Digitalisation in Steel Industry, current situation and future trends

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- **non-profit** organisation
- **applied research** driven by concrete production topics
- **steel** and other **process industries**
- app. 100 employees
- **research, development, services** around steel production (like measurements, etc.)
- located in Duesseldorf, Germany
Statement I

“Digitalisation is a pre-condition for Industry 4.0, but Industry 4.0 is much more than digitalisation!”
Interpretation of Digitalisation/Industry 4.0 for Steel Industry

- identification
- quality
- history

- product data, process data, customer demands, order data, manufacturing specifications, production sequence, maintenance data, etc.

- supply chain

- product catalogue, product data, delivery, logistic data, delivery times, etc.

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H. Peters: „Digitalisation and Industry 4.0 in Steel Industry“
Interpretation of Digitalisation / Industry 4.0 for Steel Industry

› Single plant as Cyber Physical Production System (CPPS, **vertical integration**)
› **100% traceability** of intermediate and final products
› „Intelligent“ product with knowledge of its own quality and production history (one aspect of **end-to-end engineering**)
› Intensive networking and communication of all plants (**horizontal integration inside company**)
› Intensive communication along the complete supply chain (**horizontal integration outside company**)
› Suitable handling and usage of **all data**
› De-central instead of central solutions / **self-organisation**
What is a „Cyber Physical System“?

„…merging of information processing with physical processes“

› IT-systems directly embedded in the technical process,
› Integration of processes among themselves by information flows,
› Interaction of the technical process with its environment,
› Learning functions to adapt technical processes and IT-systems.

Digital twins

- mechanics
- electrics
- automation
- IT + Software
- maintenance
- HMI
- identification

- identification
- quality / process data
- production history
- customer demands
- models, algorithms
- “intelligence”
- …
Possible “Cyber Physical Systems” in Steel Industry

Assistance systems

Plant component

Product
From the aspect of volume we don’t have Big Data in Steel Industry……

nevertheless, the application of Big Data technologies makes very much sense in many applications in Steel Industry!
“Big Data”, here: amount of data

- **steel industry**: ~500 Tera-Byte per year
- **LHC at CERN**: 25 Peta-Byte per year (during a trial: 1 Peta-Byte/s)
- **Facebook**: 500 Tera-Byte per day, 182 Peta-Byte per year
- **WWW humans and machines**: 2,5 Zetta-Byte per day

Tera: $10^{12}$  Peta: $10^{15}$  Exa: $10^{18}$  Zetta: $10^{21}$  Yota: $10^{24}$
“Big Data means the analysis of large amounts of data coming from different sources with high speed and with the aim to create economic benefit“ (BITKOM)
Big / Smart Data in Steel Industry

- High resolution and synchronised data
- Transition to more-dimensional data ("spatial") instead only 1D
- Integration of text data, video-/audio-streams, data with gaps (unstructured)
- Fast processing and "online"-usage of result
Cyber Physical Systems, horizontal / vertical integration, end-to-end engineering are only techniques to realise digitalisation.

Now we need suitable applications running in such digitalised factories only then we can realise “Industry 4.0 / Smart Factory”!
Possible application areas for Industry 4.0

› Smart control of process chain (through-process automation)
› Fast detection of cause&effect relationships
› Through-process quality control
› Self-organised production
› Smart assistance systems
› ...

Now: examples of BFI projects!
Smart control of process chain

Digitalisation and Industry 4.0 in Steel Industry
Fast detection of cause & effect relationships

New approach:
- High resolution time series analysis plus enriched data as basis for Data Mining
- Product-oriented data via NoSQL
- Machine Learning approach (‘deep learning’) + expert knowledge for labeling

Coil width

good
bad

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Through-process quality control

Forward simulation

next step: backward simulation

Detection that a product has left the foreseen quality corridor
Dynamic re-scheduling to an alternative process route / alternative process setups
Forward modelling of process chain
Selection of best suitable models to predict product properties
  1st Principle Models
  stochastic models
  data driven / statistical models
Self-organised production
Applications for reduction of energy consumption

piece related energy consumption

Energy Database

Energy Information and Analysis System

"energy certificate"

cause & effect relationship

piece related dynamic process conditions

Process - Database

plant data

process data

grid simulation

Agent system

Energy market simulation

overload event

price course

activation/deactivation of facilities

production plan

Process simulation

Production scheduling

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Smart assistance systems

- **Autonomous** flying Multicopter monitors gas pipelines by **CO-leakage sensor**
- 3D-camera allows the **automatic** navigation of the Multicopter **very near** to the pipes and avoids collisions
- Support of maintenance people by application of **high resolution pictures** from all perspectives
- Improvement of **human safety** by CO-monitoring
Conclusions

› Digitalisation is a necessary **pre-condition** for Industry 4.0 ….

› … but **Industry 4.0** is much more than **Digitalisation**

› Industry 4.0 is more a **paradigm / philosophy** than a technology

› The main job is now to find the best applications for Industry 4.0 with the **largest possible effort** for the process industries
Many thanks for your attention!