Rebeauty
Artistic Strategies for Repurposing Material Components

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**Challenge**
The project addresses material waste - the ‘dark side’ of renovation in construction. The demolishing practice in the Nordic countries today is highly efficient in terms of separating construction debris and minimizing landfill. However, discarded resources represent a triple capital related to economy, energy, and culture. The challenge is to find new ways to access this value and implement the Circular Economy in construction.

**Project**
NORDIC BUILT COMPONENT REUSE
18 months 2014-2015

**Partners**
Vandkunsten Architects (DK)  Architects
Genbyg.dk (DK)  Reuse vendor
Asplan Viak (NO)  Engineering
Malmö Högskola (SE)  University
Hjelness Consult (NO)  Consulting

**Funding**
Nordic Built
EUDP

**Most recent exhibition**
La Biennale Architettura 2018, Danish Pavillon
Background
The competition win for major renovation of 1001 social housing units at Albertslund South
Strategy for intense reuse
Featured three resource capitals and their budgets

Ambitions were cut from the project
New vision to impact decision makers
Supply the data missing regarding affordability and environmental benefits
Show the beauty of such reuse strategy

Project aims
It is the premise of this project that future construction practice must enable resource-preserving strategies, including:

1/ Repurposing building waste from demolishing, dismantling, and refurbishment.

2/ Reversible construction principles known as Design for Disassembly (DfD).
Without beauty
No sustainability
Rebeauty is the continuous search for beauty through artistic strategies for repurposing sourced materials and components in reversible architecture.
DEVELOPMENT AND ASSESSMENT

**Rebeauty Method**

1. Market Survey
2. Ideation and Analysis Matrix
3. Material Concept
4. Material and Process Prototype
5. Assessment
6. (Market)

- Interviews with market experts to state the:
  - Existing practice,
  - Volumes and availability of materials and components,
  - Types and lifetime of components,
  - Ease of mining

Denmark is the world champion in the degradation of demolished building materials to molecular level for extended reuse. This is good, but direct reuse of building components is a more sustainable alternative.
2. Ideation and Analysis Matrix

Combination of Two Existing Systems of Classification

Rebeauty Matrix

- Maps mined components according to building class
- Ideation and classification of new component concepts

Reuse Potential_Windows

Diagram with SfB system codes (SfB = Samarbetskomitén for Byggnadsfrågor)

Diagram of lifetime layer-structured construction (Duffy/Brand)
2. Ideation and Analysis Matrix

• Maps mined components according to building class
• Ideation and classification of re-use component concepts

### Reuse potential_Valyn

**UDGANGSPUNKT**  |  **FREMIDIG BRUG**
---|---
Funktionsmodel (Bygningsdele og grunddele) | Funktionsmodel (Bygningsdele og grunddele)
- 1. Bygningshus
- 2. Forebyggende
- 3. Komplettering
- 4. Overflader
- 5. UVOS anlæg
- 6. EI- og mekaniske anlæg
- 7. Inventør

**Diagram with SfB system codes**
(SfB = Samarbetsskommitten for Byggnadsfrægor)

**Diagram of lifetime layer-structured construction**
(Duffy/Brand)

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**Combination of two existing systems of classification**

**Rebeauty Matrix**

- Feedback to market
- Client engagement
- Practical handling
- Logistics, ease of transport
- Time and document management
- Remanufacture
- Products from comparable diagrams and data
- Based on flow diagrams and data
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Table 1. 21 material concepts representing six material categories were developed and assessed using architectural methods. 14 concepts listed in bold were full-scale prototyped, in total 19 prototypes. LCAs were conducted for 5 selected cases.
1.1. Hypothesis of energy, economy and culture as three kinds of value in renovation

It is the experience in the design and construction practice of the authors that decision-makers emphasize economy and short time economic factors. Yet, this one-sided approach to resources is not representative of the value found when material components or entire building structures have successfully been repurposed. For example, a transformed building may carry a strong identity based on previous use or the weathering of materials, and preserving the existing structure preserves resources for demolishment as well as for the production of a new structure. The same is potentially the case at other scales of reusing materials and this has formed the working hypothesis that reused materials and components represent a potential value in terms of culture, energy, and economy to be preserved and enhanced. Principles for reuse were the foundation of the cross-disciplinary challenge to find new ways to access this value and implement the Circular Economy in construction. The research and development introduced in the paper was established in the cross-disciplinary project Nordic Built Component Reuse (NBCR) [1] conducted by Vandkunsten Architects in cooperation with Nordic partners. NBCR ran for 18 months in 2014-2015 and was funded in parts by Nordic Innovation. The premise of the development work has been the vision that future construction practice will enable resource-preserving strategies, including: 1/Repurposing building waste from demolishing, dismantling, and refurbishment, and 2/Reversible construction principles known as Design for Disassembly (DfD).

1.2. Rebeauty as concept

The concept of Rebeauty was introduced in the project[1] as the artistic exploration of strategies for repurposing material components and summarized in the method introduced in this paper. Rebeauty entails that notions of beauty will keep changing and that the cultural accustoming to the aesthetics of weathering and pre-use must be nurtured as part of the transition to Circular Construction. A more formal definition of the term as a general practice could be that Rebeauty is the continuous search for beauty through artistic strategies for repurposing sourced materials and components in reversible architecture.

3. Material Concept

- Technical development and Design for Disassembly
- Architectural visualization to assess cultural/aesthetic potential

**Figure 1** Sequence of development and assessment of component reuse.

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![Figure 1](sequence_of_development_and_assessment_of_component_reuse.png)

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**Figure 1** Sequence of development and assessment of component reuse.
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FLOW DIAGRAM FOR CONCRETE prototype

- Original manufacturing
- Flow, 1, generated
- Reverse processing, Onsite
- Reprocessing, industrial scenario, Onsite
- Reuse
- Reverse processing, Onsite
- Reprocessing
- Reverse processing, Downcycling 1
- Reuse
- Reverse processing, Onsite
- Reprocessing
- Reverse processing, Downcycling 2
- Future resource

- Current production
- Aggregate, mix
- Potential reuse in new casting

- Reinforcement steel
- Casting tools
- Transportation

- Cutting of units
- Crane lift
- Stacking, storing
- Transportation
- Waste

- Sorting, manual
- Stacking, manual
- Transportation

- Brickwork / brick, new mortar, manual
- New walls, stabilized steel
- Sorting, manual
- Transportation
- Stacking, manual

- Reuse
- Reverse processing, Onsite
- Reprocessing
- Reverse processing, Downcycling 1
- Reuse
- Reverse processing, Onsite
- Reprocessing
- Reverse processing, Downcycling 2
- Future resource

- Direct reuse scenario
- On-site reuse scenario

- Recycling site
- Roadside filling, raw material
- Transportation

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![Diagram showing assessments of materials and components.]
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Vandkunsten
Conclusions

Selected components currently defined as waste, can indeed be transformed into high quality architectural design.

**LCAs for wood, glass, and brick prototypes** - but not for the concrete prototype showed that repurposing components potentially impact climate and environment significantly less than with use of new components.

Cost connected with rehabilitation processes often exceed the price of new products, mainly due to the high degree of human labour.

**Further development**

As the project challenges the regimes of current regulations and market conditions, numerous obstacles and dilemmas have been revealed, including:

>> **A technological gap**, where a mutual dependency exists between the critical demand for secondary products and the invention of more advanced demolition tools.

>> **A technological challenge** in documenting compliance with current critical limits for toxins in waste as well as technical quality.

>> **A cultural gap**, where the aesthetics of wear and tear challenge normal expectations towards buildings’ appearance.

>> **LCAs are difficult to obtain in the field of reuse** because of the numerous variables and the difficulties in documenting the exact processes.
5 VISIONS
Wood Treatment Facility
Five initiatives promoting a higher degree of component reuse
The traditional design process operates on the background of a product market with a stable stock of familiar products in well-known dimensions and of reliable qualities. With a practice of reusing components from one building to the next there is a need for more flexible methods for designing the geometry and describing the construction work.

The project aims at developing design models with clear hierarchies of construction in order to obtain less interdependency between different building layers. Hereby a wider tolerance can be achieved, which will permit a higher degree of unpredictability in size and quality.

"The target is to change the status of dismantled building components from waste to value - from a mere resource for down-cycling into a resource of identity".

Vandkunsten
The components from a discarded balcony can get another lifespan if implemented in a new building. Rails from the headstock are used locally in another building project, while the concrete column is cut into new building blocks for reversible use.
2. EDUCATION

Expertise in waste management

Knowledge of the demolition process and the recycling of building components becomes a specialty propelled at educational establishments. Specially trained experts will be able to give advice on recycling potentials and gentle demolition practice. This knowledge is channelled into society to generate a wider understanding of the need to recycle more building components.
5 VISIONS

Robots on the building site

FACTORY FOR WOOD REUSE
Wood of all sorts and sizes are analysed, handled and sorted by robots.

FACTORY FOR METAL REUSE
Metal of all sorts and sizes are analysed, handled and sorted by robots.

OBsolete CONCRETE BUILDing

Robots on the building site
Precast concrete panels are dismantled, cut on the site and reused as tiles.
3. DESIGN FOR DECONSTRUCTION

DfD

By inventing new ways of reuse, and by preparing new construction for future dismantling, substantial amounts of environmental, economic and even cultural resources can be preserved. With a voluminous home market for building renovation there is a strong potential for developing methods, tools and knowledge, which might in turn be spread out to markets outside the region.

At present, reselling and reprocessing reused building components is a very small market niche, mostly valid in the private sector, but it might be rapidly scaled up when methods of industrialisation are employed. "Genbyg" is a Danish based franchise that makes its economy from reselling used building materials.

New architectural motifs can be generated from reuse and DfD. Attractive design is very important for the proliferation of the concept. Therefore all technical solutions will be subject to careful designing, resulting in unique motifs derived from a combination of textures and attachment principles. In the spectator's decoding of the building design, the awareness of reuse conveys a significant narrative, which profiles the building's identity.

The building stock in the Nordic countries is characterised by being developed through several big leaps in the past century according to evolving stages of industrialism and corresponding demographic dislocation. As the rate of growth of new construction is descending, the existing building stock will continuously constitute the bulk of building resources. As a consequence, an increasing part of future construction activity will be related to transformation, which inherently generates large volumes of dismantled materials and components.
4. LOCAL DISTRIBUTION

Preparing material for direct reuse
5. WASTE MANAGEMENT

Salvaging and distribution