Reuse of building components

Jernkontoret seminar: Value creation by digitalization in the metals industry

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Petr Hradil
VTT Technical Research Centre of Finland Ltd

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• VTT is one of the leading R&D&I organisations in Northern Europe.

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Net turnover and other operating income 269 M€ (VTT Group 2016)

Unique research and testing infrastructure

Personnel 2,414 (VTT Group 2016)

Wide national and international cooperation network

Smart industry and energy systems
Research Area: Lifecycle solutions

Raw material processing and manipulation
Upscaling powder manufacturing
Advanced manufacturing methods incl. additive manufacturing
Large and full-scale testing of components and structures

Operation & maintenance

Remote monitoring & Data analysis
Performance evaluation
Data-based O&M services
Asset Management
Resilience, Safety & Security
Service Life Design
Remote monitoring & Ageing management
Risk management

Materials & design

Multiscale material modeling
Design and tailoring of performance based materials
Design, development and assessment of components and structures
Topological optimisation
RAMS design

Every step matters

Systemic design, modularity
Substitution
Utilisation of secondary raw materials & sidestreams
Business concepts

Retrofit, remanufacture re-use & recycle

Ageing & lifetime extension
VTT’s research focused on components reuse

2013-2014
Repetitive Utilization of Structural Elements

2017-2020
PROGRESS
PROVISIONS FOR GREATER REUSE OF STEEL STRUCTURES
Examples – bus terminal in Schiphol Airport

1942 London
1958 Rotterdam
2015 Schiphol

Picture credits SCI
Examples – 3x used bridge

1958: Brussel’s World Fair
1959: ”Zoo-Brücke” in Duisburg
2000: Bridge further south the A3

Picture credits Paul Kamrath
Examples – port of Helsinki

Delivery type: Best-Hall service
Site: Helsinki West Harbour, relocation of warehouse L19, Helsinki, Finland
Dimensions of the building (transferred in one piece): 74 x 30 / 5 m

The relocation took 12 hours and by the evening, the building had been moved 200 metres and rotated to a different angle.
Environmental value of reuse

Three existing methods to calculate environmental impacts:

- Worldsteel’s LCA methodology
- CEN TC350 (EN 15978, EN 15804)
- European Commission’s Product Environmental Footprint (PEF)

The most problematic is accounting for the future savings (e.g. design for reuse) in Module D of EPDs. PROGRESS project is developing a solution for this.

*Example of calculated savings compared to traditional recycling (Hradil et al., EUROSTEEL 2017)*

![Graph showing life-cycle impacts reduction](image_url)
Economic value of reuse

According to data collected recently in UK, reuse can generate substantial profit.

The worst case scenario was nearly equivalent to the new steel production, however, there are possible savings:

- Fabrication up to 27%
- Additional modifications up to 14%
- Testing up to 7%
- Additional transport up to 1%

PROGRESS project is investigating quality checking and component tracking (reduces testing costs), product design (reduces re-fabrication costs), building design (reduces additional modifications) and online marketing (reduces transport/handling).
Reuse of building components

Reuse today

Future reuse

Picture credits SCI
Building information modelling

BIM as a data carrier is a perfect tool to increase the component reuse efficiency. It can contain:

- Material properties (can be referenced to a particular inspection certificate)
- Geometry of the product
- Properties of the product (can be referenced to a particular CE marking, EPD, etc.)
- Inspection and maintenance records

Parts of BIM model can be reused in another model

What is missing:
- Software support for “virtual” deconstruction
- Model structure for historical data from the previous service lives

PROGRESS project will propose the extension of IFC standard for this information
Building information modelling
Conversion of the former heat and power plant of RWTH Aachen University into a seminar building
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Conversion of the former heat and power plant of RWTH Aachen University into a seminar building

Picture credits IParch GmbH
Building information modelling
Online marketing

Online trading can greatly boost the reuse business and match the supply and demand in the circular economy of steel construction products.
Online material exchange

Used Steel Buildings and Cement/Concrete/Flyash Silos

We can supply portal frame buildings for any requirement. A used steel frame can save you 25%.

All frame members are numbered for ease of erection. All pre used buildings come with erection and layout drawings. We guarantee that your building will be complete. Additional services: shot blasting, re spraying, alterations, are available on request.

Second hand steel does not mean a second rate job! Saving you money and winning credibility with your local planning office by reducing your company’s carbon footprint.

We can also supply concrete, cement and flyash silos.
Material and component traceability

This issue is important for the efficiency of reuse. However, it is not covered by PROGRESS project. We will be happy to investigate it further.

Digital pre-deconstruction audit

PROGRESS project uses drones to generate 3D models of buildings before deconstruction. Such models can be further converted into objects (e.g. BIM) and used in deconstruction planning and new building design.
Blockchain

“Blockchain” is a distributed database that maintains a continuously growing list of data records, chained together against revision and tampering.

“Distributed consensus” is an agreement between different compute-nodes over what is a true or false record.

As every client has a copy of the blockchain it is impossible to manipulate information and cover up your tracks. The integrity and provenance of information systems can be mathematically proven.

Source: Guardtime 2017
Blockchain and BIM

Planning Systems

BIM designed buildings can be estimated to within a 95% accuracy. This is because the estimating process has moved from “representation to simulation”.

If the client has TRUST that the building can be delivered for the price tendered, the delivery of assets could be efficiently organised via a construction project blockchain with smart contracts triggered by “as constructed” building information modelling eliminating the need for a middleman.

Tender systems based on “Value” rather than lowest price. This value proposition can extend into the lifecycle of the building with a new funding model for...

Public Tender Systems

Multidisciplinary Collaborative BIM can present problems of IP (intellectual property) and causation, (the action of causing something: “investigating the role of design in the causation of an accident”).

“Determining authorship of each element of the model is a projected problem coming from model authors, but is not just a question of rights over it, but is closely related to civil and criminal liability of a design flaw that might arise on a project. Blockchain can act as a certifier of the activity of each agent on the model, with the importance that this entails determining the responsibility to causation.”

Ref: Flores FV (2016) Grant Thornton Spain and can be found at http://blog.grantthorton.es/2016/06/30/bim-MarkShain/
Blockchain and manufacturing

- Product design
- Product tagging & provenance
- Smart Contracts
  - E.g. Autonomously sourced materials and services
- Blockchain enabling DAO (Decentralized Autonomous Organization)
- Logistics
- Product lifecycle data
Acknowledgements

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