4TH CONFERENCE ON LEARNING FACTORIES
Sustainable manufacturing in learning factories

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Sustainable manufacturing in learning factories

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- Research Assistant at the Chair of Quality Science at Technische Universität Berlin since 2010
  - In charge of three lectures with 250 students a year
  - Topics of lectures: Six Sigma, Quality Methods and Lean
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Agenda

- Bayer Lean Factory
- Definition of sustainability
- Learning objectives
- Didactic concept
- Economic effectiveness
- Ecological effectiveness
- Social effectiveness
- Social efficiency
- Eco-efficiency
- Ecological Justice
- Sustainability
- Summary and outlook
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Bayer Lean Factory

Pharmaceuticals

Division Quality Management
Division Corporate Management

Chair for Quality Science
Chair for Assembly Technology and Factory Management
Chair for Logistics
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Set-up of the Bayer Lean Factory

- Drying
- Granulating
- Wet mixing
- Mixing
- Weighing
- Sieving
- Tableting
- Coating
- Packaging
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Definition of sustainable manufacturing

![Diagram showing the definition of sustainable manufacturing with economic, environmental, and social aspects.](image-url)
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Definition of sustainable manufacturing
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Learning objectives

- **Environmental objectives:**
  - How to reduce harms to the environment
  - Connection between economical and environmental consequences

- **Social objectives:**
  - How to achieve positive societal development
  - How to reduce negative impacts in factory environments
  - The importance of communication
  - Safe and healthy work place

- **Economical objectives:**
  - Products need to be demanded by markets
  - Know the difference value-adding and non-value-adding processes
  - Acting of employees reflects on the economic goals of a company
Economic effectiveness

- **Definition:**
  Economics is the totality of equipment and actions that serves the planned covering of demand. Economic effectiveness describes the ratio between planned and realized output.

- **Method:** Value Stream Method
Environmental effectiveness

- **Definition:** Environmental effectiveness focuses mainly on awareness for material flows and their transformation within the value creation process.

- **Method:** Ecological Rucksack

\[ ER = W - MI \]

*ER* = Ecological Rucksack

*W* = weight of Product

*MI* = Material intensity
Environmental effectiveness

- Application example:

<table>
<thead>
<tr>
<th>Abiotic raw materials</th>
<th>Biotic raw materials</th>
<th>Moved Soil</th>
<th>Air</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum from Bauxit</td>
<td>Rucksack 85:1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Aluminum</td>
<td>Rucksack 3.5:1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Social effectiveness

- **Definition:**
The term social describes the relation between people and groups of people and also includes aspects of safety, health, compliance with law, respecting human rights and fairly treating of suppliers.

- **Method:** Job Hazard Analysis
Social effectiveness

- Application example:

Video examination → Self-reflecting → Fundamentals Ergonomics → Applying in the learning factory
Social efficiency

- **Definition:** Social efficiency not only describes the relation between people and groups of people but also ratio between interacting (used resources) and outcome.

- **Method:** Shop Floor Management
Social efficiency

- Application example:
Eco-efficiency

- **Definition:**
  Eco-efficiency is the combination of economical and environmental efficiency and shows the mutual dependency of both sustainable factors.

- **Method:** Energy Analysis

[Diagram showing energy components and losses]
Environmental Justice

- **Definition:**
  Environmental justice describes the environmental harm of regions or places and its impact on the social and ethnic groups who live there.

- **Method:** Fair Trade
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Sustainable manufacturing

- **Definition:**
The creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound

- **Method:** Key Performance Indicator

**Understanding KPI’s**

A car accelerates in 7 seconds

A car accelerates in 7 seconds from 0 to 100 kph
Summary and outlook

- It's possible to train methods to every topic of sustainability
- Environmental and economical topics taught in learning factories
- There is no learning factory which consider all topics of sustainability
- Identify the mutual influence of method and content
- Find the right combination of methods
- Learn how to teach them