Industry 4.0 - Digitalization trends

Smart-Factory Solution
WITTMANN 4.0 in Injection Molding

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Industry 4.0

History and Industry developments
Industrial Revolutions

History and Industry developments

» **1st Industrial Revolution**  
  around year 1800  
  improved production processes by using water power, steam power and machine tools

» **2nd Industrial Revolution**  
  around year 1900  
  installation of production lines, change to mass-production

» **3rd Industrial Revolution**  
  1970 - 2010  
  digital revolution, change from mechanic to electronic and digital technology  
  computer systems, PLC, automation

» **4th Industrial Revolution**  
  now and future  
  networking, interoperability of machines sensors, devices and people  
  information transparency, technical assistant and support systems,  
  cyber physical systems, decentralized decisions, virtual production simulation
Industry 4.0

Expectations
Expectations in Injection Molding

Smart Factory
full connected planning in manufacturing and machines, flexible and optimized production slots and production quantity

Cyber-physical system
real time knowledge about each detail in the production process e.g. status, sensors, deviations… from everywhere in the world

Internet of Things
People and equipment communicate with each other in a smart way like Internet of Services

Virtualization
a virtual model of the plant allows to simulate the production process
Industry 4.0 technologies

Expectations in Injection Molding

**Real-Time capability**
collect and analyze data in real time to make decisions

**Technical assistant and support systems**
intelligent process and production analyze tools
to control the process and react automatically
in case of deviations

**Service orientation**
web services, online diagnostics, use of Smart-connections
24 hours / 7 days a week availability

**Modularity**
flexible modular system in Smart-factories
to react to changed requirements and demands
Requirements
Implementation of Industry 4.0 technologies

Requirements:

1. Coherent network integration of machines and equipment

2. Standardized data-communication (digital data sheet, process data)

3. High performance control units IPCs with modern interfaces
Typical actual production situation:

» Mixed machinery
  – different brands
  – different machine generations, many control unit generations
  – Many different software versions

» Communication with numerous protocols
  – IMM ↔ MES/ERP-system
  – IMM ↔ robot / temperature control unit / mobile dryer / etc.
  – central material handling system ↔ MES/ERP-System
  – dosing unit ↔ central material handling system

» Mobility / flexibility in the production
  – various combination of production cells
Production Challenges

Some typical samples
Challenge: Flexibility in the production

Production Work-Cells

» Combination of work-cells on MES/ERP-level or within the Injection Moulding Machine

» Static IP-addresses each unit is defined

» MES/ERP takes control data collection and right combination of different data streams

» Work cell set-up configuration according to the production demands
Challenge: flexibility in the production

Maintenance case:

» Maintenance unit
  a mobile unit
  here a Thermolator needs to be taken out of the production cell for maintenance

» Set-up
  the replacement unit needs to be manually assigned to the work-cell
Challenge: flexibility in the production

Production change:

- Cell 3 reaches end of production for part “A” and starts next production of part “B” needs 2nd high-temp Thermolator and no Dryer
- Cell 2 after some time Cell 2 starts with production of part “A” needs related peripherals
- Set-up new aligned units needs to be manually assigned to the work-cells
Challenge: flexibility in the production

Cell set-up and connected units:

» No match
  The combination of the devices within the work-cells does not reflect their real positions any more

» Data validity questionable
  the data collection and validity has to be questioned

» Step-back
  due to limitation I4.0 technology
Safety issues in mixed systems

- Rights of access
direct on equipment level

- Unknown network architecture
depends on connected units of each production cell

- Mixture of IT-systems
of company / office - IT and production – IT systems

- Firewall
safety set-up required for each individual connected unit

- Software versions
various newer and older versions to handle
Wittmann 4.0 solution

“plug and produce”
WITTMANN 4.0 – Router functionality

- **Management**
  of all WITTMANN 4.0 – devices within the work-cell

- **Identification**
  units and devices register to the router
  device type is detected and recognised

- **IP-addresses**
  allocated by the router

**GOAL:** “PLUG & PRODUCE”
4.0 Router central communication point

» One central gateway
» Just local IP-addresses within the work-cell
» Automatic and logical device connection and set-up within the work-cell
» Peripheral equipment connected to the router dynamically – according to the production requirements
» Automatic identification of a peripheral device in the Injection Moulding Machine set-up and assigning of its individual functions
» OPC UA Server
Separation of the work cell from the network

» Security
  – Restrictive firewall
  – Intrusion Detection (DoS, Closing of sockets)
  – Closing of ports

» Port-Forwarding
  – Router informs outside devices which ports are aligned to the connected units (e.g. for the QuickLook app)
  – Setting only by authorized WITTMANN devices
  – Can be manually extended by operator via Injection Molding Machine interface
Secure configuration via WITTMANN 4.0 Router

» One single IP-address for the total communication with the working cell
  – easy access point to all data in the work cell
  – only the end point in the router needs to be secured configured

» WITTMANN 4.0 Router combines all data of all connected WITTMANN devices in the complete work cell for one easy access by the MES system

» MES/ERP can access the data of all devices without physical access to the device (port forwarding)
  – e.g. Actual temperature of temperature controller

» MES does not need to know which equipment is actually in the work cell

» Future automatic updates of Router through certified signed updates
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“Advantages”
Operator Solution - Smart User Interface

Requirements and Advantages

» One single central screen for all devices within the work-cell
» Visualisation and operation of all devices centralised at the IMM
» Remote service capability
» Unified alarm system
» Quick change of product in production
» Device adding very simple

Plug & Produce !
Wittmann 4.0 solution

“Plug-In”
WITTMANN 4.0 Plugin

Device identification
- Automatic identification of connected devices, e.g. type of Thermolator
- Check of valid, safe and allowed device

Software synchronization
- Check software version match
- If no match of software is given, it get uploaded to the machine
- Machine starts connected device „App“ locally in the B8 control
Operator Solution - Smart User Interface

Single Screen display
4.0 Integration Thermolators

Process control of the hot water/oil circuits for the mold temperature

- **Thermolator - Type**
  TEMPRO Type definition stored for reference information

- **TCU-Visualization “App”**
  software runs in B8 machine control

- **Settings**
  stored in mold-production-dataset

- **Alarm actions**
  configurable
Operator Solution - Smart User Interface

4.0 Integration FLOWCON

Process control of the water circuits for the mold temperature and water flow regulation

» FLOWCON - Type
FLOWCON Type definition stored for reference information

» FLOWCON - Visualization “App”
software runs in B8 machine control

» Settings
stored in mold-production-dataset

» Alarm actions
configurable
4.0 Integration GRAVIMAX

Process control of the materials mix by the gravimetric material blender

» **GRAVIMAX - Type**
  Blender Type definition stored for reference information

» **GRAVIMAX - Visualization “App”**
  software runs in B8 machine control

» **Settings**
  stored in mold-production-dataset

» **Alarm actions**
  configurable
Operator Solution - Smart User Interface

4.0 Integration DRYMAX

Process control of the materials drying by the DRYMAX dryer

» DRYMAX - Type
   Dryer Type definition stored for reference information

» DRYMAX - Visualization “App”
   software runs in B8 machine control

» Settings
   stored in mold-production-dataset

» Alarm actions
   configurable
4.0 Integration Robot

Process control of the automated insert or deposit by Robots and Automation systems

» Robot - Type
   Robot Type definition stored for reference information

» Control sequence
   operating modes with reference moves
cycle start and operation with or without robot

» Robot - Visualization “App”
   software runs in B8 machine control

» Settings
   stored in mold-production-dataset

» Alarm actions configurable
Data Solution: central data-storage

Data management

» One common load and store of all process relevant data in the Injection Molding Machine

- Injection Molding Machine
- Robot
- Material dosing/mixing
- Temperature Controllers
- Water Flow Controllers
- Dryer

Objective:
complete defined process simple, safe and easy set-up after product changes
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“CMS”
CMS to control production equipment with additional sensors

» Switch cabinet 1
» Switch cabinet 2
» Oil
» Hydraulics
» Water/Air
» Mechanics Injection unit
» Mechanics Clamping unit

Status OK
Solution Condition Monitoring CMS in 4.0

CMS – Condition Monitoring System

Service WITTMANN BATTENFELD

Further IMMs

CMS central

Control station

B8
Cell 1

CMS

B8
Cell 2

CMS

B8
CELL 3

CMS
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“Support Systems”
4.0 support systems

Smart Machine: *QuickSetup in UNILOG B8*

- Quick and easy programming of the production system’s initial parameter settings via *QuickSetup* function:
  - Selection of the material data from the database within the B8
  - Entry of the mold dimensions
  - Main Settings get automatically calculated
- Initial setting can be taken over for production start-up
- Help library for cycle optimization and for solving problems in the process sequence
4.0 support systems

MES – SmartMonitoring

» Production monitoring via MES Software-Module SmartMonitoring:

– Monitoring of machines, complete production cells or entire manufacturing areas

– Visualization current status of the injection molding operation on any of the machine`s B8 screen in real time or in the central computer system

Co-operation
4.0 support systems

QuickLook – App

Runs local in the internal WLAN/LAN

Quick data overview on mobile devices

» Operation mode
» Order number
» Teach-program Name
» Cycle Time, Times
» Alarms
» Number of produced parts, good parts, rejected parts
4.0 support systems

Web-Service 24/7

Connection between the machine and the WITTMANN BATTENFELD support center via the internet

Facts:

» More than 7,000 machines with Web-Service since beginning of 2008

» Already more than 2,500 connected machines in more than 40 countries

» Expert team in 4 Web-Service stations worldwide

→ USA – GERMANY – AUSTRIA – AUSTRALIA
4.0 support systems

Connectivity

Various external units can be connected to the Molding machine control B8

- Webcam – visualization on the control system UNILOG B8
- VNC connections
  remote control via VNC
- Hotrunner controls
  e.g. Gammaflux Hotrunner
4.0 Virtual Model of a Device

Virtual Machines

» Direct integration of robot models into the new WITTMANN robot control R9

» Virtual execution of a program sequence
WITTMANN 4.0

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Thank you for your kind attention

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