AI Applications in Manufacturing

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Concepts

Industry 4.0
Smart factory
Autonomous systems
Predictive maintenance
Automated quality control
Cyber-physical systems
Digitalization
Collaborative robots
Digital twins
Factory of the future
etc.
Concepts

- Industry 4.0
- Smart factory
- Autonomous systems
- Predictive maintenance
- Automated quality control
- Cyber-physical systems
- Digitalization
- Collaborative robots
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- Factory of the future
- etc.

Techniques

- IoT
- 3D printing
- Artificial intelligence
- Machine learning
- Deep learning
- Computer vision
- Big data
- Cloud computing
- Data analytics
- Decision making
- Optimization
- etc.
Benefits

Create rapid, data determined decisions
Facilitate enhanced production outcomes

Advance process effectiveness
Minimize operational costs
Facilitate superior scalability
Facilitate product development

(The Future of AI in Manufacturing Industries)
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(The Future of AI in Manufacturing Industries)
Predictions

Market size for AI in manufacturing is anticipated to grow more than 40% from 2019 to 2025
(Global Market Insights)

Industry 4.0 market worth $156.6 billion by 2024
(MarketsandMarkets)

By 2025 smart factories will generate $37 trillion
(McKinsey)
While AI is growing and by all resources will continue to, maturity, confidence, ROI, scaling, and connectivity might be slowing mass adoption

(MachineDesign.com)

AI will make manufacturing operations smarter – but a learning curve comes first

(Gartner)

The increasing scale of adoption of AI in manufacturing seems more like an evolution, rather than an industry disruption

(R. Chuprina)
Problem formulation

Input variables (Process parameters) → STEEL CASTING → Output variables (Metallurgical criteria)
Problem formulation

Input variables
(Process parameters)

STEEL CASTING

Output variables
(Metallurgical criteria)

\[ X = ? \quad F(X) \quad Y \]
Simulation-based optimization

- Initial solution
- Optimization algorithm
- Candidate solution
- Cost function
- Optimized solution
- Numerical simulator
- Quantities of interest

Cost
Solution visualization for decision support
Solution visualization for decision support
Computer vision approach ...
... combined with machine learning
... combined with machine learning
Implementation on a production line
Techno-economical optimization
Techno-economical optimization

![Graph showing the relationship between unsupplied energy and costs (in kEUR).]

<table>
<thead>
<tr>
<th>Variable / Criterion</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
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<tr>
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<td>12</td>
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<td>Type of photovoltaic modules</td>
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<td>Number of batteries</td>
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<td>9</td>
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<td>4</td>
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<tr>
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<tr>
<td>Costs [kEUR]</td>
<td>3,3</td>
<td>25,1</td>
<td>29,3</td>
<td>56,1</td>
<td>59,1</td>
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<tr>
<td>Unsupplied energy [%]</td>
<td>94,5</td>
<td>30,5</td>
<td>30,4</td>
<td>4,3</td>
<td>0</td>
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</tbody>
</table>
Sensitivity analysis

The diagram illustrates the relationship between costs and unsupplied energy under different scenarios. The graph shows the original scenario, demand decreased by 30%, and demand increased by 30%. The data points indicate a strong negative correlation between costs and unsupplied energy.
Summary

- AI certainly has great potential in manufacturing.

- However, do not expect unmanned factories too soon, rather count on the interaction between humans and technology.

- Most successful applications have been in the form of testbeds, not full-scale projects.

- We are contributing to these as shown in this presentation.
Acknowledgements
Acknowledgements