Quo Vadis, Industrial Production? Factories in the Global Environment

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Berlin, July 25th, 2016
Production infrastructure is built for decades – however, the requirements change with increasing time.

During the next 20 years, the world will change as much as it has changed in the past 100 years.

Sources: Supply Chain Management Review/ January/ February 2014/ AT Kearney; H+ Magazine June 2014; pictures: Volkswagen; Vau-Max; Secusmart

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New needs lead to a marginalization of the production sector – the quaternary (virtual) sector rises

**Market perspective**

**1943: Maslow hierarchy**

**Maslow hierarchy of modern society**

- Self-realization

**Examples**

- UBER 3x worth more than PSA
- 100,000 people in China earn their money with virtual WoW-gold

GDP = Gross Domestic Product  
PSA = Peugeot Société Anonyme  
WoW = World of Warcraft

Sources: Selstad, T.: The rise of the quaternary sector. 1990  
Hilary Frazer, 2010  
eBay  
manager-magazin; onvista.de  
Kzero  
Forbes  
Statistisches Bundesamt

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The consequences are severe: the ability to generate profits in production is in danger.

Production in existing structures is becoming more difficult.

Increasing skills shortage.

Decreasing ability to generate profits.

Decreasing innovation.

Decreasing interest in production.

In the future, will production still be a promising business model?

Sources: Faculty of Mechanical Engineering, RWTH Aachen University, 2015, "Zeitreihe der Neueinschreibungen"
The visions of the Factory of the Future determines the normative guidelines and objectives

Factory of the Future

- **Attractive**: 10 out of 10 points in the StepStone workplace happiness study
- **Ecological**: Reduction of CO2 emissions by 55% until 2030
- **Profitable**: Above average return on investment (ROI)
- **Speed**: Halving of the required time
- **Smart**: 10x more sensor data p.a., and full utilization of the data
- **Sustainable**: Efficient

The Factory of the Future provides an answer to the question: What does our production signify?

ROI = Return on Investment  p.a. = per annum
Sources:  
1 StepStone Deutschland, 2013  
2 Bundesregierung 2013  
3 Houston Chronicle 2015 “ROI Calculation for a Manufacturing Company”  
4 Kampker, A. et al., 2015, “Planungszeit Halbe”  
5 Siemens AG, 2014, “Von Big Data zu Smart Data”
Three factory archetypes can be distinguished in the future

**Factory Types**

- **High-volume**
- **Volume of production**
- **Low-volume**

**Mega-Factory**
- **Cost competitiveness by cost degression**
- **Industry (automotive, machinery, consumer goods...)**

**Micro-/ Nano-Factory**
- **Source of value**

**Shared Factory**
- **Customization/differentiation**

**Sources:** own illustration, pictures: Tesla Motors, Local Motors
Virtual & Augmented Reality – Collaborative planning and support in production processes for the flexibilisation of employees

Integration of augmented and digital tools in daily work

By superposition of the reality allocation efforts of information can be reduced → Information on demand

Digital planning and development enables the reduction of coordination processes by collaborative work and an intuitive visualisation of components, systems and work environments → Faster approval and ramp-up

Current developments and next steps in Aachen

- The factory planning table enables a participatory planning approach
- Digital tools for the visualization of the prototype production make primo- and virtual prototypes possible
- The automated generation of assembly sequences from CAD is developed up to a maturity level for series production

StreetScooter Research

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Autonomous systems in production – Self-driving chassis after first startup and autonomous transporters in the plant

Smart logistics, reduction of path-widths and autonomous startup

Self-driving chassis lead to autonomous check processes after initial startup, by reduced conveyor technologies the sequence of the final assembly can be flexibilised (car sequencing problem)

Autonomous transporters deliver parts and transport waste and chips

Current developments and next steps in Aachen

- The StreetScooter can already perform autonomous delivering processes
- Self-driving chassis are key for low cost assembly, cost-intensive conveyor technologies can be omitted from initial startup
- The Campus Shuttle at RWTH Aachen Campus is qualified as an autonomous support for the final mile (person transport at plant)
**Smart Robots – Self-optimizing assembly systems make autonomous decisions regarding the compensation of manufacturing tolerances**

### Learning and self-optimizing systems react on tolerance situations

By detection of deviations in the component the target tolerances are achieved with flexible equipment.

In case of deviations in single components, compensation elements are automatically produced by additive technologies so that higher tolerances can be processed and single components can be produced and transported more cheaply.

### Current developments and next steps in Aachen

- Series ready 3D-printed tolerance compensation elements for add-on parts in final assembly
- Automated calculation of tolerance compensation geometries on the basis of measuring data
- Rapid fixture elements for interfaces in equipment for reduction of ramp-up risks

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StreetScooter is the perfect example of the disruptive network approach

Disruptive network approach

1. StreetScooter founded as a spin-off of RWTH
   - Q2 2010

2. Commercial version (Work) designed
   - Q4 2010

3. 1st prototype (Compact) presented
   - Q2 2011

4. Disruptive partner network established
   - Q4 2011

5. Commercial version Prototype
   - Q2 2012

6. SOP (< 5 vehicles/day)
   - Q4 2012

7. Small series production (50 vehicles)
   - Q2 2013

8. Q2 2013

9. Q4 2013

10. Q2 2014

11. Q4 2014

12. e.GO Mobile AG founded
   - Q1 2015

13. Commercial version (Work) designed
   - Q4 2015

14. StreetScooter is the perfect example of the disruptive network approach

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The infrastructure on the RWTH Aachen campus enables the development of solutions for the Factory of the Future by linking research with industry.
Thank you for your attention.
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