A holistic approach for industrializing timber construction

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13 Sept 2019
A holistic approach for industrializing timber construction

1. Motivation and strategy
2. Background and foundations
3. Empirical Study
4. Case Studies
5. Conclusions

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1. Motivation and strategy

Environmental Assessment

- 33% global CO2 emissions

Resource Use

- 30% EU waste annually
- 40% Global resource use

Urbanization

- 40% global population will need new buildings

Source: Eurostat 2015b, McKinsey Global Institute analysis 2014
1. Motivation and strategy

Environmental Assessment

- GlueLam
- CLT
- Hybrid

Urbanization

- Columbia
- Via Cenni
- Puukuokka

Resource Use

- 62% Value
- 26% Waste
- 12% Supporting activities

- 10% Value
- 57% Waste
- 33% Supporting activities

The chronic problems of construction are well known:
- Low productivity
- Poor safety
- Inferior working conditions
- Insufficient quality

Source: Koskela, 1992, Construction Industry Institute 2004
2. Background and foundation

Why timber?

- Engineering performance
- Effective off-site construction (Local factories)
- Resources Management
- High Prefabrication Grade

- Dry Construction – Plug&Play
- Just in Time Delivery
- Expertise – Know-how
- Thermal Capabilities, Fire Resistance...
3. Empirical study
Holz.System.Bau

<table>
<thead>
<tr>
<th>Urgent value-adding goals</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIGN</strong></td>
<td></td>
</tr>
<tr>
<td>• Extended knowledge in architectural design</td>
<td>• Define a reactive and adaptive modular system with standard assemblies from already existing components</td>
</tr>
<tr>
<td>• Know-how exchange platform</td>
<td>• Develop an integral catalog with all load-bearing and not load-bearing modular system elements</td>
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<tr>
<td>• Specific academic training</td>
<td>• Use rainproof constructive elements</td>
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<tr>
<td>• Energy and material efficient concepts</td>
<td>• Spread the solutions through a BIM library as an open source</td>
</tr>
<tr>
<td>• Less constructive elements, joints and details</td>
<td>• Advance a collective value-adding actions catalog throughout the whole process</td>
</tr>
<tr>
<td><strong>PRODUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>• Optimized logistic and coordination</td>
<td>• Implement a crossed specific training</td>
</tr>
<tr>
<td>• Competent handcraft</td>
<td>• Improve efficiency through Lean Management</td>
</tr>
<tr>
<td>• Shorter production time in factory</td>
<td>• Promote reliable cost and time plans by implementing Lean Construction</td>
</tr>
<tr>
<td><strong>ERECTION</strong></td>
<td></td>
</tr>
<tr>
<td>• Faster assembly through higher prefabrication grade (plug-and-play)</td>
<td></td>
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<tr>
<td>• Better performance on site against weather detriments</td>
<td></td>
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<tr>
<td>• Optimized logistic and coordination</td>
<td></td>
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<tr>
<td>• Null-error performance</td>
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<tr>
<td><strong>Cost-time</strong></td>
<td></td>
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<tr>
<td>• Refinement of planning costs</td>
<td></td>
</tr>
<tr>
<td>• Reliable cost and time plans</td>
<td></td>
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<tr>
<td>• Faster offers and lighter comparability</td>
<td></td>
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<tr>
<td><strong>End-product</strong></td>
<td></td>
</tr>
<tr>
<td>• Cradle-to-cradle</td>
<td></td>
</tr>
<tr>
<td>• Improved end-product quality</td>
<td></td>
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</tbody>
</table>
3. Empirical study

Lean Design

Implementable planning

Specific timber construction expertise

Planning
- Architect + engineers
- Timber construction company

Workshop planning
- Timber construction company

Pretabration
- Assembly

Redesign
- Delay
- Coordination / Synthesis

Implementation
- Architect
- Timber construction company

Other construction participants
- Structural engineer
- Building technology planner
- Building physics planner
- Fire safety planner
- Other planners

Open System

Source: LeanWOOD 2017 / Kaufmann 2018

Erne
Cree
Kaufmann Bausysteme
Elk Fertighaus
Binderholz
Storaenso
Dataholz
Baubook
Lignum Bauteil Katalog
4. Case studies
Moholt 50|50, Norway

Source: Høyer Finseth/MDH Arkitekter / Veidekke
4. Case studies
Risch Rotkreuz, Switzerland

Suurstoffi 22

Source: ERNE / Zuschnitt / Burkard Meyer
## 5. Conclusions

<table>
<thead>
<tr>
<th>HSB-Urgent value-adding goals</th>
<th>HSB-Strategies</th>
<th>Take-home-Strategies</th>
<th>Moholt 50</th>
<th>S22 + Arbo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIGN</strong></td>
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</tr>
<tr>
<td>• Specific knowledge in design</td>
<td>• Adaptive modular system</td>
<td>• Early key decisions</td>
<td>x From brick to CLT</td>
<td>✓ ERNE</td>
</tr>
<tr>
<td>• Know-how exchange platform</td>
<td>• Open BIM</td>
<td>• BIM</td>
<td>✓ BIM model</td>
<td>✓ ERNE</td>
</tr>
<tr>
<td>• Less constructive elements and details</td>
<td>• Integral catalog with all standard elements and assemblies (BIM library)</td>
<td>• Early involvement of the construction company</td>
<td>✓ Vaidekke</td>
<td>✓ ERNE Building set libraries</td>
</tr>
<tr>
<td><strong>PRODUCTION</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Optimized logistic and coordination</td>
<td>• Lean Management</td>
<td>• Lean Production</td>
<td>✓ Stora Enso</td>
<td>✓ ERNE</td>
</tr>
<tr>
<td>• Shorter production time</td>
<td>• Competent handcraft</td>
<td>• Kaizen. Jidoka</td>
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<tr>
<td><strong>ERECTION</strong></td>
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</tr>
<tr>
<td>• Faster assembly on site</td>
<td>• Higher prefabrication grade</td>
<td>• CLT</td>
<td>x CLT</td>
<td>✓ Building blocks</td>
</tr>
<tr>
<td>• Independence of weather</td>
<td>• Use rainproof elements</td>
<td>x JIT (4days/floor)</td>
<td>✓ TTP for internal work</td>
<td>✓ Concrete layer</td>
</tr>
<tr>
<td>• Optimized logistic and coordination</td>
<td>• Collective value-adding actions catalog</td>
<td>✓ Involved Planning</td>
<td>✓ TTP</td>
<td>✓ TTP</td>
</tr>
<tr>
<td>• Null-error performance</td>
<td>• Shared and crossed specific training</td>
<td>• LPS</td>
<td>✓ LPS</td>
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<tr>
<td><strong>COST-TIME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Reliable cost/time plans</td>
<td>• Lean Construction</td>
<td>• Off-site+4D+Libraries</td>
<td>✓ Preconstruction</td>
<td>✓ Preconstruction</td>
</tr>
<tr>
<td>• Faster offers and comparability</td>
<td></td>
<td>• Design-Bid-Build</td>
<td>x Rework / Redesign</td>
<td>x No comparable offers</td>
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