URBAN MINING AS A DRIVER FOR TEACHING ARCHITECTURAL DESIGN

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ABSTRACT: To teach sustainable architecture is an ongoing process of establishing a frame where the students' creativity can be challenged by dealing with actual demands on the anthropogenic scene. To use Urban Mining as a driver has been one of the most challenging teaching approaches for many years. This approach involves a complex journey from investigating and harvesting local resources to gaining insight into metabolism and finally to designing a project of diversity. The methodology used was based on industrial ecology. By realizing local resources and their potentials, the students acquired knowledge of available materials, and components and as well as their upgrading or downscaling. The design process explored ways of interconnecting the mined resources and to establish businesses based on these interconnections, producing economic value and social identity for the locals. Working on a site characterized by abandoned buildings was a challenge. Both human and environmental aspects were implemented in the project to meet the necessity of future responsible architecture. The discussion sums up the experiences acquired during a semester course at the graduate level and speculates how the material flows could be utilized, if a better and easier access is established located at the urban areas. The conclusion argues that there is a need for critical studies and change in the waste industry which would provide possibilities for new perspectives in architectural design.

Keywords: urban mining, teaching, local materials, abandoned buildings, transformation, social space

1. INTRODUCTION

1.1 Going beyond the current way of managing waste

It is necessary briefly to characterize the actual situation: Waste management in Denmark is regulated by law. All waste is either collected by the municipality or delivered by the waste-producers to recycle stations, the companies and the building sector. Danish regulations urge households and companies to minimize their waste (Denmark without Waste 2014). Every disposal must be sorted prior to delivery. Waste is sorted at the source in fractions, fractions are handled responsible. Hazardous waste has its own treatment codes. Non-hazardous waste is incinerated and used for district heating.

This paper suggest to go beyond what is legislated and insists on exploring the significance of circular loops not only to the amount of waste or to the economy, but even more interesting to a new quality of the architectural design (Hinte et al. 2007).

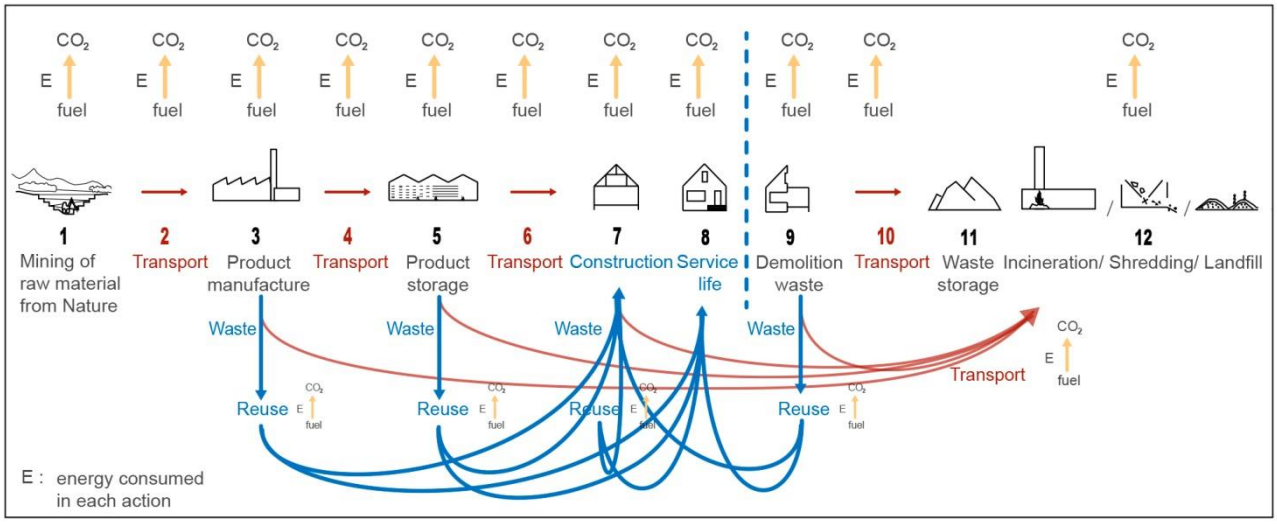

Figure 1. Waste return

1.2 Developing a new architectural design process that exploits Urban Mining

After conducting several educational courses dealing with subjects such as ´Strategy of Reuse´ and ´Sustainable Transformation´, we have discovered the need for two main subjects of research: How to identify relevant waste to architecture? What does waste mean to the design process and results? The intention was to integrate local resources in the form of manpower in a more human design. While exploring the possible didactics for teaching we contacted the Dutch firm Superuse Studios, Rotterdam (Superuse Studios 2016) with whom we started a collaboration conducting a semester course at Aarhus School of Architecture.

The purpose of the semester outcome was to build with neglected resources and to demonstrate the usefulness of such resources to architecture and to business enterprises (Martin Jiménez, 2015 a). By bringing together the themes ´Sustainable Transformation´ and ´Urban Mining´ we saw excellent possibilities to establish a holistic understanding all the way from the approach to the project to a responsible result. Through the semester course Urban Mining was always a central element of the creative process.

Through their education the students are taught Problem-Based Learning (Knudstrup, 2004) in order to handle an integrated project: integrated form generation means including all relevant form parameters in parallel when designing an architectural product, ranging from the contextual to the culture-bearing, the aesthetic and experimental, to parameters related to the environment and resources, as well as to technical issues and production. The knowledge and the range of considerations regarding a design strategy necessary to quality which is more holistically-oriented is acquired with the help of a series of workshops, lectures, preliminary studies and trial sketches. The project foundation and the strategic reflections are summarized in a program for the project work (Vestergaard, 2012).

The students conceived unconventional business models by realizing local waste and interconnecting outputs. Through this work the students obtained an insight into materials, components and upgrading versus downscaling. They learned about the area, and they were able to identify the existing infrastructure most adequate for their business model. Against this background they gained an inside knowledge of the concept, which was decisive for the architectural design of multi-facetted projects.

The content of this paper will briefly in chronological order follow the educational process of the curriculum (Vestergaard, 2014) and how we prepared and programmed the transformation of an abandoned suburban area with abandoned resources by using Urban Mining (Cossu, 2013). Finally one student's promising project will be presented and commented by pointing out the directions which might be taken in future Urban Mining in relation to building materials.

2. METHODOLOGY

The methodology followed through the semester is based on industrial ecology, and applied into the urban environment as system analysis and urban metabolism (Jongert et al., 2009 a). The thinking behind the methodology is based on analogies between the basic conception of nature and the conception of the anthropogenic society, parallel to nature where all waste are nutrients for other species

(McDonough and Braungart, 2009). We see the industrial ecology from the same viewpoint: all resources must be kept within circular loops in order to avoid waste for incineration and landfill. Often waste is understood as solid waste, but in our case we also looked for additional waste sources such as wasted clothes, food, energy, wasted humidity and water in order to draw parallels to a more holistic system as the Kalundborg Symbioses have dealt with (Jongert et al., 2009 b). To understand the complex industrial ecosystem we studied the System Thinking phenomenology as elements, interconnections and purpose (Meadow, 2008).

The aim is to reuse at a systemic level the energy, the material and the economical flows in our environment and thereby allow these flows to contribute positively to design. Positive influences in relation to the users' needs, the client's interests in their environmental impact and ultimately in the quality of the resulting design (Jongert, 2013).

3. URBAN MINING IN AN INDUSTRIAL AREA

3.1 Planning Process

In the following the planning process will be summed up in a condensed form: An appropriate site on the outskirts of Aarhus was chosen. The area is an industrial park characterized by mixed production, storage and office buildings situated south of Aarhus. During the economic crisis in 2008 the production stagnated and 80% of the buildings have been out of use since then. The size of the area is 45.000 m^2 with many abandoned buildings. The municipality does not pay attention to such areas, but there is an urgent need to create hope and positive development here.

We tested the area for potential buildings: we found 10.000 m^2 office buildings, which hadn't been rented out for the last 10 years. We got permission to use one of the production halls as our workshop for a couple of months. In that way we could work on site.

We prospected the area for waste resources and examined the materials for building possibilities and their availability. We found much of waste. The local companies were very astonished by our interest in their waste. In fact many of them were open minded to our project. Other companies were already aware that their waste was an attractive resource; therefore they were reluctant to donate the material. Some industrial companies pointed out to us, that they had no waste at all, since they used it to retrofit their production.

3.2 Developing Process:

3.2.1 Mapping the area and digital market place

Figure 2. Mapping the area, discovering materials and registering them at a digital market

The preliminary phase consisted of two segments of investigations:

For the students it was essential to detect local waste with information about its quantity and frequency of production. All kind of waste was registered (Figure 2). The knowledge of the urban mining was organized in Superuse Harvest Map (Harvest Map, 2016).

Another investigation regarding the potentials of the urban area and the functional lacks was carried out. The students learned a lot about the area through street interviews: what was the local history? What was happening at the moment? What did local people wish for the future?

3.2.2 Prototyping and performance

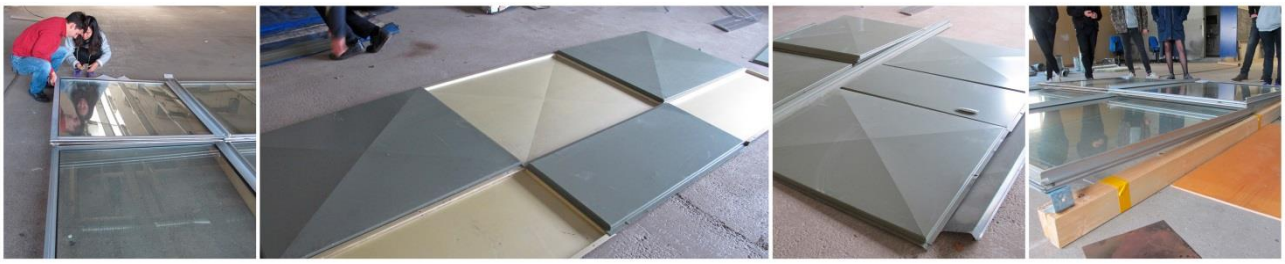

Figure 3. Prototyping, improving the buildings performance

Next phase was to build prototypes and improve the building's performance. Prototypes were constructed in scale 1:1. As an example is shown a prototype of a greenhouse roof built with discarded windows from a retrofitting site nearby (Figure 3). This prototype may serve to enhance of urban farming, provide additional roof lights or as insulation reinforcement for the building roof (Martin Jiménez, 2015 b).

3.2.3 Existing buildings as potentials for mining

The office buildings are from the 60s. They were first used as headquarters for a construction firm and later as a school. The system is very regular and effective, but

with bad daylight conditions. Buildings are rather ordinary with very deep building depth and lots of concentrated square meters (Figure 4). A transformation was needed to bring daylight into the core of the building. The structure is established from concrete panels, which is a pragmatic building system.

Figure 4. Existing buildings as potentials for mining

3.2.4 Developing possibilities and a business model

Materials were analyzed by flows and output. As answer to the needs registered at the local area different business models were sketched. The most successful models integrated unemployed people, building transformation and urban mining at the site, adding waste resources from the neighborhood into the program.

3.2.5 Programming the architectural project

Figure 5. Textile workshop for local women

As an example for this paper we have chosen the project `Textile Workshop´. The workers are meant to be unemployed Arab women living in the nearby social housing area. The raw materials for the production were mostly old clothes and other textile waste harvested in Aarhus (Figure 5). The transformation of the given vacant building was intended to give these women a comfortable and daylit working place that resembles a traditional Arab home, with its spatial organization around a central courtyard, which provides both daylight and privacy from the outer world.

3.2.6 How to design on the basis of Urban Mining

Figure 6. Sketching the glass roof, from ideas to detailing

The building materials applied to the transformation were mostly mined materials from the area, such as aluminum windows from renovation works or cardboard tubes from nearby paper industry. From the building itself was mined both concrete slabs and acoustic ceiling panels. To bring daylight into the building volume was crucial for better comfort and the challenge of human space inside the building. A greenhouse glass construction solution was investigated by using the mined windows (Figure 6). The students played with materials and proceeded to more precise decision on joints and detailing.

3.2.7 The actual architectural design

The design process started by looking at the entire volume of the building and thereby drawing up a strategy for establishing better relations between spaces at all levels, creating spatial atmosphere and enough daylight for the working spaces. The structural system was analyzed and compared with daylight studies in order to create the interior atmospheres for the employees.

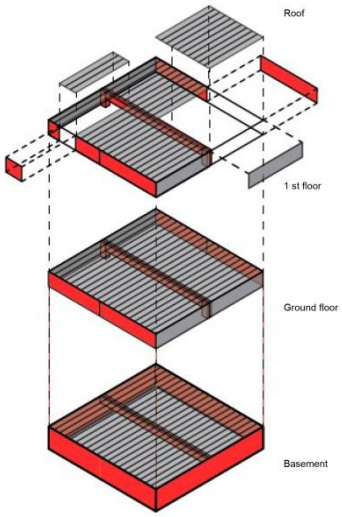

Figure 7. Analysis of the building structure

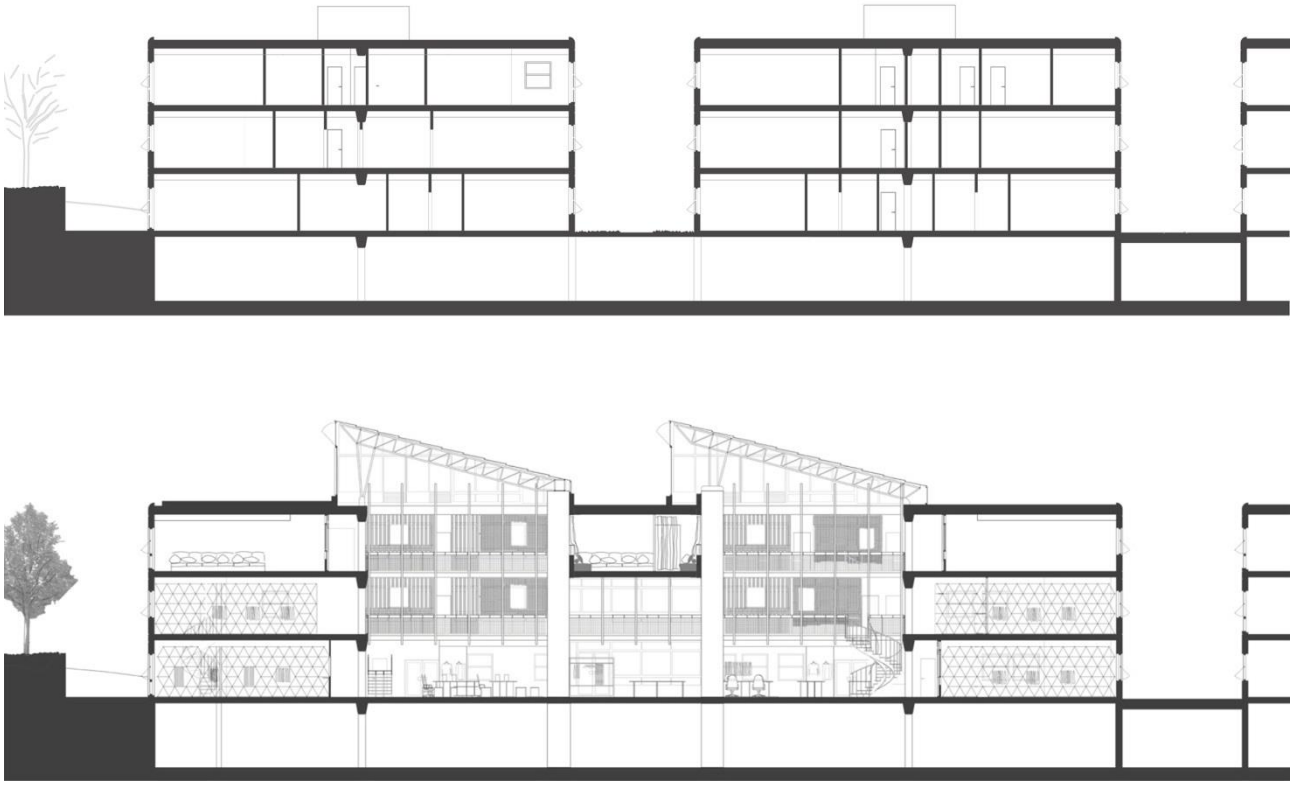

Figure 8. Section showing the principle before/after removing the slabs to create space and light

This analysis opened the possibility of removing several slab elements (Figure 7), and creating an important intervention which opened both the roof and a horizontal division between the ground floor plan and the two upper floor plans. A new space concept was conceived of using urban mining inside the building (Figure 8). This intervention permitted both spatial communication and the possibility of a skylight over an indoor courtyard. Some of the horizontal slabs were converted into columns and beams for the new structure. Minimal waste resulted from this intervention, and maximal use was given to the three floor plans.

As a result the transformation of the existing structure provided a solution to the task of the program: to give the women a working environment, where they can feel comfortable and relaxed while working in a social atmosphere. The character of the main sewing hall is intended to be similar to a domestic living room and to an Islamic courtyard with its plants and water fountains. The whole new structure of spaces consequently seeks to resemble a traditional Arab Islamic home with its courtyard, its galleries and private rooms, all together providing soft transitions between public and private rooms. This is done by lattice screens.

Figure 9. Indoor courtyard and two story-high galleries

The main working area is situated in the core of the house, expanding across the two building blocks under the blue light of the sky falling through two new glazed roofs (Figure 9). The two new indoor courtyards are linked through a two story-high gallery built with the concrete slabs, which have been removed prior to opening the courtyards.

Figure 10. Construction isometric showing resituated slabs, wasted material and indoor glass walls

The materials mined nearby serve to build the new interiors. Like the glazing components from dismantled facades, which are reused for the walls along the galleries and for the skylight glazing. Cardboard tubes and profiles from the paper industry are reutilized as lattice elements in the galleries. Chromed steel supermarket shelves serve as railings. Surplus acoustic panels from the very building display triangular meshes, which work as open shelves (Figure 10).

With the exception of the structural material for the glazed roof, all materials utilized for this building transformation are mined locally within a radius of two kilometers.

4. WHAT DID WE LEARN?

The goal of programming in an industrial ecological system is to achieve an awareness of both the economic and the environmental challenges. In our case the transformation of the buildings and the management of the intervention had to employ people from the local area and had to minimize investments. To fulfill this goal urban mining proved to be useful.

Working on a site in the suburban area, interviewing real users and exploring materials, the students acquired knowledge and practiced their communication and craftsmanship skills.

Through the process of urban mining and the following integrated design process the students realized, in the scale of one to one, a lot of unexpected resources. To design architecturally with these random materials provided insight into the very special design process of operating in a concrete situation and letting the design follow certain unpredictable rules determined by wasted objects, which were predestined for other purposes. The creative way of thinking required abilities to explore and improve, but did also encourage a playful attitude to design. The results were diverse, and had also the quality of telling a story about the local area and the leftovers from former activities.

The students discovered how many potentials the existing buildings have for urban mining. The buildings have their own logic, and by respecting and investigating the pragmatic structure several challenging spaces were created. Combining these investigations with daylight studies a new inner courtyard was designed. The extruded concrete slabs were decisive for the design of beams, columns and railings. Heavy concrete elements can be difficult to operate, but can also be changed into an advantage.

By playing with the urban mined resources and developing appropriate detailing, the students discovered how to design with a focus on disassembly and

development of the mechanical joints: the best results gave the components an aesthetic elegance.

5. DISCUSSION

If we, in the future, intent to rely on circular economy within architecture, we must acquire new habits and develop new technologies: when deconstructing the urban and rural anthropogenic areas, it is decisive to use selective working processes. A lot of materials are wasted and downscaled through the actual demolition processes, based on the economic argument of getting rid of the material in a fast and effective way.

We see a lot of downscaling within the building industry. If only looking at the material stream from the building site in our area and only focusing at the south side of the buildings, we have estimated a constant flow of materials over 3 years from the demolition of 13.300 m^2 reusable glazing, and 4960 m^2 of reusable metal cladding. Multiplied by estimated 30 large reconstruction sites running at the moment in Denmark the amount is 399.000 m^2 glazing and app. 15.000 m^2 cladding. One can only speculate about the increased development in terms of activity and economy if such streams were utilized. Utilization could also be an advantage for the environment.

When upscaling the waste it is important to look at the imbedded qualities of the actual resources and to reuse these qualities in the design. This also requires a strong storage strategy, which can improve the aspects from deconstruction to new utilization. Deconstructed materials should be easily accessible to the public through a digital market place as Harvest Map.

When constructing a new architecture we must use the best techniques for assembling the structure. The urgent demand of this higher quality is that architects and designers must qualify their skills with responsibility when joining materials and elements together without making composites, and instead designing and building for disassembly.

Architects and designers should create a palette for common solutions and components of recycled resources.

An important aspect of urban mining and building with waste is to establish a control system for the content of toxins in the waste, and how to neutralize these dangerous substances.

6. CONCLUSIONS

The projects showed the participants that there are enormous undiscovered potentials in mining in an urban context. The way we treat the waste flow as a linear process must be changed and brought into circular loops. It is also obvious that there are lots of barriers, of which the participants only saw a few. There is a need for critical studies and change in the waste industry. In total the entire project showed a lot of promising aspects, which have to be investigated and developed further in terms of habits, lifestyle, economy and responsibility to the environment.

As a final statement one could say: there is a need for new ideas and new designs.

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