
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Smart assembly
Smart assembly

- The valve variant (block, spool, additional parts) are entered on a tablet or detected via RFID
- Possibility of virtual training for employees to practice the assembly sequences
- The next assembly step is displayed as soon as the camera mounted above the workbench determines that the assembly step has been successfully completed
- Pick by light: the PLC activates the LEDs in the Workbench for the next step
- Nexo intelligent tightening guns are used to tighten the screws, allowing control of tightening torque and wireless communication
- The assembly is monitored at the Active Cockpit. Following Data are to displayed:
  - times per workpiece and per operation,
  - torque figures,
  - warnings and errors,
  - digital stock overview
Quality assurance

The entire workpiece carrier is set on the coordinate measuring machine.

Following tolerances are tested:
- diameter of each section of the valve spool
- the size of the different boring diameters of valve block
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Next steps: Set up of a Sino-German cooperation platform

Customized production solutions with high OEE
Thank you for your attention

Prof. Dr.-Ing. Jürgen FLEISCHER
wbk Institute of Production Science
Kaiserstr. 12, 76131 Karlsruhe
Tel.: +49 721 608 44011
Juergen.Fleischer@kit.edu
www.wbk.kit.edu

Prof. Dr.-Ing. Bin SHEN
AMTC
Cao An Gong Lu 4800, Jiren Lou,
Room 217, 201804 Shanghai
Tel.: +86 21 6958 8715
bshen@tongji.edu.cn

Prof. Dr.-Ing Weimin ZHANG
AMTC
Cao An Gong Lu 4800, Jiren Lou,
Room 218 201804 Shanghai
Tel.: +86 21 6958 8981
iamt@tongji.edu.cn