# Reuse as a strategy for sustainable building rehabilitation



Ana Pereira Roders
Delft University of Technology

# RE-USE AS A STRATEGY FOR SUSTAINABLE BUILDING REHABILITATION

Ana R. Pereira Roders, Geert-jan W. van den Brand

The construction demolition waste stream is one of societies' largest ecological burdens and it is still increasing. For example in the Netherlands, it had reached 18 million tonnes per year in 2001 (Ministry of VROM 2001). We don't intend to stop building, neither do we stop intervening and demolishing our existent built environment. As long as we don't change our attitude, landfill sites will become more and more overloaded. Additionally, in countries where the building sector already has an increased level of building materials reuse, society might deal with a "next level" phenomenon, which is the increased overload of warehouses with recycled materials stock. We believe that this problem can no longer be ignored; therefore, our current approach to construction waste management should be fundamentally altered.
The problem already emerges in the design stage, when determining the building substance / characteristics. Designers should design buildings that can easily be dismantled and adapted, not only with new, but also with "second-hand" components and materials. But is it possible to use all "second-hand" components and materials. But is it possible to use all "second-hand" components and materials, i.e. to keep them in their own life cycle, when we are looking at rehabilitation of existing buildings?

That was exactly the challenge raised to the three Dutch students attending ECOPOLIS workshop: Marieke Evers, Bastien Vievermans and Niels Oudenaarden. They received the present publication as theoretical support (Meer et al., 2006) and they were asked to go further in their final project, during the ECOPOLIS week; however especially considering the Integral Chain Management (ICM) in their design developments.

## Integral Chain Management

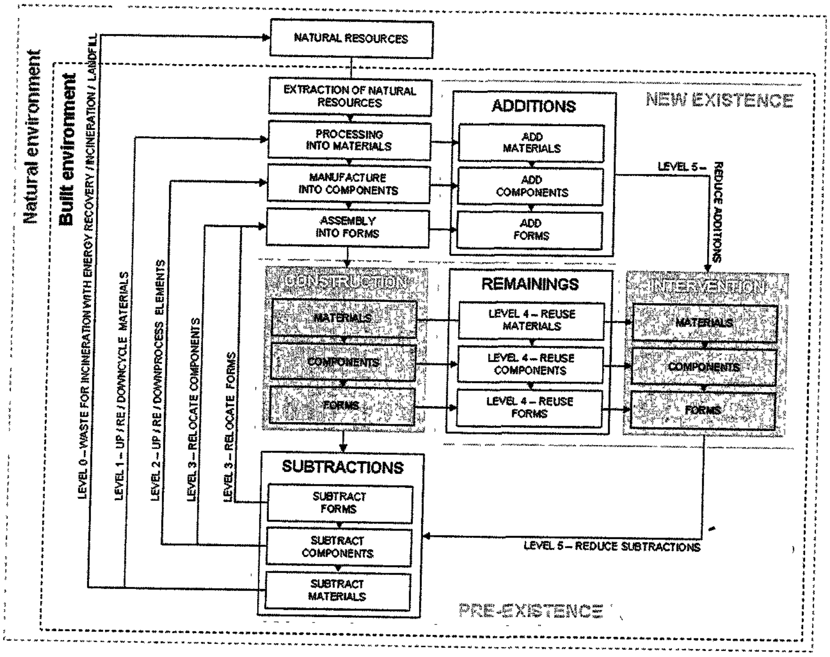
An option to minimize the C&D waste stream is to improve the current waste management, by changing it into an ICM approach. With ICM integrated in the building sector, all building materials must be reused within their own life cycle and degradation of materials must be limited. To achieve this goal, Crowther [2000] describes four different scenarios "The four scenarios for materials reuse in the built environment": recycling, reprocessing, reuse and relocation.
Figure 1 describes their viable placement within the building process: the process from extraction of natural resources till waste for dumping, through processing into materials, manufacture into components, assembly into buildings, building use, and disassembly. (...) It becomes then visible that relocation and reuse are preferable to reprocessing and recycling because in such case, materials only go one or two steps back in the building process, and the waste of resources and energy to convert it into functional is not so difficult for its effective achievement. According to Crowther's theory relocation and reuse are the most environmentally beneficial uses of waste.

## The parallel realities in rehabilitation

If relocation, reuse, reprocessing or recycling must be an option at the end of the service life, the design stage becomes very important. When de-

*The ICM method integrated in the rehabilitation design stage. (Pereira Roders, 2006)*

signing a new building it is relatively easy to improve the design in terms of demountability and adaptability. If we deal with an existing building it becomes harder to materialise such ideologies. When developing a building rehabilitation design, a designer will have to deal with different realities: subtractions, remainings, connections and additions. 'The four parallel realities in rehabilitation' shows the relation between these realities, within the pre-existence and new existence of existing buildings. In a rehabilitation process, the building's pre-existence is divided in subtractions and remainings while the new existence combines the pre-existent remainings and the new additions. The connections are added as a fourth parallel reality because they form a very important factor between the remainings and the added components, when considering future options.




## ICM in existing building rehabilitation

When dealing with rehabilitation, the designer has to deal with a pre-existence and develop a new existence. In a rehabilitation design ICM can be achieved, preserving materials from subtractions and remainings within the built environment. The subtractions should be re-integrated in the rehabilitated building, or even of another building (new or existent). Not only the subtractions, but also the additions should be controlled in such design developments.

Pereira Roders (2006) has studied both Lansink (SDU, 1980) and Delft Ladder (Hendriks, 2000) and proposes the Eindhoven Ladder, oriented towards rehabilitation designs. The Eindhoven Ladder, based on ICM, is composed by 5 levels, plus level 0 (six in total), which in ideal procedures, should be only considered when the materials have surpassed their durability and can no longer fulfil any other purpose. Due to the fact that level 0 removes the subtractions out of the built environment range, it is not considered in the ICM method for rehabilitation designs, even though theoretically it is part of it. Perceived through a ladder, level 0 is the first degree, but the worst environmental option regarding waste management. Level 5 is the best environmental option, in current practice it will appear to be the last 'unreachable' degree. When levels 1 till 5 are applied, ICM is achieved, when dealing with rehabilitation designs of existing buildings.

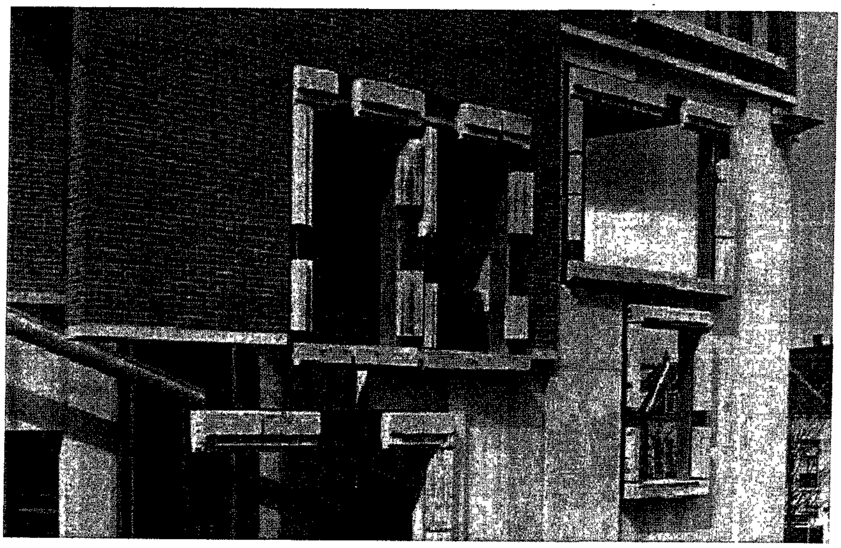
The following subchapters will briefly describe the five levels of the Eindhoven ladder.

*Table 1 The Eindhoven ladder. (Pereira Roders, 2006)*

*Respecthouse, Tilburg (Nl). (van Hal, 1999)*

*Town hall Utrecht (Nl).*

| | |
|---|---|
| level 0 | waste for incineration with energy recovery / incineration / landfill |
| level 1 | up / re / down-cycle materials |
| level 2 | up / re/ down-process elements |
| level 3 | relocation of components / forms |
| level 4 | reuse remainings: forms / components / materials |
| level 5 | reduce additions / subtractions: forms / components / materials |



**ICM Level 1 - Up / Re / Downcycle materials**

Recycling is a process where 'waste' materials are (re)processed to fulfil a new function. Three different recycling methods can be distinguished: downcycling, recycling and upcycling. These three methods can be defined as follows (De Jesus, 2005):

- Upcycling: this means turning a low-grade material into a high-grade material. Up-cycling may include conversion of timber into wall-panelling. Recycling: this means the manufacture of a new product using reclaimed or waste material, for example, turning scrap steel into new steel bars. Downcycling: this means turning a high-grade material into a low-grade material. An example of down-cycling is converting concrete slab into coarse aggregate;
- Recycling puts waste to new uses, thereby not only reducing waste ending up at landfill or inceneration sites, but also helping to conserve energy and resources. However, additional energy is still spent on manufacturing the materials. In the Netherlands some examples can already be found using recycled materials in new buildings, e.g. the ten 'Respecthouses', in Tilburg, realized by IBC Vastgoed. Due to the large percentage of recycled materials used, this project received several awards and governmental financial support. This project aimed to develop of new building products from C&D waste, e.g. window frames made of old roof trusses.

**ICM Level 2 - Up / Re / Downprocess elements**

The reprocessing of elements involves reconfiguration of existing elements or systems to restore its condition to "as good as new" (Durmisevic, 2002). Similar to recycling it can also be distinguished as:

- downprocessing,
- reprocessing and
- upprocessing.

Respectivelly, the quality of the remanufactured product should retreat, meet, or surpass the tolerances and capabilities of a new product. Such methods, as recycling, also encount additional energy to be spent on remanufacturing those elements into components or systems.
In the rehabilitation design of the Town Hall in Utrecht between 1997 and 2000, the architect Enric Miralles created a new façade with some subtracted elements. Old limestone frameworks of the demolished Registry Block were reprocessed and used as architectural elements in the façade (Jamar, 2000).

### ICM Level 3 - Relocation of components / forms

The relocation of components / forms is based on prolonging the life of the building components by dismantling the component at the end of the buildings functional life cycle and relocating it to another (new or existing) building (Durmisevic, 2002). The relocating components / forms can reduce or avoid embodied energy [Growther, 2000]. Therefore, relocation is more environmentally beneficial than recycling and reprocessing. However, energy is still required to dismantle the building and to transport the components.
An example of relocation of forms is the Polynorm dwelling, in the Netherlands. The Polynorm dwellings (1950) were built with an industrially manufactured system based on structural steelwork (the polynorm system) in the district Strijp in Eindhoven. The 212 houses were dismantled at the end of 2005 and two of these houses have been relocated and rebuilt at the Eindhoven University of Technology (Timmermans, 2005).
In Portugal the architects Victor Mestre and Sofia Aleixo realised the rehabilitation of the Carlos Relvas Photographic Studio, in Golega, between 2000 and 2004. They chose to remove some elements of the previous intervention, in order to restore the coherence of the original photographic studio. So, the building was partly dismantled, and those components which were not relocated in the design, were sent to an archive. For example, the roof tiles were dismantled from the Photographic Studio and were relocated in the roof of the additioned building (das Neves, 2004).

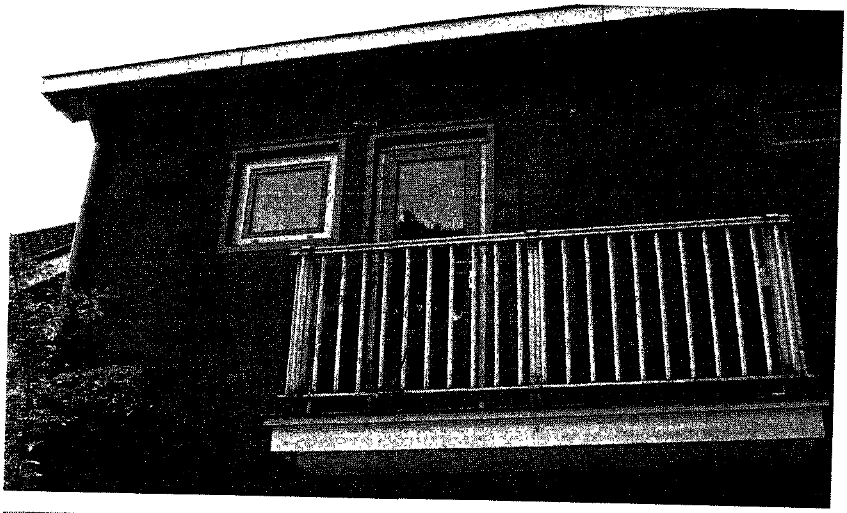
### ICM level 4 - Reuse remainings

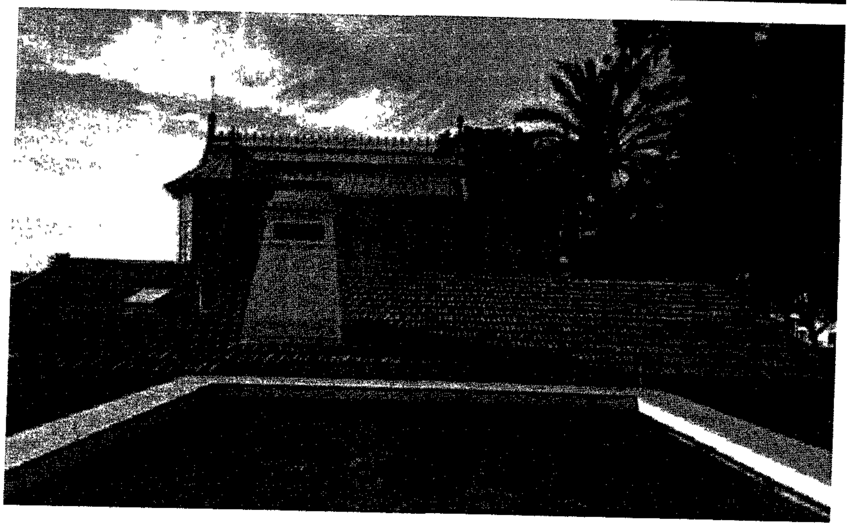
The materials, components and forms of the building that will remain can be reused and form the new existence, together with the additions. This way of keeping the building materials in the built environment is the more environmentally beneficial than the earlier options, because hardly energy is required to keep / preserve the materials in the built environment.
On the Eindhoven University of Technology campus an example of reusing the remainings of a building can be found: Vertigo, the building for the Department of Architecture, Building and Planning. The main structure of reinforced concrete (primary elements) of the building, was reused, which lead to a reduction in the use of reinforced concrete of about 13.800 tonnes (de Jonge, 2002).

*Polynorm, Eindhoven Nl. (Timmermans 2005)*

*Photographic studio, Golega Pt. (das Neves, 2004)*

### ICM Level 5 - Reduce additions / subtractions

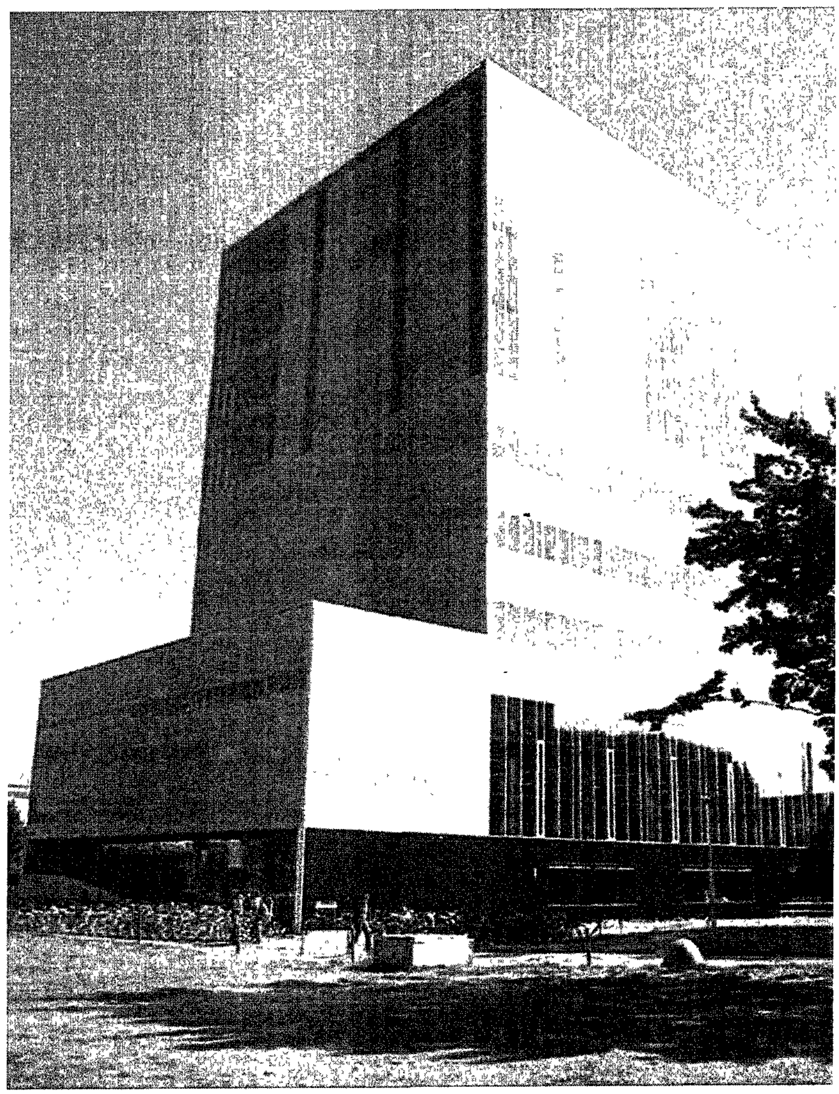




With a rehabilitation design, there are always sutractions and additions. Level 5 intends to integrate into the rehabilitation design stage, the reduction of unnecessary subtractions, as well as, of unnecessary additions. By not extracting natural resources for the additions, the designer will be preventing and preserving the natural resources. Consequently, also by not subtracting from the pre-existence, the designer will have more remainings to reuse, and won´t spend energy for the subtractions. Of course, there cannot be rehabilitation without additions and subtractions because the rehabilitation intervention improves the performance of the building. However, when considering the ICM approach, while designing and taking decisions, the probability of reaching higher degrees in the Eindhoven Ladder are considerable.

### Conclusion

The viability of ICM for existing building rehabilitation designs, has reframed Growther´s four scenarios, within Pereira Roders's four parallel realities. The scheme shows the possibilities of keeping the building materials within the built environment. The examples presented show that it is already possible to use recycled, reprocessed or relocated building materials, components and forms, so it is possible to apply ICM to the existing building stock. However, it is hard to determine if the materials in these examples, which went still to incineration / landfill sites, were effectively highly degraded or just had no other destination. If designers start using more second-hand materials, this market will grow and the possibilities for ICM in the existing building stock will increase. When the five levels are followed, as much as possible, the C&D Waste will decrease. However, the viability of these methods may vary according to the design and building.



*Vertigo, TU/e Architecture faculty building, Eindhoven Nl [TU/e, 2005].*

**REFERENCES**


MEER S.E. VAN DER et al., *Minimizing C&D Waste through rehabilitation*, Adaptables 2006, Eindhoven.

DURMISEVIC E. 2002, *Design aspects of decomposable building structures*, Conference proceedings of TG 39 conference 2002, Germany

CROWTHER P. 2000, 'Building Deconstruction in Australia', Meeting of Task Group 39 'Overview of Deconstruction in Selected Countries', Watford, England, 19 May 2000, pp. 14–44.

HENDRIKS CH.F. 2000, 'Nationaal congres Bouw- en Sloopafval, kwaliteit in de keten', the Netherlands, in *Hendriks*, 2001.

HENDRIKS CH.F. & TE DORSTHORST, B.J.H. 2001 *'Re-use of construction at different levels: constructions, element or material'*, CIB World Building Congress, New Zeeland, April.

JAMAR J. 2000, *The town hall of Utrecht*, Uitgeverij Matrijs, Utrecht; in *Hendriks*, 2001.

DE JESUS A. 2005, 'Green Architrends; Demolition or deconstruction?', *Philippine Daily Inquirer*, B2-2.

DE JONGE et al. 2002, 'Dilemmas, shifting between extremes', in *Bouwstenen: Beyond Sustainable Building*, Eindhoven University of Technology, Eindhoven, pp. 95–114.

MINISTRY OF VROM (Housing, Spatial Planning and the Environment) 2001, *Construction and Demolition Waste*, Directorate for Substances, Waste and Radiation Protection, Factsheet, Ministry of VROM, The Hague, June.

DAS NEVES J.M. 2004, *Victor Mestre Sofia Aleixo - Restoration of time*, Caleidoscópio, Casal de Cambra.

PEREIRA RODERS A. 2006, 'Re-architecture: lifespan rehabilitation of built heritage', Eindhoven University of Technology, Eindhoven, April (draft version).

SDU 1980, 'Report of parliamentary debates 1979-1980', Den Haag; in *Hendriks*, 2001.

TIMMERMANS G. 2005, 'De Polynormwoning', Bouwpers 10, Eindhoven University of Technology, Eindhoven.