The Digital Transformation - Chances and Challenges for the Foundry Industry

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In order to lead a company to the top, you must have experienced top-performance.

Sales development in million €

We are available worldwide. From our 13 locations, we work on projects in 25 countries and in 14 languages.

Employee development

We are available worldwide. From our 13 locations, we work on projects in 25 countries and in 14 languages.

Employee development
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Evolution of production strategies:
Industry 4.0 is powered by digital transformation

Industry 1.0
Mechanisation

Late 18th Century
1784 – First mechanized loom

Late 19th Century
1870 - First conveyor belt, Cincinnati slaughterhouse

Industry 2.0
Manufacturing

Early 1970s
1969 - First Programmable Logic Controller (PLC), Modicon 084

Industry 3.0
Automation

Cyber Physical Systems (CPS) by digital transformation

Industry 4.0
Integration

Mass production and division of labor powered by electrical energy

Mechanical production facilities powered by water and steam power

Automation by electronics and IT
Definition of „Digital Transformation“

- Digital Transformation means an integrated network of all segments of economy. All stakeholders have to adapt to the realities of digital economics. Managerial decisions in network systems are related to data: data exchange, data analysis, calculation and evaluation of alternatives, and initiation of action and judgement on implications.

- Digital Transformation implies rapid radical changes for the business: „Disruption“
Current Situation September 2016

- Digital Transformation is no longer just a vision
- Leading industry branches are the automotive industry and logistics: Automotive manufacturers have started to implement digital factories at different levels
- Foundries are following behind: Just a few examples have been noted

What does digital transformation mean for foundries:

„Without data you‘re just another person with an opinion“
W. Edwards Deming, Data Scientist

„Every Company will be a Software Company“
GE-CEO Jeff Immelt, March 2014

What does digital transformation mean for your customers?
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The Challenge – Company’s strategy might be facing disruption

- Digital Transformation is not a single project, it is a marathon race – the beginning of a change in economy, where the critical factors for success are radically changing: „Disruption“

- What does disruptive innovation mean?
  Examples in other industries:
  > Photography: Film → Digital memory
  > Telecommunication: Business model SMS → WhatsApp
  > Automobile trade: retail markets → e-tail managed by OEM
  > B2C: retail markets → e-commerce (Amazon, Alibaba, ebay)
  > Marketing: printed advertisement → Crowd marketing (Facebook etc.)
  > Music and video distribution: Physical data storage media → Streaming

- How does disruptive innovation affect the foundry industry?
  Examples:
  > Automotive industry: combustion engine → electric motor
  > Production of prototypes or small series: machining → additive manufacturing
  > Customer requirements differ: Automotive OEM ↔ special purpose machine manufacture

- What does this mean for your company’s business strategy? What will be your foundry’s customers and products in 2021?
The Challenge – Company’s processes facing smart competitors, who combine lean principles with Industry 4.0

In 2015, Staufen carried out a survey on industry 4.0 among industrial companies in Germany, Switzerland, and China.

CEOs in China, Germany and Switzerland agree, that processes have to be well organized first: Process and leadership excellence is the goal, automation and integration are built up on that basis.

Thus, a lean enterprise is the basis for a smart factory.
The Chances - Staufen’s digital ecosystem („Industry 4.1“): Develop your lean enterprise into a smart enterprise with power to compete

"Ecosystem conveys the idea that all the pieces of an economy come together in particular places, and that their strength and interactions determine prosperity and economic growth."
Rosabeth Moss Kanter Chair & Director of the Harvard University Advanced Leadership Initiative
The Chances – Thanks to digital transformation you can use all of your data to augment your knowledge and your foundry’s process excellence

Purpose: “Knowledge Discovery within Data”

Staufen Quality Engineers have developed a method which combines engineering knowledge with statistical methods to guide manufacturing / business decisions in real time. Production data which is crucial to the product performance is analyzed through correlation, regression, and variance analysis.

- Easy to use human interface to sort through technical data quickly
- Method to identify patterns and connections
- Method to report the vast amount of data analyzed into a human intuitive condensed output (“Data Imaging”)
The Chances – Digital transformation enables access to the knowledge within your data by novel algorithms and human data interfaces

- Knowledge is gained by identifying non-random patterns in your company’s data base.
- The identification of these patterns allows ranking of key parameters which will be subsequently analyzed through regression techniques and other forms of correlations/trending statistical analysis to predict future behavior.
- The results is that knowledge is obtained without requiring expert statisticians, engineers, or IT gurus thus enabling many more people in your organization to navigate through vast data to identify trends, correlations, key indicators, and ultimate root-cause.

In a foundry process, we have a vast amount of data from the sub-processes (melting shop, laboratory, pattern, cores, molding sand system, molding line, fettling, grinding, quality department)

- Data imaging is a technique whereby processed numerical results are converted into images in order to take advantage of the human brain's capacity to process true images much more efficiently than tables or graphs.
- Current visual displays are limited to Tables and Graphs where a few amount of variables are being displayed but becomes confusing and inefficient for a large quantity of variables.
- By turning data into pixelated images, trends and non–random patterns can be easily recognized, memorized, efficiently stored, and further processed.
- The image itself serves as the best mnemonic implementation.
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The Smart Factory enables flexibility in production by smart products, we can learn from examples outside the foundry industry.

Automotive supplier

- Uses autonomous, self-organizing production units
- Self-driving transport systems
- „Marriage“ of production order with mobile assembly CPS
- Production unit is supported by logistics unit
- Smart Product carries all information relevant for value stream

SEW

Electronics

- Uses digital factory concepts for simulation and tests
- Integration of ERP-MES-PLM
- Siemens production system incl. certification and process optimization
- Entire digitization of all parts, components, products and WIP
- Smart data system for on-line analysis

Siemens
Technology examples: Shop floor logistics CPS and RFID based CPS are already in use, to some extent in foundries

Transport box with RFID

Logistics and assembly CPS

Self-driving transport unit

Self-driving transport unit

Photos: SEW, Kuka, Kurtz
**Technology examples:**
Augmented Reality based assistant systems

**Google Data Glasses**

**MS-HoloLens**

... combining mobile computing with connectivity and location-awareness

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**Practical Use**

**Data Glasses are used for quality inspection of the interior of a car**

... not only in quality control but also in maintenance and repair tasks of complex machinery providing guidance to the user in the form of visual, audio and locational instructions.
Digital Transformation: From what we can see in other industries, we can deduce the elements of a Smart Foundry

**Requirements**

**Digital Factory**
- **Product**
- **Production**
- **Facilities**
- **Integration**

**Lean Management**

**IT Standardization**
- Enterprise Level (ERP)
- MES & Automation Level

**Smart Foundry**

**Digitalization**
- Mobile Solution
- Real Time Enterprise
- Digital Foundry
- CIP incl. simulation
- Cloud & IT Security

**Smart Production**
- Stable processes
- Flexible production facilities
- Assistant systems, AR
- CPPS
- Minimal inventories
- Sustainability

**CPS**
- Predictive maintenance
- Tele maintenance
- Self optimization
- Sensitive robots
- 3D printers

**Smart Data**
- Intelligent data collection
- Data life cycle
- HMI & 3D reporting
- Big Data along value stream
- Role based informat.

**Network**
- Self optimizing order fulfilment process
- Supplier integration
- IoT, IoS
- Integrated quality management
- Horizontal and vertical integration

**Smart Logistics**
- Self-driving / autonomous systems
- Integrated tracing of the supply chain
- Suppliers risk management
- RFID based solution
Foundry examples of Industry 4.0 applications: Additive manufacturing

**Additive Manufacturing (metal)**

**Wolfensberger AG:** 3D printing (Selective Laser Melting – SLM) is used to manufacture metal parts (250 x 250 x 300 mm). Materials are corrosion resistant steel alloys or cobalt-chromium-molybdenum-based alloys. Advantages are lower costs (no patterns / tools required) and delivery time. Manufacturing of spare parts, products with high geometrical complexity.

**Additive Manufacturing (sand / plastics)**

Numerous foundries use 3D printing

Printed sand patterns/cores/molds
Binder Jetting (Phenolic binder), e.g. 3D Systems, ExOne, Voxeljet, Zcorp.
sand molds up to 4,000 x 2,000 x 1,000 mm

Printing of durable molds: Poly Jet or Fused Deposition Modeling (e.g. Stratasys)
molds up to approx. 900 x 600 x 900 mm
Foundry example: Smart data along the value stream and on-line data analysis with the AppliediT software

- **RTM™ Real Time semi-automated tools**
  - Run-Charts
  - Histograms
  - Trends
  - Pareto
  - ANOVA (ANalysis of VAriance)

- **Warranty and Special Event**
  - Historical Path Analytics
  - Automated Search for „Special Condition“
  - Rework database

- **Wormhole™**
  - Fully Automated Correlation Search
  - Data Imaging and „Process Signature“
  - Transfer Functions and Reporting

- **CTT (Cycle Time – Time Analytics)**
  - Real Time Loss Time Management
  - Micro-stops and Changeovers
  - Best demonstrated performance

AppliediT software package is based on the experience of Staufen Quality Engineers
Foundry example: The use of data imaging - Process signature of automated molding line data on two different days

The process signature of 30 x 30 variables depicts the correlation intensity of any two parameters measured. The color is related to the magnitude and the sign of the correlation coefficient.

If we compare two different process signatures we can see

1. correlations are stronger on day 2
2. correlations are not visible on day 1
3. correlation have changed from red (positive correlation) to blue (negative correlation)

Source of diagrams: AppliediT
A mouse click on one of the changing correlations shows what has changed behind:
On day 1 the automated molding line experienced various incidents, on day 2 it was running rather well.
The other changes in the process signature lead to changes in the subsystems, e.g. the molding sand system, and the quality data (scrap rate).

Source of diagrams: AppliediT
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Digital Transformation
Next steps

Foundries...

- Evolution towards a digital enterprise is foreseeable, relevant topics are clear
- Pressure forces change
- You are not alone, ask for exchange of ideas and help

… on their way to digital transformation

The choice is yours
- Competitive advantages from superior processes
- Growth from fulfilment of customers’ requirements
- Business as usual: Die of confirmed habits

- Strategic Excellence:
  Innovation, foresight, adjustment of your business model
- Operative Excellence:
  Generate knowledge from your data and improve your processes continuously with that knowledge

„It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change“

Charles Darwin, 1809
- Thank You -