How could Industry 4.0 transform the Steel Industry?

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Prof. Dr. Harald Peters
“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

How could Industry 4.0 transform the Steel Industry?

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

supply chain

product catalogue, product data, customer demands, logistic data, delivery times, etc.
Interpretation of 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.

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

+ identification
+ quality data
+ production history
+ process data
+ customer demands
+ algorithms
+ ....

Digital twins
Possible “Cyber Physical Systems” in Steel Industry

Assistance systems

Plant component

Product

How could Industry 4.0 transform the Steel Industry?
“Cyber Physical Production System”

- Simulation, smart maintenance
- Intelligent plant monitoring
- Process automation/control
- MES/dec. production planning
- Annealing
- Communication
- Data stream
- Simulation, learning function
- Steel shop
- Assistance systems

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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 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

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Additional to the “disruptive” technologies we need solutions for many small problems/tasks like digital twin of a coil / digital handling of basic information / meta model of steel production etc.
Digital twins and “end-to-end engineering”

plant

digital model of the plant

product design → production planning → production engineering → production → services

digital model of the product

product
Concept for data storage / data handling

- technological solution
- MySQL
- Oracle
- SQL
- MS_SQL
- MongoDB
- NoSQL
- CouchDB

1-D continuous: strip tension, width, speed, etc
2-D continuous: thickness, flatness, temperature, coating layer
Event-based: Surface defects, internal defects, Manual data

Coil A  CoKl B  CoKl C
Rolling direction

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Digital and processable information, here: manufacturing specifications

Manufacturing specification No. 4711 Rev. 7
Strip speed for customer 1 and customer 2

For customer 1 and customer 2 the material 0815 produced via process route P5 at the annealing line a final strip temperature of about 1234°C has to be ensured. For strips up to 0.9 mm thickness the speed is around 20 m/min, for thicker strips 15 m/min.

<table>
<thead>
<tr>
<th>Rule condition</th>
<th>Monitored process value</th>
<th>Allowed values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material=0815 &amp; P=5 &amp; customer like [customer 1 or customer 2]</td>
<td>final strip temperature</td>
<td>1220 °C … 1250 °C</td>
</tr>
<tr>
<td>Material=0815 &amp; P=5 &amp; customer like [customer 1 or customer 2] &amp; thickness between 0.00 and 0.89</td>
<td>Strip speed</td>
<td>19 m/min … 21 m/min</td>
</tr>
<tr>
<td>Material=0815 &amp; P=5 &amp; customer like [customer 1 or customer 2] &amp; thickness larger than 0.90</td>
<td>Strip speed</td>
<td>14 m/min … 16 m/min</td>
</tr>
</tbody>
</table>
Meta model: Semantic modelling of process chain

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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”!

Statement IV
Possible application areas

› Decision support regarding quality control
› Smart control of process chain (through-process automation)
› Smart evaluation of large amounts of data
› Re-scheduling of materials
› Smart assistance systems
› Smart (predictive) maintenance
› .....
Decision support for material allocation

Rule based (2006)

Knowledge based (2011)

order customer application
manufacturing specifications
quality rules lower & upper limits

decision support

not ok
ok

quality
met?
no
yes
ok

quality data
process data

multi-criterial opt.
rule treatment
environment

experience knowledge

ok for allocation?
Smart control of process chain

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Smart Data for correlation of surface defects
Software agents to realise a virtual market place

one piece of product misses its target specifications…

… uses models to predict its future state…

… and negotiates at a virtual market place for an alternative order.
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 Steel Industry