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Vestergaard, Inge; Martin Jiménez, Guillermo

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Exploring secondary resources in an architectural project

Inge Vestergaard, corresponding author
Aarhus School of Architecture
vestergaardark@gmail.com

Guillermo Martín Jiménez
Independent researcher
guillermoelan@gmail.com

20190601ive_gmj

Abstract
The research aims to explore to what extent secondary resources can provide a response to architecture at a time when the building sector overspends the use of primary resources. The research illustrates, at the scale of a neighbourhood, how natural metabolism can be transformed into a technical metabolism, pursuing to implement industrial ecology. The investigation is multifaceted and takes its departure in the secondary resources of the Anthropocene. In order to understand the question of resources, local resource streams are studied. The secondary resources found are salvaged and mapped. The possibilities for integration of human resources are analysed. Inquiries on how streams of specific resources may flow in circular loops are used as design drivers. A focus on circular sustainable business models is explored. Qualified potentials are finally reflected in a set of design intentions. These intentions constitute the architectural case project. The findings mention the aspects found at the different research activities: from investigating industrial ecology to the concrete salvage of resources, and how to turn the resources into building components. Integration is achieved by realising how locally found resources have the ability to narrate the aesthetics and identities of the site. The case project illustrates an architectural design answer that relates to its context, reflects the history of our social welfare architecture and expresses a built environmental diversity as an architectural patchwork that offers a proposal for new social facilities for the housing area. The discussion draws upon some open perspectives from other initiatives in society where industrial ecology has been used to overcome the complex questions of reorganising already existing waste management habits.

Keywords: secondary resources, circularity, business model, assemblage

Introduction

The Danish Waste Statistic from the Ministry of Environment states that the Danish Building Industry produces 35% of all waste produced in Denmark (Miljøstyrelsen, 2016). A report made by the EllenMcArthur Foundation for the Danish government claims that the built environment as construction and real estate sector has major potentials for reuse and for circular economy (MacArthur, 2015). Statistics shows that 87% of the building industries waste is utilized for recycling, 6% is stored in land fill and 7% is burnt in the incineration plants (VCOB, 2019). The ruling resource treating process in Denmark is recycling, which represents a process of using a lot of energy and labour force as well. A precondition for this research is to reuse waste as resource for architecture. The research investigates how the potentials of reuse in its extreme form are possible for architecture in future; it is about identifying workflows that save resources with already inherent qualities and thereby optimising circularity.

The research aims to explore to what extent architecture can provide a response to our contemporary overspending of resources. The research investigates how secondary resources in the building industry can play a predominant role in architecture. ´Secondary resources´ are those material resources that have been used before, while ´primary resources´ equal virgin materials. This technical terminology is used in the essay in order to emphasize the view of ´waste´ as a ´resource´. The intention is both to create artistic and meaningful architecture, and to create technical circular loops understood in parallel to those in nature. The term ´nature´ is used as a frame to understand the current discussion on circularity (McDonough and Braungart, 2009).

In order to understand the building sectors complexity regarding resources, system theory is taken into account (Meadow, 2008). By relating systems theory to the familiarity of ecological networks, which consists of links as interrelations and notes as actors (Ecological network, 2019), a theoretical platform for this research is shaped, namely to study the technological streams of resources and their relations. Both human and technological aspects are included in the architectural creation.

The Dutch office ´Superuse Studios´ sees sustainability and ecology as an affordance for the future. They claim that the answer to the problem in every architectural project relies on the demands of the users, to value for the users and the society, and how to realise this through production with an affordable economy (Jongert, 2013).

> *"There may be methods to reuse what has already been made to circumvent this waste of effort. Because of the sheer amount and diversity of waste, it is highly likely that at least some of all that stuff can be put to use in a new design, provided the designer has an open mind for the implications. On the other hand not every design is suitable to be made out of waste. The important thing is awareness of the interaction between design and the availability of existing materials.*
> *...generally a building can be considered to consist of a hierarchy of ingredients, in which the highest grade, the building itself, has the most value added during its production process. The lowest is raw materials; the kind that is produced in bulk…At a higher grade we find what is material. It is composed of raw material and has certain dimensions but not, or not entirely, the proportions and shape it will have when it has found its application"…*
> (Hinte, Peeren and Jongert, 2007)

The quotation mentions dreams on how to get closer to a vast circulation of resources. Regarding reuse of resources several initiatives have been launched recently, both in the public and the private sector: the EU directive on waste (European Union, 2008) has been followed by cross-industry global initiatives to help

scale the circular economy (MacArthur, 2012; WEF, 2014). These initiatives have led to a questioning of the current waste management systems. Furthermore, they point at ways of improving the existing systems, such as selecting waste at the source, harvesting materials before they are down-cycled in the public waste-system, and how to value waste in general.

The case project in this paper informs the research with knowledge for comparing the contemporary discussion on circular economy with the existing building practice. In other words, it is here the intention to contribute to the discussion of circular resource management from an architectural point of view. That is, to consider the implications for architecture and its artistic expression of working mainly with existing buildings and materials, while supporting circular business models.

The research questions are: How to identify, to map and understand the secondary resource streams and the complexity of industrial ecology? How to create and offer an architectural design that embraces local secondary resources?

Methodology

The research has been developed within recent years in the graduate studio ´Approaching Sustainable Architecture` of Aarhus School of Architecture. The curricula of this studio have challenged the general attitude toward architecture making sustainability a main theme based on its actual relevance to society (Vestergaard, 2014). Specific working methods involving sustainable parameters have addressed research in learning methods (Vestergaard and Henriksen, 2012). The complexity of sustainability is implemented in the design process (Vestergaard, 2012; Vestergaard, 2014). The designs aim at exemplifying the affordance of responsible ways of managing our resources locally.

The specific attitude in this educational approach is not different from a professional attitude to research: the mapping, the analytical work and the design process could have taken place in an architectural studio or in a scholarly research group. The present essay is a reflection on the assignment and its results.

Since the ´70s the teaching methods of Aarhus School of Architecture have been focused on Project Based Learning PBL. When problems are used as the starting point for an assignment the combination of ´problem-based´ and ´project organised´ approach to design will lead to PBL (Graaff and Kolmos 2003, Knudstrup 2004). Years of experience show that applying the PBL method opens up a lot of new opportunities, which enrich both the project and the reflections useful for further research (Vestergaard & Henriksen, 2012).The architectural working method is divided into two main processes: one is to identify, to map, and to understand the problem in its complexity; the other is to create and offer a design as an answer to the problem.

The Superuse methodology is recognised for a deep understanding of how the systems of nature work. If the resources are identified and visualised, then it is possible in an urban area to harvest and utilise relevant amounts of these resources. Resources can be understood as users, urban fabrics, buildings, materials, productions, infrastructures etc.. Underlying this vision there is an understanding of society, economy and design grounded on fundaments of sociology, biology and anthropology and their interrelations; this forms a system of interconnections.

To integrate secondary resources in an architectural project demands a systemic search for resources. To this purpose, the research applies the methodology of Superuse Studios regarding the search for streams of resources occurring near the site (Hinte et al., 2007). In addition the studio unit studied theory on circular design strategies (Jongert et al., 2009 and 2013) prior to the beginning of action.

An expanded investigation of an urban area is multifaceted and grounded in the conviction that an assessment of secondary resources spreads the architectural field to territories not explored before. In fact a spectrum of methodologies is applied in order to seek comprehensive knowledge and to prepare, investigate,

develop, and finally create the architectural design.

The graduate studio visited and interviewed production sites and stores located nearby in order to map the resources. Once being recognised the resources were registered in an online database of open access (Harvest map, 2016; Vestergaard and Jiménez, 2016).

> *"A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models"*
> (McArthur, 2012; World Economic Forum, 2014).

Through this preliminary work of awareness the students of the graduate studio became acquainted with the meaning of ´circular economy´, and therefore with the understanding of the multiple networks through which resources stream in a society.

When new innovative roads are taken, it is important to conceive unique business models. The business model is significant for the content of the project and for giving new perspectives for development in a specific local context. When a Superuse project has started, it is important to create reasonable business models depending on users, resources and an appropriate place. From different accessible resources close to this place a lot of preliminary preparations are done: interviewing the locals, identifying resources in a wide perspective, utilising working power at the nearby area, and investigating the local municipality is subsidising working power. The business model, which is a project in itself, operates with local secondary resources and addresses concrete issues of the local community. (Figure 1). An evaluation of the different business models was proposed, one was chosen to be developed into an architectural research project (Vestergaard and Martín Jiménez, 2016).

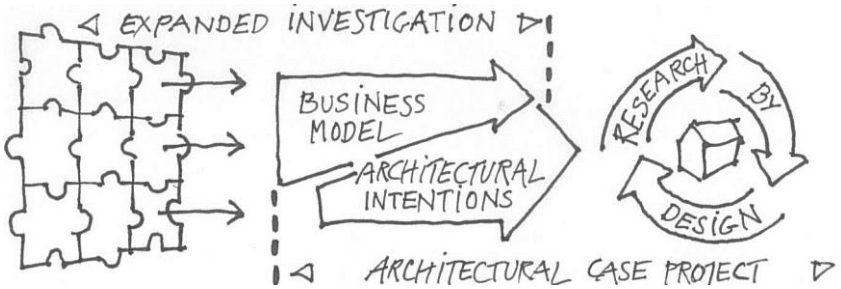

Figure 1: Working process illustrating the whole project complex and connecting the methodologies with the concrete investigation and design process for the architectural project. From left to the right: Puzzles represent site investigations, users' needs and mapping of the secondary resource, all the information for the development of the business models. One chosen business model translated to architectural intentions, which are the background for the design project developed in an iterative working process. (ill. Vestergaard)

A definition of the specific architectural intentions follows, in which the context, the functional purpose, and the means of realization are described and articulated as design parameters (Vestergaard and Henriksen, 2012). In the chosen specific design proposal, the purpose or functional intention is a circular business.

Interviews in the streets of the neighborhood provided important information on the overall needs that had

to be addressed. In the context studied, the most relevant challenges were a high level of unemployment and a certain degree of social segregation of the community from the rest of the city.
The means of realization of the project are based on the recovery of local secondary resources. In such an approach to architectural design, the local resources are utilised in two main ways.

The first way is as resources for the business, and their manipulation, such as redesigning in some cases or energy transformation in others, will create values of multiple natures e.g.. The second way in which resources are reactivated is as building materials or components, and their integration into the architectural design will create values inherent to architectural expressions, such as values of utility, beauty, history and ecology.

The last methodology integrated in this research is ´Research by Design´. It is the preferred design methodology by Danish architects when they want to give a holistic answer to a task, fulfilling the qualities of the ´Vitruvian triad`: durability, usability, and beauty (Vitruvius, 30- 15 BC).

> *"Research by design is any kind of inquiry in which design is a substantial part of the research process.*
> *In research by design, the architectural design process forms a pathway through which new insights, knowledge, practices or products come into being.*
> *Research by design generates critical inquiry through design work that may include realized projects, proposals, possible realities or alternatives.*
> *Research by design produces forms of output and discourse proper to disciplinary practice, verbal and non-verbal that make it discussable, accessible and useful to peers and others.*
> *Research by design is validated through peer review by panels of experts who collectively cover the range of disciplinary competencies addressed by the work.*"
> (Hauberg, 2012).

This definition has been elaborated on and developed in the teaching practice of Approaching Sustainable Architecture Studio at Aarhus School of Architecture in order to investigate design methods for an artistic approach (Vestergaard, 2012: Vestergaard, 2014).

Case: expanded investigation

The following presentation will fold out the case and show how the methods were used for developing the project. The different phases referring to Figure 1 are written in a linear form, but it is stressed that also the process flow and the singular investigations and results are done in an iterative working process.

The site for the research case is a modernist housing area from the welfare states birth in the late 60s in a typical suburb of the southern periphery of Aarhus, in Denmark. The housing scheme of the area is a compound of three and four-storey residential blocks, a single-family housing area, and a park of offices and small industries.

There are some institutions that service the housing areas: a secondary school, a primary school, a kindergarten and an after school club childcare. A small outdated single storey shopping centre constitutes a resource for the project. The shopping center is framing a quiet urban square and a parking lot, which is an appropriate place for new businesses. The buildings around the shopping center have great potentials for revitalization and remodeling. Over the last years housing areas in Denmark have undergone through important renovations. Their aim has been to convert the mono-functional housing areas into diverse and multifunctional cityscapes. The goal of such transformations has been to upgrade the modernist suburban residential areas to lively and well-functioning urban areas (Vestergaard 2017). The purpose of the case project is to transform and upgrade the existing environment by profiting from on-site resources.

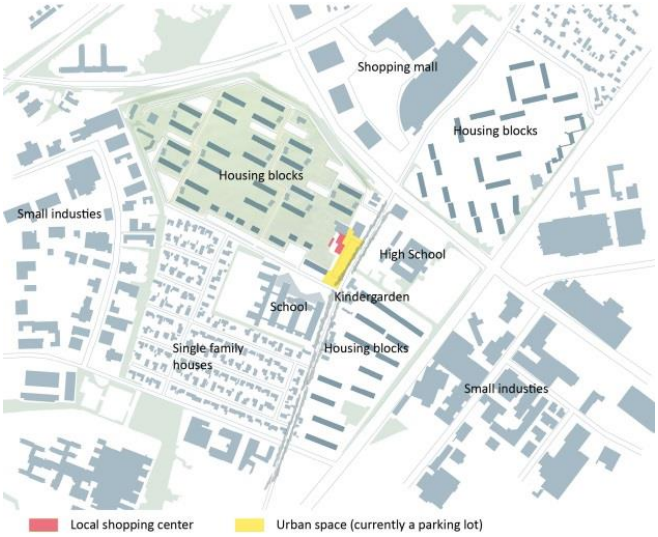

Figure 2: The lay-out of the modernist housing area is surrounded by the urban fabric of detached houses, shopping centers and institutions. The local shopping centre and urban square are marked. Illustration Martín Jiménez.

Mapping human resources and user needs: The majority of the neighbourhood´s residents are families of immigrants from the Middle East and East Africa, who arrived in Denmark since the ´70´s. The unemployment rate is high among them. It is especially the women, who in most cases are mothers of several children, who find it most difficult to integrate. These women have found a hobby in sewing together with other women from the neighbourhood. In an adjacent building, the local social services have been running for years a small textile workshop for the residents. The workshop is an initiative aimed at teaching the participants skills in order to open a door to the labour market for them. The products are sewn mainly from old clothes and are charming samples of clothing redesign. The workshop sells their textile products in craft markets twice a year. The participation in the workshop and the sales in markets have a positive effect on the trainees, improving their self-confidence.

Figure 3: Examples of building waste found locally: window glass, construction timber, aluminium doors and windows, and chromed shelves. Photos Vestergaard.

Mapping secondary resources: The precondition of the mapping respects the Superuse methodology´s principle of seeking to keep the components as untouched as possible in order to preserve the components´ values (Figure 3). There are several arguments for the convenience of minimizing fragmentation on reused

components: to cut the material in smaller pieces compromises their functional qualities, their original shape, and structure; additional consumption of energy and consequent CO2 emissions are needed to fragment the product. Such an added environmental footprint is also incongruent with the purpose of saving resources and can reach significant numbers; a whole element has more value when reused in future assemblies; and lastly, on an aesthetical level, there is an inherent beauty in the specificity of shape, structure and colour of almost any component, which becomes visually powerful and surprising when designed to a new purpose. However, this power is somehow unrecognisable and lost when the element has been fragmented.

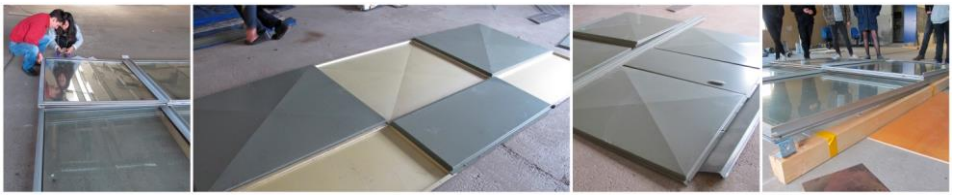

Figure 4: Exploring the aesthetic potentials of secondary resources. Photos Vestergaard.

In this case the secondary resources found were surplus materials that were being discarded by stakeholders as by-products of their systems (Jongert, 2013). A scan of the site surroundings identified several building materials, of which the most relevant were: cardboard profiles and tubes from a printing manufacture; chrome steel shelves from a large supermarket chain, and a regular flow of small aluminium composite panels. These materials have functional and aesthetic potential for being adapted to indoor spaces (Figure 4).

At the time when this case was elaborated, the twenty-seven residential blocks from the area were under transformation. The south facades, which were made of steel cladded balconies glazed and sliding windows of aluminium, were being entirely demolished and renovated, while the north ones were being modified by external insulation and new windows (Vestergaard and Jiménez, 2016).

The secondary resources found in the neighbourhood were of multiple kinds and qualities. Within their diversity, they were classified into two main groups: One group comprised the harmless materials, which were ready to be used without any previous processing, such as building components that could be retrieved from the building site as whole elements. That is, the aluminium window frames and the steel façade panels. In the existing procedure, these components are demolished and directly transported to a down-cycling factory. There the glass and the aluminium are melted, and part of it is recycled. Nevertheless, such a strategy, common practice in the building sector, is eminently wasteful in terms of energy, material and value. Other harmless materials found were those that are used for protecting products. They are hardly recovered by the existing waste management system. Such was the case of the cardboard elements and the chromed steel shelves that were found. These materials are either sent for incineration, which fuels district heating, or they are disposed of in landfill. The other group of material resources comprised those containing hazardous chemicals. Such as window panels sealed with the toxic compound polychlorinated biphenyl PCB (Andersen, 2017). The windows were being broken in containers for an easier transport to different channels of distribution. Normally they are transported to Germany for further treatment. As a matter of fact, the treatment of toxic waste represents an opportunity for economic growth rather than a problem. The salvage of these and other similar materials will demand further research on how to eliminate toxic substances.

The business model integrates different aspects of importance related to the local society in order to create and deliver added value, to whome it does so, and how to do it. Likewise the model shows the ecomonical income and output.

> *"Industrial ecology focuses mainly on manufacturing processes and also on product design. Companies are seen as agents for reducing environmental harm, as they possess the technological expertise to improve their processes and products."*
> (Jongert et al., 2009)

The business model is inspired by the idea of industrial ecology, and in this context, it is based on a textile workshop already existing in the neighbourhood. The business model´s potentials are developed through a dialog between the local women, the local social workers, and architects with visions.

Figure 5: The textile workshop pursuing to be a welcoming and creative work environment for resident women of migrant backgrounds. Illustration Martín Jiménez.

The women´s wish to sew as a form of expression is complemented by the commercial aspects of selling their results. The business model would be a textile business that produces and sells clothing and home textiles out of recovered textiles, principally discarded clothing. The apparel would be sourced from clothing disposal flows of Aarhus. Each textile product would have a unique and artistic patchwork design. The managers could be Danish fashion designers with good communication and relationship skills. The manufacture of the products would give employment to neighbour women living at risk of exclusion. The designs would result from participative teamwork between the employees. The sales of the artwork and redesigned clothes will allow the women to become self-sufficient, thus making no longer necessary the social subsidies that they receive from the municipality. As a result of this, the women will gain more self-confidence, and they will begin to recognise themselves as active members of the society. The municipality might support for a period of time the initiative, and later on reduce gradually the grant as the business gains momentum (Forretningsmodellen, 2018). Adding to the circular quality of the business, many forces are working for circularity within the textile business in order to bring used textile into the circular loops again. The French RETEX has recently released news that their aim is to integrate all textile waste in the ever-increasing textile waste stream (RETEX 2019).

Case: Architectural design

The architectural intentions for the case project are enumerated as follows, in order to understand the multiple demands to the design:

- Taking the context into consideration, and fulfilling the users' needs with the existing resources and means.
- The building should be located in the existing shopping centre, and thereby strengthen the urban environment currently offered to the neighbourhood's urban life.
- The architectural intervention should support and nourish the already existing functionalities.
- The building design should perform the function of a textile circular company where the majority of employees are women from the neighbourhood.
- The building should perform as a public facility for the area: the functions could include spaces for activities such as offices for start-ups and support from the municipality for creating local jobs; informal

social gatherings and events; a playroom for children of different ages and a medical clinic. These functions satisfy some of the demands and suggestions expressed by neighbours and local social service workers.
- The project should optimise the reuse of local material resources, which means that the design should be substantially made of discarded materials found nearby.
- The harvested components should remain whole and their joints should be designed for disassembly.
The intentions set the agenda for the architectural design (Martín Jiménez, 2015).

The local shopping centre acts as a central place for a relatively large housing area. This place is frequented by many locals throughout the day. The shopping centre is composed of a row of five shops with a wooden portico in front, a hall for bingo, and a hall for a supermarket. It is a valuable environment and the heart of urban life of the neighbourhood. Throughout the day, the centre and its parking lot are visited and passed by many locals of all ages.

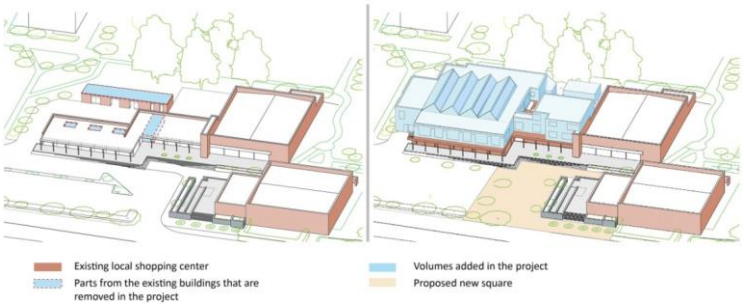

Figure 6: Isometric views before and after the transformation. Illustration Martín Jiménez.

Some of the existing buildings in the shopping centre form a courtyard. The courtyard qualifies to become a protective atrium for the women, whose comfort is culturally dependent on privacy from the exterior. The existing courtyard, being the core space of the project, becomes the sewing hall for the textile company. The project adds one storey to the existing shopping centre, covering the courtyard, and adding towards the park a new wing destined for childcare. The result is a two-storey building whose activity will enhance the existing daily life of the site.

Figure 7: Ground floor and first floor plans of the project. The existing construction is shown in red colour and the new additions in grey colour. Illustration Martín Jiménez.

On the ground floor the functionalities are strongly related to the existing environment: namely, the sewing hall to the existing courtyard, the existing shops to the street space, and the childcare wing to the park gardens (Figure 6). The designed hall, which has a double height, is lit by skylights oriented to north (Figure 7). On the first floor the spaces are organized by a gallery that runs along the perimeter of the hall. Additionally, it is opened a new passage, through the whole building structure, offering to pedestrians a new possibility of movement and a new public yard.

The interior envelopes are made up of the materials salvaged in the locality. To the interior, the partition walls that face the main hall are built with the recovered windows and doors; the cardboard tubes are reused in form of lattices that complement the transparent inner walls; and the steel supermarket trays are redesigned to be the railings of the gallery surrounding the hall.

Figure 8: The south facades have large balconies. At the time of the investigation the facades were being demolished due to renovation works. The facades have clear potentials for reuse in new building layouts.
Illustration Martín Jiménez.

Figure 9: Upper picture: Shopping Centre as it looks before the transformation. Lower picture: transformation of the case project, where the façade is created as an assemblage of the existing wooden portico in combination with the façade expression created with reused steel plates in a modular surface design articulated by the plate's two colors.
Illustrations Martín Jiménez.

The exterior facades are also designed to be made up entirely of the components that once enclosed the blocks´ south facades in the housing area. That is, reused aluminium sliding windows and doors, and a steel rain screen composed of cladding panels, corrugated sheets, and U shaped profiles. The potentials for reuse available from the south facades in total was 13,305 m2 of glazing, 4,955 m2 of cladding with steel panels and 1,944 m2 of corrugated cladding steel; the utilised material for the transformation case project was 675

m2 of glazing, 622 m2 of cladding with steel and 278 m2 of corrugated cladding sheet. The difference in each category was surplus material, which could have been contained in a material bank. This is just an example of how much material is managed for demolition.

The placing of windows in the building envelope seeks to achieve openness and lightness, with the intention of facilitating visual communication between interior and exterior space. The steel panels have two colours, and the façade design profits from this variation (Figure 9). The panels have holes along the edges, which allow an easy assembly and disassembly. The skylights too are designed to be glazed with panels from the recovered window compounds. This solution has downsides since these windows are not meant to work on a skylight. To reduce heat transfers, it is proposed to add complementary glass layer immediately underneath. Lately the Danish office Lendager Architects has effectuated a similar solution; the office managed to prove the current energy demands by reused windows. (Lendager, 2019).

Figure 10: Sewing workshop two storey high, lit by skylights. View to the north. Illustration Martín Jiménez.

The material chosen for the structural elements, wall frames, decks and roofs of the extension is new timber. Regarding the structural design, it is adapted to the conditions given by the preserved building, so the structural spans and bays can fulfil the functional demands of the new building while not interfering with the old one.

Findings

In Denmark the streams of waste follow certain management rules. A lot of materials are taken back to the producers through the building process. Regarding the remaining waste, a great deal is produced by demolition. Waste is separated in fractions and it is down cycled, thus becoming new raw material for the building industry. The investigation of the resource streams shows that it is possible to salvage resources without losing their value, and therefore remain as resources directly available for new buildings. To look at the resource system with the vision of industrial ecology was a way to find new opportunities in the system. Through the analysis of the resource streams this research gave insight into how many resources are thrown away and how effectively is waste managed without nearly anybody realising the amount of resources being downscaled. With this insight it is obvious that a great deal of this waste could be rescued from the existing waste streams and thereby salvaged for reuse for new purposes. It is obvious when studying the resource

streams that a deeper analysis of the resources potentials is necessary, and consequently reorganised, if the existing habits have to be altered in order to establish more discriminating strategies of waste management.

A relatively high rate of waste is incinerated and utilised for district heating. This procedure is positive in terms of heat supply, but definitely negative in respect of the environmental footprint. However, the research has witnessed that few practicing architects can see resource potentials in large amounts of waste fractions, which so far are being down cycled. If the Danish waste management takes responsibility for selective collecting, great potentials for reuse will be at hand and a greater perspective in circular economy will be visible.

By perceiving waste as a tool for development, the studio acquired dawning comprehension of the potentials of resources that usually are neglected. This discovery was open and unbiased, and brought to light new and unseen possibilities. In one week the architectural students found plenty of affordable resources and harvested fifty-seven samples in a periphery of three kilometres from the project site.

The design project showed, that even in a local housing area, where no one would expect to find cheap or even free materials, a lot could be found at renovation sites. There are potentials for architects and other facilitators to develop businesses with the purpose to salvage waste for new use. The effective public waste system is to collect and empty every second week the waste containers. This procedure has to be rethought, since it is obvious that new possibilities for business will unfold when the owners of the industrial productions begin to see waste as a resource, such as material, water and energy for sale or exchange with other products.

The transformation project was situated in an area with important social problems and unemployment. The business model in the design project followed a bottom up policy; the local inhabitants and their needs of a sewing workshop with an additional showroom and shop were seriously taken into account. In future such a process can be beneficial for new business models, which must meet the actual challenges of how to integrate segregated neighbourhoods: that is, to engage the local citizens from the first stages in the purposes of the design, so they see themselves involved in the development of new ideas to improve their locality. This will allow them to feel part of the transformation of their quarter. It seems obvious that the application of such strategies will increase integration and satisfaction among the residents.

From the design project it is also learned, that reusing an abandoned building is worthwhile. Firstly, the building does not have to be demolished, thereby resources are saved. Secondly, the building and its context carry a story about the area's history, telling the story of how this area was born as a part of the Danish Welfare society, where housing areas were served with small local shopping centers. Thirdly, the local inhabitants are still using some few functions still taking place in the buildings. Fourthly, that used materials from the existing housing area can find new and beautiful narratives when assembled in new ways; the reused materials can, in a new design context, form new expressions when used in unforeseen relations, and even get a new detailing through another way of assembling like e.g. in the façade design.

Discussion

Going through a project from identifying resources, realizing the local citizens demands and wished, to create a business model, to define the architectural intentions and to give form and materialize the design was a long journey. This journey was filled with unexpected learning and surprises, starting from acknowledging how short-term it is to think that waste has to be down-cycled, to the sight of waste as a ready resource. This led to the following discussions and perspectives:

There are many ways of down-cycling a building: being aware of the values and embedded energy of buildings is conclusive against the current demolition practices, which need to be changed in favour of

selective demolishment and disassembly, and thereby rescuing unique materials and whole components. The research suggests that there are latent possibilities of rescuing value in every phase of the demolition.
In respect of dismantlement two issues of relevance were found: one was toxins and the other was the presence of dangerous substances spread in large amounts of material from the ´70s. Add to this, there is in the processes of demolition a general lack of environmental responsibility; in the wake of time efficiency, demolitions ruin most of the worthy material in the process. It seems evident that the materials are not perceived as secondary resources, which may explain, apart from economic reasons, why primary resources are often if not always preferred. A close examination of the demolition phase in the building industry reveals that secondary resources could intensify new potentials for circularity.

Each phase of the research yielded insights for further development and a new attitude to urban areas, buildings, and materials. Starting from a focus on materials was an interesting challenge. Looking at existing buildings as resources defied normal attitudes and prevented from choosing the erase option: buildings, at least those of good quality, can last for a very long time if they are maintained regularly. Even if the building´s functionality disappears, buildings can be reorganised and revitalised with new purposes. Already existing buildings can transform into new designs, carrying values in the future. Nowadays there are many very authentic buildings that are neglected and in risk of being demolished. Even well preserved valuable buildings are often demolished for being an obstacle to bigger building plans. To change this habit will thereby create a greater respect for the building culture and history of the city in which the building belongs. In the case exposed in the research, none of the existing buildings are to be demolished, and only additional structural elements are added to raise the new building. Towards the street the shops and the wooden portico are entirely preserved, so the project respects the existing built environment and stresses its values.

The actual transformation provides an extra benefit to the design: the architectural language speaks with local terms: firstly, the original shape of the square is preserved and reinforced; secondly, the existing structures have been given new life and meaning; thirdly, the design opens a new passage connecting the local square with the park of the residential area, which also gives access to the sewing hall and the childcare wing; and finally, all through the design you can discover the materials from the former housing facades. Their assembly and montage form a collage, which narrates the story about the changing appearance of the quarter over the buildings lifetime. In relation to the expression of the architectural intervention, it may illustrate another way of anticipating new attitudes in architecture. Memories of earlier appearances and materials will form the articulated narrative of a specific place. This might be seen as something unexpected, but over time such an attitude will be common and tell a new story of responsibility.

Starting off an investigation of the resource systems, a parallel was drawn between this research and the waste distribution system of a Danish project from the ´90s: the Industrial Symbiosis in Kalundborg (Kalundborg Symbiosis, 2017). An industrial symbiosis is an association between two or more industrial facilities or companies in which the wastes or by-products of one become the raw materials for another (WRAP, 2017). In Kalundborg the resources are utilised in the form of energy, water, and others, which are exchanged between seven factories. Every factory involved takes the other´s waste as a resource for their production. This concrete example serves as an inspiration to similar resource systems in circular economy. Furthermore the implementation of symbiotic strategies should be enlarged to include whole districts, or perhaps even municipalities or regions. The predominant opinion on industrial symbiosis among professionals is that it would be too difficult and it would require too much work to discover the potentials of resources on a large scale. In any case, it is recommendable to give more visibility to resource flows. Information on the quality and the quantity of the resources must be available to the public and the consulting professionals through a digital marketplace.

Another shift in perspective would be to look and evaluate existing buildings as materials banks (Bedre

Innovation, 2018). Today, many buildings from the ´60s are being demolished, and vast amounts of valuable materials are being down-cycled into gravel for motorway sinks: such downscaling should be balanced, and valuable elements should be withdrawn from the waste streams in order to function as reused components for new architecture. At the moment we do not have a system that takes care of these materials and components, preventing them from being lost.

There are barriers to an innovative and circular development of the demolition processes. Their agenda, with an economy based on time optimization, do not yet realises the advantages of changing to a circular process. As a result of this misunderstanding, the selection of the materials that are rescued undamaged from the demolition work is random, and only very valuable materials are recovered and stored.

Significant amounts of materials could be saved for rebuilding if the system was reoriented towards careful dismantlement, shortage and storage. In conclusion, the existing structures must be adapted in order to conduct more resources in circular loops. Control and certification of already used materials should be CE certified: in Denmark there is already one enterprise of reused material, that is CE certified (CE-Marking, 2018). The CE certifies that these reused bricks are apt to be used in all kinds of enclosures, and that it is up to the client and his advisors to choose the affordable quality and atmosphere for his specific building. However a gaze to the marked shows that reused materials are still expensive in comparison with new ones, which also tells a story that society needs to understand if increased use of already used resources is to become common.

In future it is likely that architects will have new capabilities to challenge the appearance of architecture; according to a research done by Kalakoski and Huuhka, the principles of reuse of spolia can be articulated in contemporary architecture. Normally it is expected that spolia as historic items can be implemented in design, such as wood carvings or old window frames in order to manifest an atmosphere (Kalakoski and Huuhka 2017); but in contemporary times architecture has the opportunity to assemble different resources and implement spolia from the welfare society in a holistic collage. Diverse elements such as concrete panels, steel structures, and cladding of different types will enrich the coming architectural assemblage. By implementing these items the designs will be fed with responsible resources. Moreover, architects will discover new potentials for their design: architecture will tell stories concerning the affluence of society.

On beat with a crescent reuse of resources, more sensible architecture users will appreciate the narrative atmosphere and our physical environment will have the opportunity to get an interesting appeal.

Figure 11: Close-up photomontage of the façade turning the urban square. Illustration Martín Jiménez.

Conclusion

The intention was to show how a transformation of an existing building structure using local resources can surpass the ´use and through away´ practice in architecture.

Through the research the local streams of waste materials were identified. The possibilities for reuse were explored in parallel to the possibilities for upgrading the architectural quality. The system of the local waste managements was studied with the aim of saving more resources for possible use in architecture. Discourses on shaping the architecture opened the perspective on circular flows, and unnoticed potential resources were discovered, such as the buildings existing at the site or the significant amounts of resources that were found nearby.

The goals of the research were reached and managed to explore several gaps. A future circular attitude within the management and the prevalent mind-set regarding management of materials are recommended. We have looked at the built environment as a resource. The case proposed a circular building that articulates a more evocative architecture where reuse narrates new cultural values.

Architecture is not the problem; the problem is the difficulty in getting access to materials which can be used again, and in covering the expenses of overviewing, reorganising and cleaning the secondary resources. The challenge of today is to inspire to a further understanding of the potentials of using secondary resources in architecture, and thereby to narrate stories of a society of abundance, where materials are being thrown away in the belief that the globe can replace them without bearing the consequences.

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