RECLAIMING AMSTERDAM

the role of discarded materials in the architectural design

Architectural Engineering Graduation Studio 14
Technical Research Paper
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Research paper "Reclaiming Amsterdam"

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CONTENT

1. ABSTRACT 3
2. INTRODUCTION 4
Designing with reclaimed materials 4
The graduation project 5
Relevance 5
Structure of the paper 6
3. RESEARCH FRAMEWORK 7
Material flows 7
Material lifecycles 8
Recycle vs. Reuse 9
The design process 9
Different forms of reuse 11
Current design approaches to reuse 11
Chosen approach; position of the research 12
Scenarios 13
Demands from the design 14
The economic aspect of reuse 16
4. METHODS 17
Literature 17
Mapping 17
Research by design 17
Choosing materials 17
5. RESULTS 20
General architectural implementations 20
Architectural implementations in the design project 26
6. CONCLUSION 28
7. REFERENCES 29
8. APPENDICES 32

1. ABSTRACT

Keywords: reclaimed materials, reuse, waste flows, Amsterdam

Contemporary topics within the field of architecture are the scarcity of resources and vacancy. On top of that we are a consumer society; we produce a lot of waste. Reuse could be an interesting solution for these problems; especially since besides being one of the biggest material consumers, the building industry is the biggest contributor to the annual waste in the Netherlands. This paper will elaborate on the following question: *What role can local waste that is both available in large quantities and within the coming years play in the redevelopment of vacant large scale buildings?*

Besides describing the underlying problems and changes of working with reused materials, the paper will give some examples on how to find these materials, how to evaluate them and give some examples of general architectural implementations. The research paper is therefore set in Amsterdam as this city is the main contributor to both building related waste and the vacancy in the Netherlands.

Three scenarios for finding these materials are given; of which two will be further elaborated. Both scenarios have been mapped to give an insight of the waste flows. The first scenario looks at the problem of office vacancy. The biggest category is offices from the 80s and in their current state these buildings would score a G on the EPC. In order to reuse these buildings, they need to be renovated; which means generation building and construction waste. The second scenario focusses on the harbour of Amsterdam and it's waste flows.

An example of a reclaimable material from office renovations is the carpet tile. Although it may sound like a very simple object; it is one of the best reclaimable and one of the most available products. Reusing carpet tiles is not limited to their original application; examples will be given for implementations in constructions, facades and interiors.

The higher purpose of this research paper is to inform anyone that's interested in designing about the possibilities of reclaimed materials; to make them reconsider the design process. Because implementing reclaimed materials does change this process; the materials are a given and will form the starting point of the design.

2. INTRODUCTION

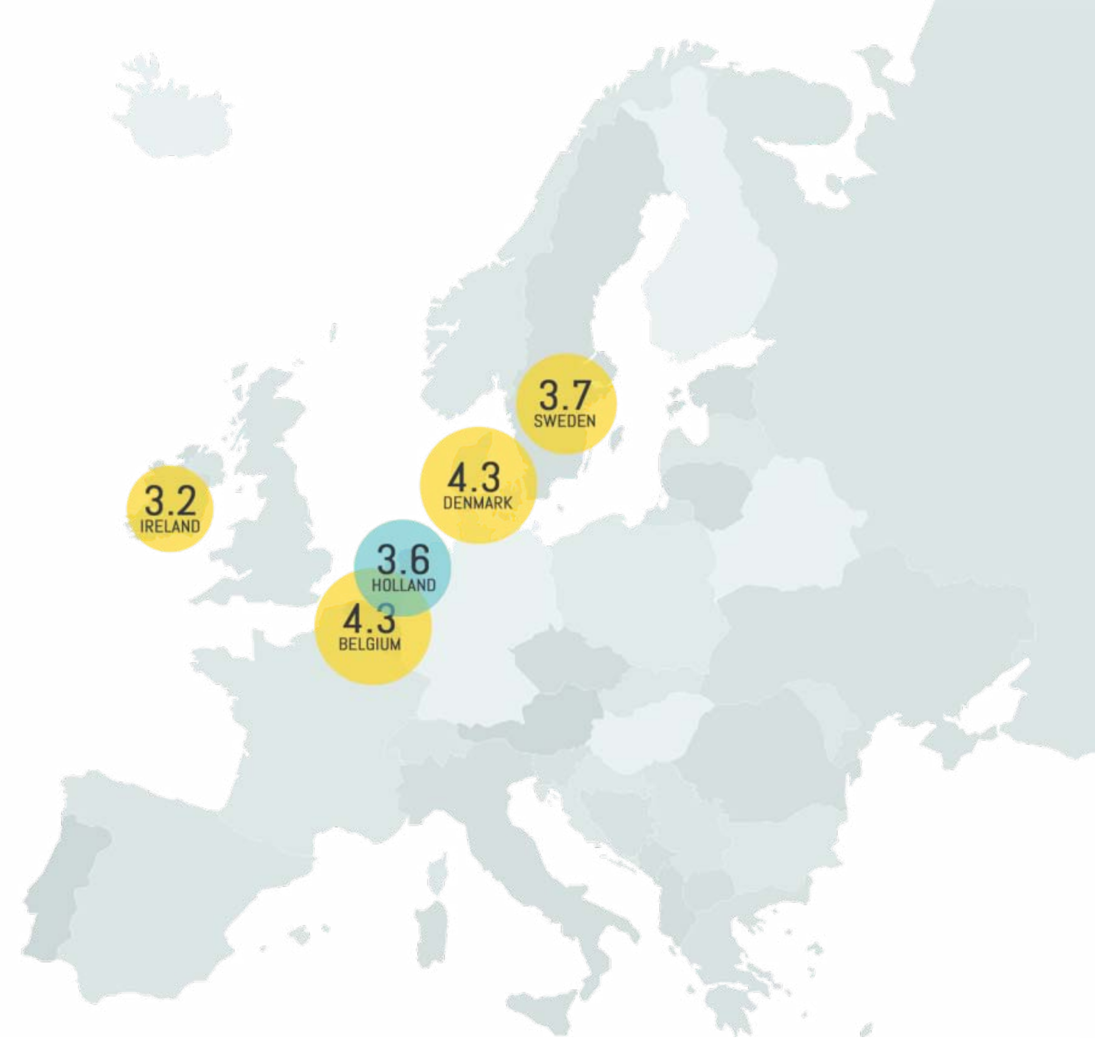
Designing with reclaimed materials

According to the Living Planet Report (WWF, 2014) if all people on the planet had the same footprint of the Dutch, we would 3.6 earths to supply this demand. That places us in the top 5 of EU countries with a high footprint.

The Netherlands is also one of the countries with the highest municipal waste generation per capita (Bogdanovic, 2011). The report on waste production (Rijkswaterstaat Leefomgeving, 2010) states that in 2010, almost 60 million tonnes of waste was produced and nearly forty percent is building and construction related.

A third problem is the vacancy in the Netherlands; the government makes a distinction between different vacant buildings. Of all dwellings in the Netherlands as of January 1st 2013, 37.000.000 m^2 was vacant (Centraal Bureau Statistiek,

3.6 earths are needed if everyone had the same lifestyle as the Dutch (WWF, 2014) (Own Image)



The Netherlands have the fourth highest footprint of Europe (WWF, 2014) (Own Image)

2014), and approximately 8.500.000 m^2 of office are is currently vacant (Rijksoverheid, n.d.).

A possible solution for these problems could be found in reuse. Reusing materials has always been a personal interest of mine; whether it is reusing old home-trainers to create blender bikes for the D-Exto pavilion or designing with the existing stock. Reuse has played a part in all my design projects since my minor

Archineering; and in this final project reuse will again play a major role, but this time in more than one way.

The graduation project

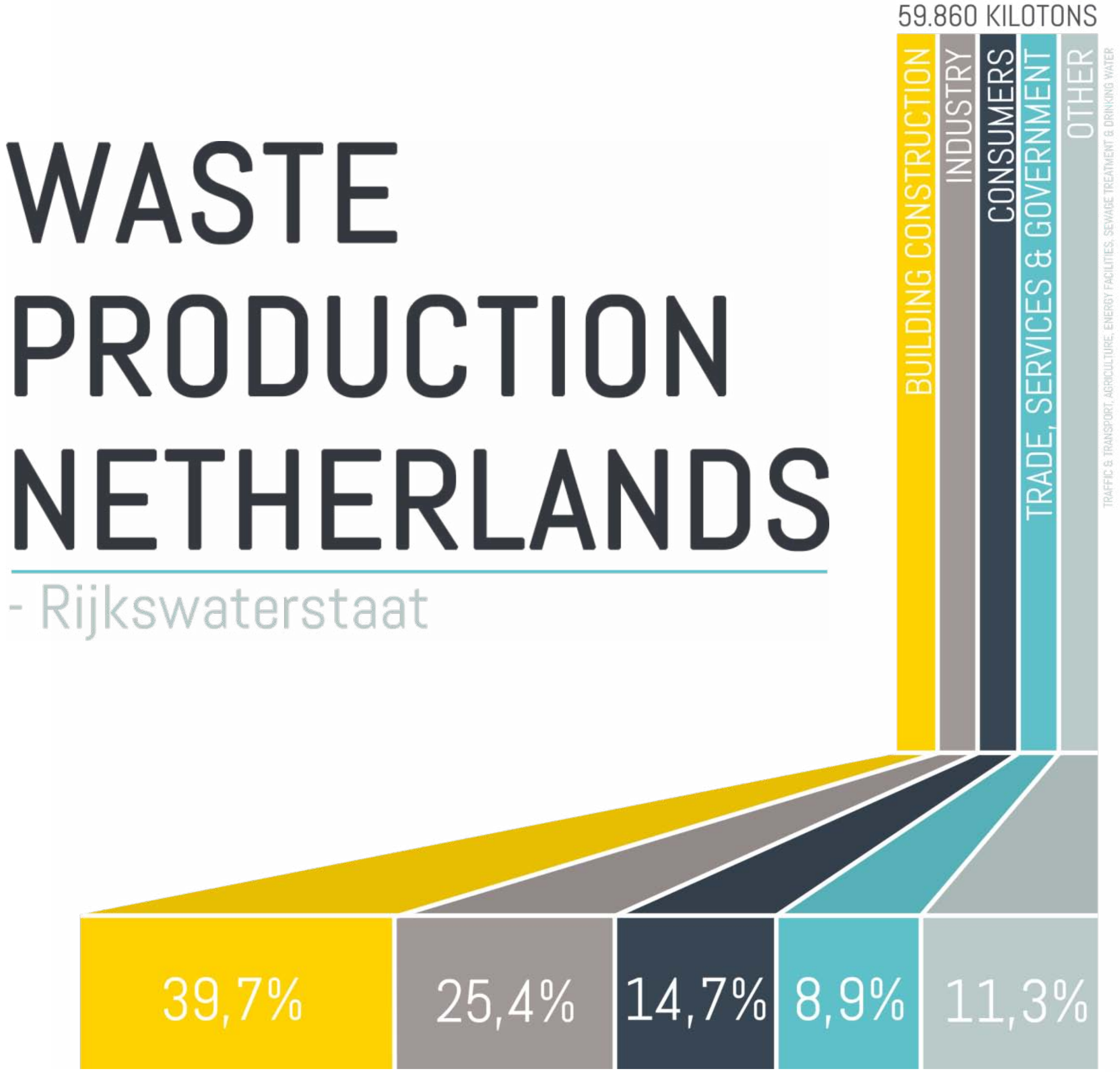
This research paper has been written for the Architectural Engineering Graduation Studio, Faculty of Architecture, TU Delft. Within this studio students formulate their graduation project around their technical fascination. In this paper the technical research behind the graduation project will be described. The title of the graduation project is 'Dutch Design Dock' and will focus on *'How to revive an isolated area such as the Van Gendthallen by providing a new accommodation for the creative industry in the form of a creative chain incubator*[1] *using locally reclaimed materials.'*

This paper will focus on the use of reclaimed material and the leading question is: *'What role can reclaimed materials that are both available in large quantities and within the coming years play in the redevelopment of vacant large scale buildings?'*

Relevance

The Van Gendthallen in Amsterdam from the context of the graduation project. For this research paper the same context is chosen for several reasons:

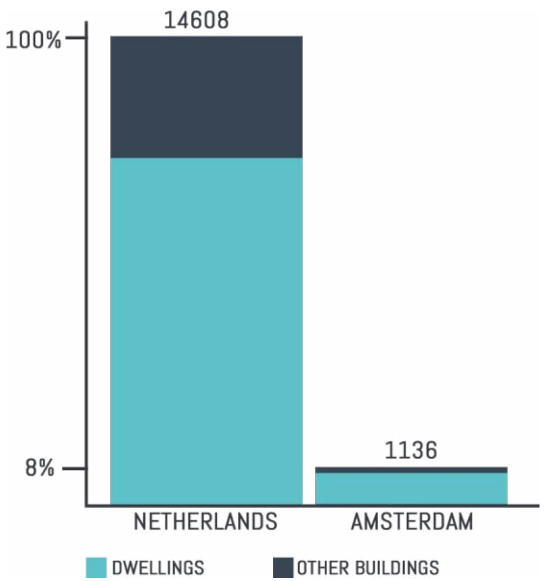
Setting the city of Amsterdam as boundary, automatically the transport distance of the materials will be limited and therefore not generating more CO2 then using virgin materials would cost.



In 2010 23.752 Kilotons (39,7%) was building and construction related (Rijkswaterstaat Leefomgeving, 2010) (Own Image)

[1]See appendices A. Glossary (Stipo, 2011)

Off all demolished buildings in the Netherlands in 2014, the city of Amsterdam was responsible for 8% of this total. To compare the city of Rotterdam or the entire province of Groningen were responsible for approximately 3% each (CBS, 2015a, 2015b). Amsterdam is therefore one of the main contributors to the 39,7% annual building and construction related waste of the Netherlands.



The city of Amsterdam's share in the demolition of buildings in 2014 **(CBS, 2015a, 2015b)** (Own Image)

Amsterdam is also one of the main contributors to the vacancy in the Netherlands; 17% off all offices in Amsterdam are (mostly permanently) vacant. This equals 1.300.000 m^2 (Gemeente Amsterdam, 2011). Besides the high percentage of vacant offices, the book '*De Oude Kaart van Nederland – leegstand en herbestemming*' (Harmsen, 2008) mentions that there are over nine hundred listed buildings in the Netherlands that are permanently vacant, temporarily reused or about to lose their function. The Van Gendthallen in Amsterdam aren't mentioned in this book, but it is partially vacant and temporarily reused; which makes this building an excellent example and context for this graduation project.

Reclaimed materials can be used to create fun objects, but what role can these materials play in the building and construction process? This process is considered to be quite conservative and this is mostly related to the regulations from the government. For every part of the design there are requirements; on the total building itself, but also on separate elements, materials even. And the designer has to guarantee that the design will meet these standards. Using new materials is therefore the easiest option; for each material the values are given, but this is different when it comes to reused materials. The main thing that gives the designer a guideline for the design is missing. But on the other hand, besides the environmental benefits, reused materials are a lot cheaper than new materials. Is it possible to choose for the more environmental friendly and economical option and still meet the structural and building physical requirements of the design?

This paper will provide an insight in how reclaimed materials can be used in architectural implementations; with the focus on the redevelopment of large scale buildings.

Structure of the paper

This paper will look at the opportunities for reusing waste materials within the city of Amsterdam. The design and research task of this paper will first be further specified in the framework. This chapter will describe the material flows in Amsterdam, what the focus of this paper will be when it comes to the origin of the waste material and the type of reuse. When the guidelines of the research have been specified the methods used for this research will be elaborated.

In the net part the results of the research will be described; this part will give an insight to what kind of reclaimable materials can be found in Amsterdam and their possible implementations. Lastly the conclusion will elaborate on the limits of this research and the recommendations for the future.

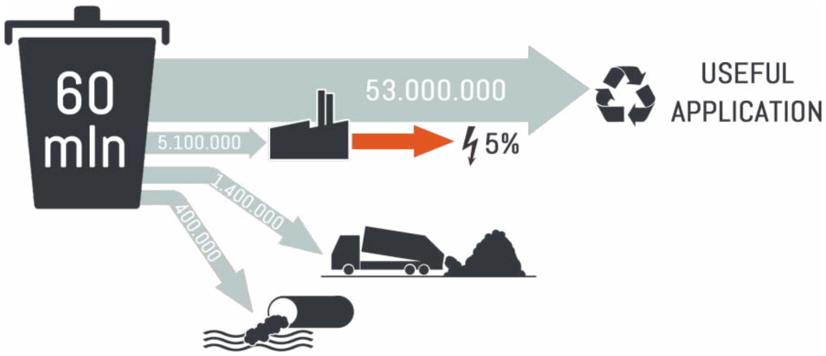
3. RESEARCH FRAMEWORK

In this part the framework of the research will be further elaborated; this part will provide the extra background information needed and also form the guidelines for the research.

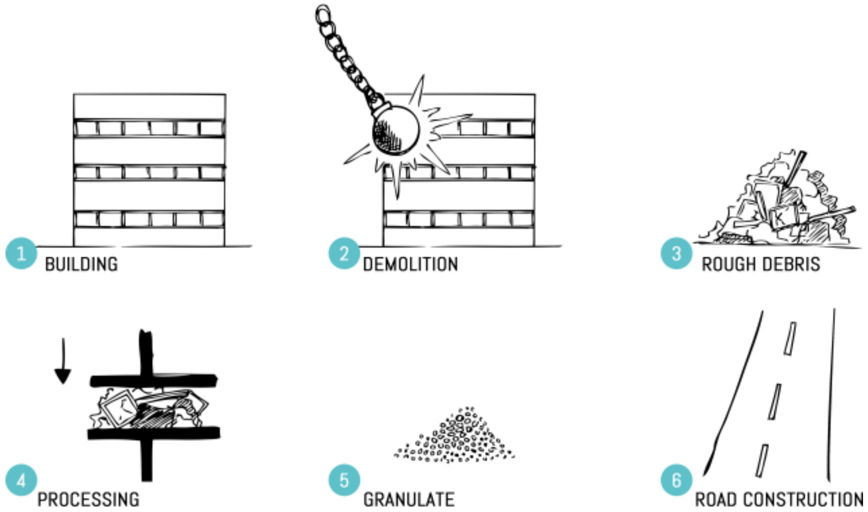
Material flows

There are 14 analysable flows that can be divided into three categories; Physical, Energy & Value (Feder, 2014). As described earlier the focus of this paper will be using reclaimed materials; this means the research will focus on waste flows.

Of the 60.000.000 tonnes waste produced, 53.000.000 tonnes has been 'applicated usefully' (Rijkswaterstaat Leefomgeving, 2010).



Processing the waste in the Netherlands **(Rijkswaterstaat Leefomgeving, 2010) (Own Image)**



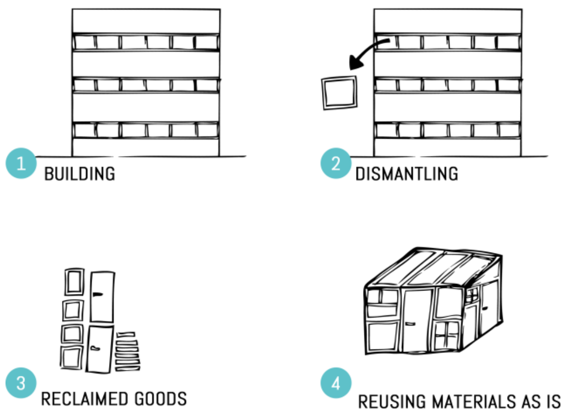
Demolition **(Rijkswaterstaat Leefomgeving, 2010) (Own Image)**

Looking at building and construction related waste a 'useful application' is processing the waste to granules for use in the construction of roads. The Dutch government considers this to be a high-quality form of reuse. In *Building with reclaimed building components and materials,* Bill Addis (2006) describes the 'Delft Ladder', which describes the different options when it comes to reuse; from best to worst solution:

1. Prevention
2. Object Renovation
3. Element Reuse
4. Material Reuse
5. Useful application
6. Immobilisation with useful application
7. Immobilisation without useful application
8. Combust with energy recovery
9. Combustion
10. Landfill

By crushing the waste to granulate the value is lowered; and according to the 'Delft ladder' this useful application is actually one of the lowest qualities of reuse; it could be described as down-cycling. Besides the fact that we can always do better, we simply cannot continue with the current practice; there are only so many roads to be laid in the Netherlands.

Since almost 40% of our annual waste is building related, we as architects are in the position to make a positive change in this. Therefore the demolition process has to be changed; in fact demolition should change in dismantling and reclaiming; which will ask for 'element reuse'.



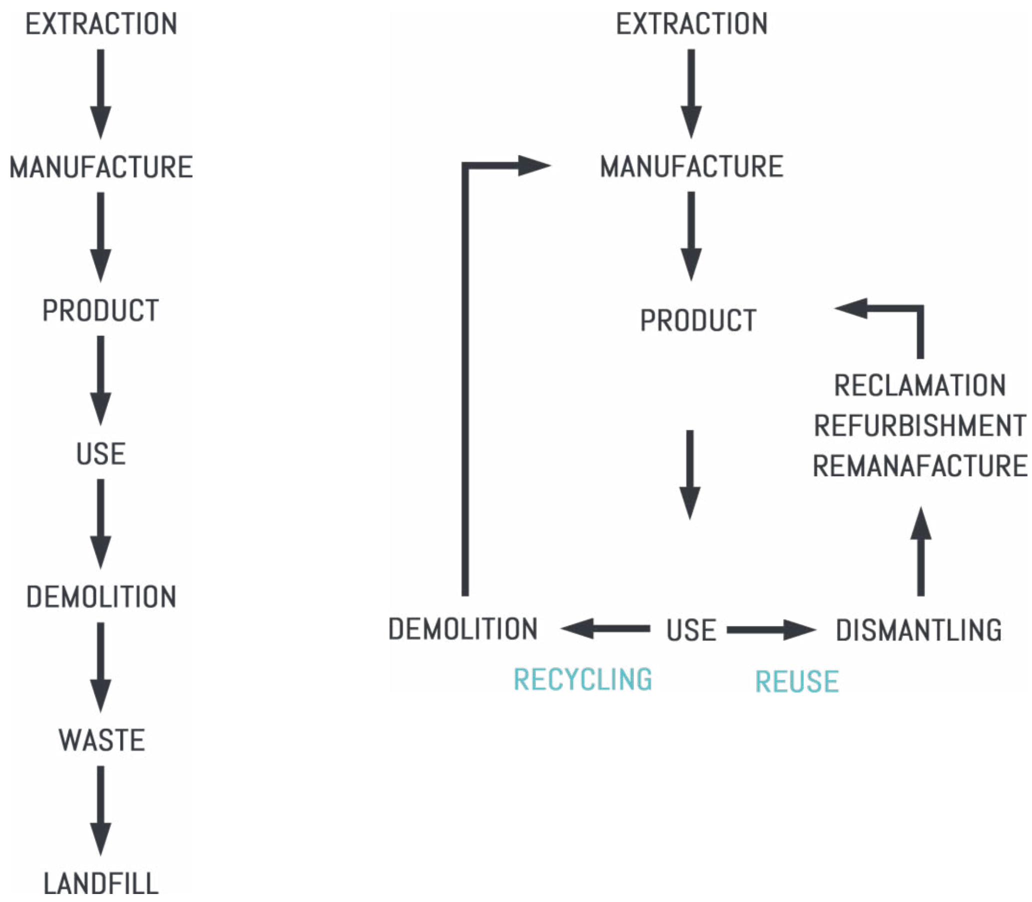
Dismantling (Own Image)

Material lifecycles

Designing with reclaimed materials sounds like a great solution, but unfortunately the building sector has a quite conservative character. This means the design process has to be restructured if 'designing with reclaimed materials' needs to become a vital part of this process.

Looking at the original (linear) material lifecycle which starts with extraction and ends in the landfill; this process can be described as cradle-to-grave. In order to turn this linear process into a circular one; there are two options after the use stage:

- **Recycling**: bringing the demolished goods back to the manufacturer in order to create new products
- **Reuse**: dismantling the product into ready to reuse products.



Linear vs. circular material life cycle (Bill Addis, 2006) (Own Image)

Recycle vs. Reuse

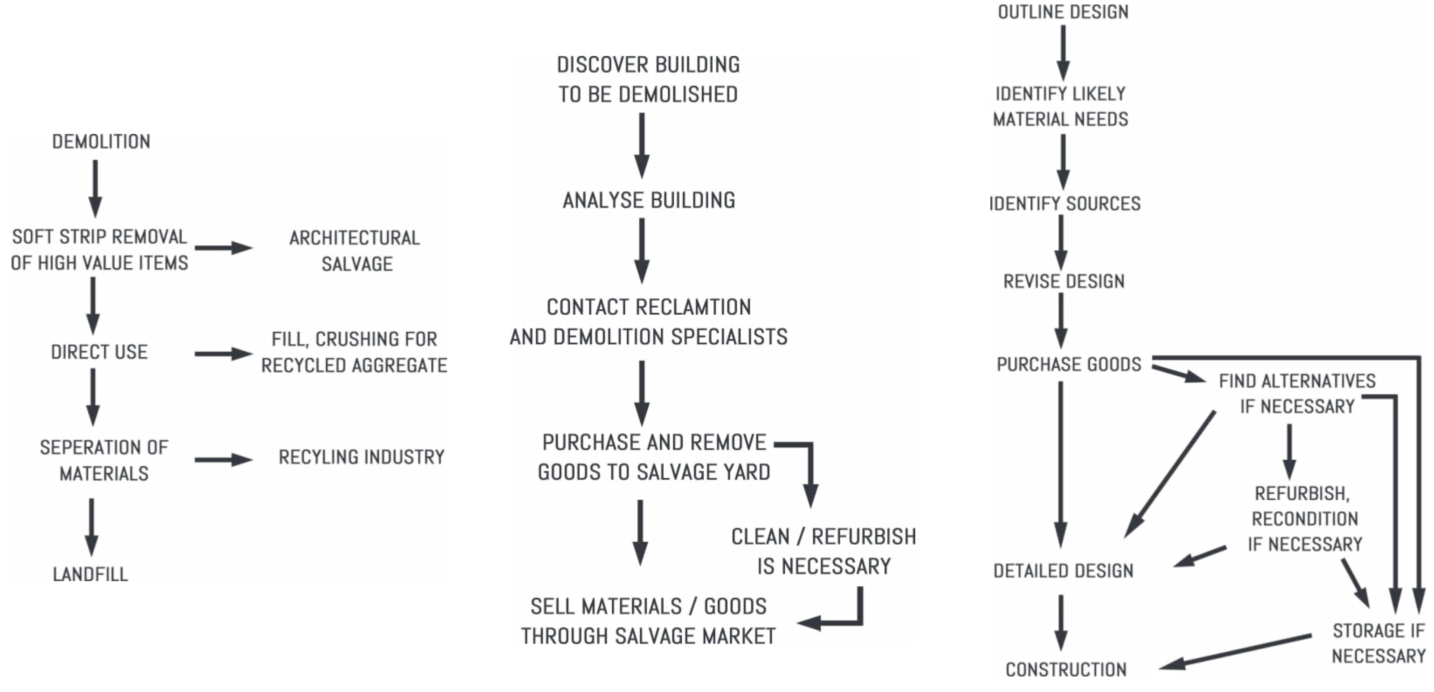
Recycling is often considered to be the same as reuse; but it's actually a different form of reuse.

Recycle

In the second scheme we can directly see the difference between recycle and reuse. Addis (2006) describes recycling as the use of waste to create new products; which are often different from the products in which the materials were used during their previous life.

Reuse

The brochure by WRAP (n.d.) states that reclaimed (reused) materials are products and materials which were taken from the waste stream, but are reused in their original form (with minimal processing).

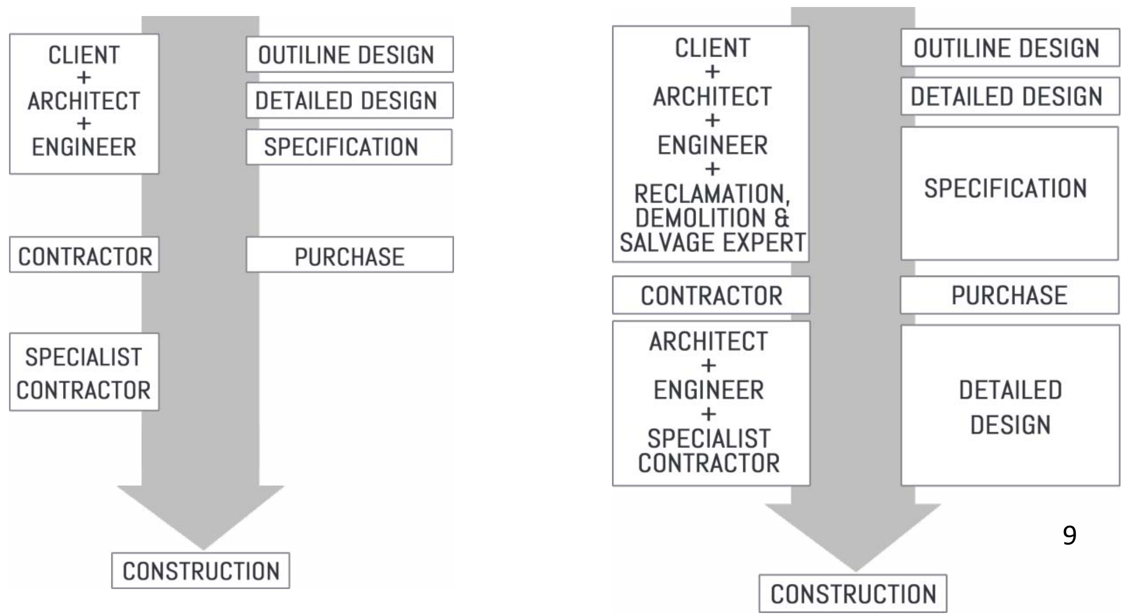


Reclamation process: Demolition POV , Salvage POV. Design POV (Bill Addis, 2006) (Own Image)wn Image)

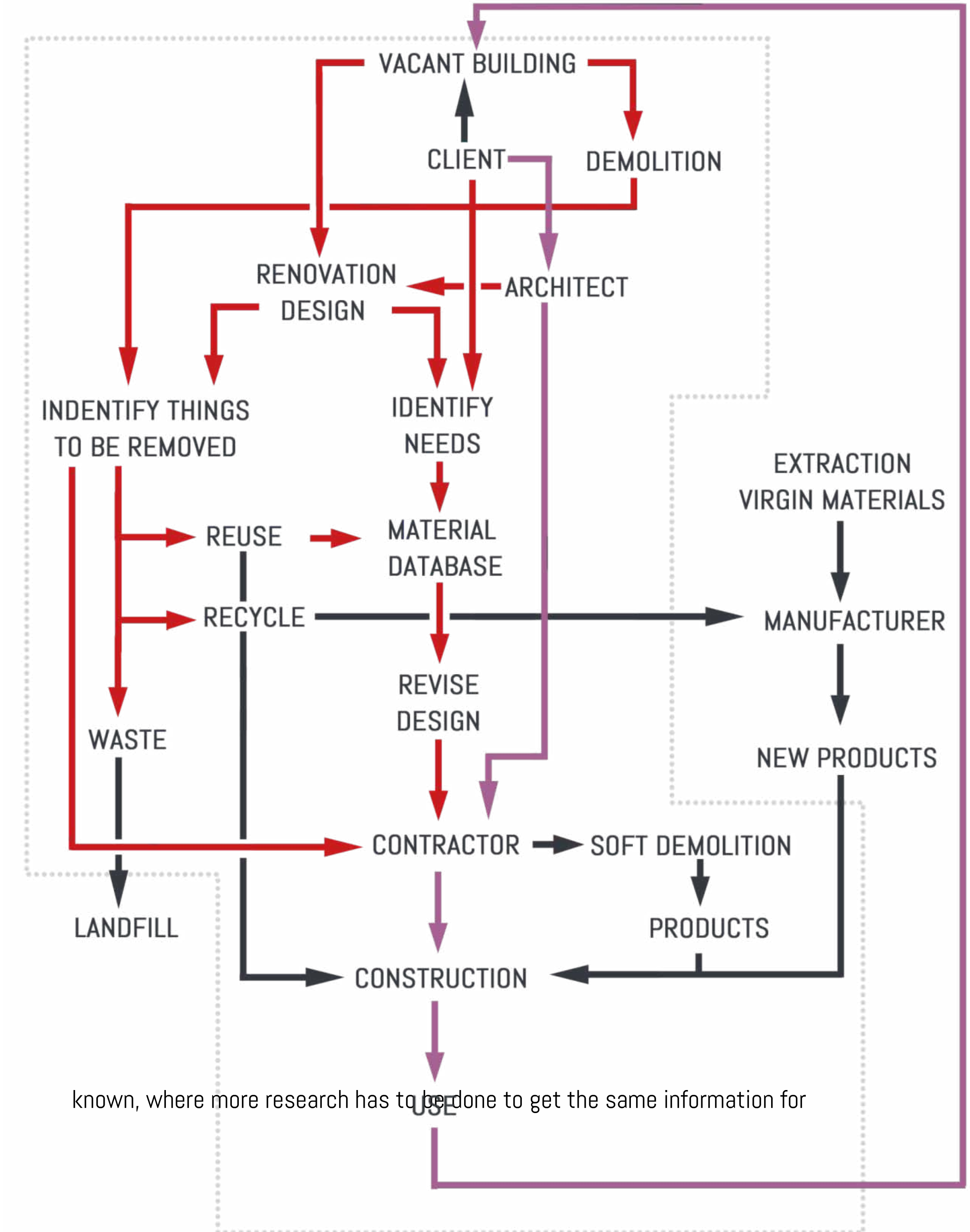
The main difference between recycling and reuse is the state of the materials being used; where reuse focusses on the materials as is, with recycling the materials are processed; often to a lower valued product. As is also shown in the graph of the Delft Ladder, reuse is better than recycling since the value of the product isn't decreased and there isn't any (real) processing needed before reusing the materials. Recycling only eliminates one step of the material life cycle, where reuse eliminated two steps.

The design process

The focus of the graduation project will be reuse and in the optimal scenario reusing elements from buildings slated for demolition. This requires a change in the design process; the values of new products are



Design Process & Actors (Bill Addis, 2006) (Own Image)



Design decisions for a vacant building (Own Image)

known, where more research has to be done to get the same information for reclaimed materials. On top of that there are different perspectives to this process. In the scheme the process steps from the demolition expert the salvage specialist and the designers point of view (POV) are shown.

When combining both the circular material lifecycle flowchart and the 'POV' process schemes; the question rises if it is indeed the responsibility of the architect. Is the architect the one who can make the change in the process? Yes and no, on the bottom image the design steps with the responsible actors are shown (B. Addis, 2012). The scheme shows that the architect is responsible for the detailed design. Comparing that to the reclamation process from the design POV, then yes the architect is the one who can make the change as the information on the reclaimed materials enter the design process in this stage. The second scheme shows that working with reclaimed materials brings in some extra actors in the process; the demolition and salvaging expert. Together with the architect (and the engineer) they will work on processing the data of the reclaimed materials into the design. So not, it's not solely the architects job or responsibility, but I do think the biggest opportunities lie in the position of the architect. Although the information of the reclaimed products are used at the stage of the detailed design; the detailed design is a result from the original concept design and revised design; which are both steps taken by the architect. To have a better chance at using reclaimed materials, these should be taken into account as early as possible and this does mean the architect has the best position in changing the design process.

On the right a scheme is presented of the possible steps to be taken when one has a vacant building. The scheme tries to show the options/steps that happen when choosing for either renovation or demolition. It also shows that by reusing materials we can cut off the material production process.

Different forms of reuse

For the graduation project reuse if preferred over the use of recycled objects. There are however different forms of reuse.

Reuse in situ

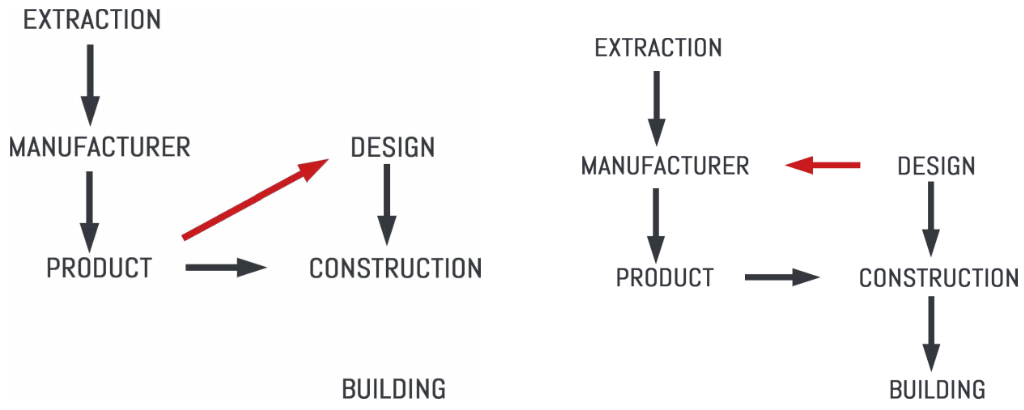
The highest form of reuse is considered reuse in situ. In this case a part of or the entire building itself that was slated for demolition is reused on its existing location. The components are used in their existing form as much as possible. (Kahley, 2006).

Reuse of salvaged goods

In this case the components or materials are reclaimed from a different location that the location of the intended use. The components are still used in their existing form as much as possible (Kahley, 2006).

Both reuse in situ and reuse of salvaged goods can contain the reuse of different type of building products. Mick Eekhout (1997) writes about three different types of building products; the standard product, the system product and the special. A standard product has unchangeable properties; it may be cut but it will always be the same material (f.e. a brick). A system product consists out of multiple elements and can therefore contain different materials. A special product is a unique product designed for a project.

The book also describes the differences in the design process using standard products or special products. In the process of designing with standard products the values provide the input for the design. When using special products, the design forms the input for the creation of the products; they are specifically manufactured. Designing with reclaimed materials as process looks more like the first system; in which the reclaimed materials can be seen as the newly produced materials that provide the input for the design.



Standard design process & special design process(Eekhout, 1997)

If we compare the different type of building products described by Mick Eekhout and the Delft Ladder, we can conclude that reusing a system or special product is considered element reuse and reusing a standard product would be material reuse. But material reuse can in itself be both in the form of reuse or recycling; a brick is considered to be a standard product. It can be reused as is; but if the quality isn't good enough it can also be crushed and recycled to create new bricks. Which are both forms of material reuse.

Current design approaches to reuse

Architecture using waste materials brings images of buildings made from plastic bottles to mind. This is however not the only option as the main source of waste is the building and construction industry. There are several initiatives that already promote this type of design.

Cradle to Cradle

An approach to reuse is the Cradle to Cradle concept. This concept, developed by Braungart and McDonough, focusses on a step before the use of reclaimed goods. It emphases on designing for disassembly and therefore eliminating waste (McDonough & Braungart, 2010).

Reuse of building materials

WRAP | This UK institute published the 'Reclaimed building products guide', which shows the different kinds of materials that can be found and also provides information on the environmental impact. An example of this is the use of reclaimed structural steel which will reduce the environmental impact of a construction by 25 times. (WRAP, n.d.)

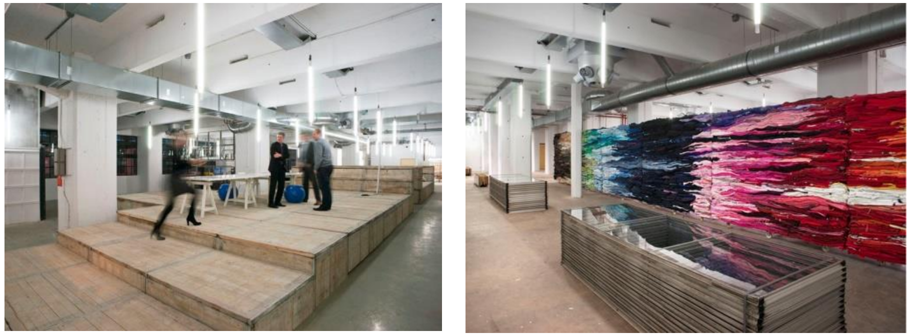
Rotor | Rotor is an architecture studio located in Brussels that researches the building industries waste flows. One of their initiatives is the online platform; opalis.be which shows what kind of reclaimed building materials can be found.

Superuse | Formerly known as 2012 architects, superuse is a Dutch example of an architectural firm that focus on reusing materials; in their case of all types, sizes and origins. They call their process 'superuse': 'a way of creating architecture by shortcutting the flow of products and elements from their state of maximum added value to the stage at which value has either been dissipated or been broken down' (Van Hinte., Peeren., & Jongert., 2007). One of the best examples of implementing reused material in architecture in the Netherlands is Villa Welpeloo; of which the construction has been made out of a discarded textile machine. Wooden planks from cable reels have been implemented on the façade (Hinte. et al., 2007).

(Superuse Studio, n.d.)

Another example of reusing reclaimed materials is the HAKA-office in Rotterdam. In this interior design by Doepel Strijkers architecten, doors are implemented as wall elements and roof slats were used to create a platform.

Chosen approach; position of the research



(Doepel Strijkers Architecten, 2010)

Talking about waste household waste is usually what comes to mind. This is only 17% of the annual waste production; the biggest part comes from the building and industry (Rijkswaterstaat Leefomgeving, 2010); which is often still of high quality; as the materials have only been used a couple of times, which makes them very suitable for reuse. Within the industrial waste there are a couple of different categories:

- **Production waste |** Left overs; materials that are discarded after a production process. Beams of 5 meter from which 4 beam lengths of 1,02 meter leaving a piece of 92cm of waste every time (Rosen Jacobson, 2014).

- **Dead Stock** | Materials that are in stock, but will never be needed again or are abundant in number. Car windows of a car taken out of production (Hinte. et al., 2007).

- **Packaging** | Materials that have been used to protect a product during transportation.

- **End of life** | Materials that cannot serve their initial purpose anymore and are discarded by the user. This can be materials from building demolitions.

Scenarios

For this paper the focus will be building and industry related waste, but this is still a very vague and large term. The first direction of this research was to look at current building projects and buildings that will be demolished in Amsterdam. Since every project is different and will therefore generate different types of waste; the research has shifted towards materials that are both available in large quantities and over a period of ten years. These new demands have been translated to the following scenarios:

Scenario 1 | Office renovation

Amsterdam is the main contributor to office vacancy in the Netherlands. There are several options for these vacant buildings, but for 70% of these buildings the only solution seems to be demolition (Rijksoverheid, 2012). Another option is transformation; where the office building gets a new function. This scenario will focus on the materials that could come from these office buildings.

Scenario 2 | The harbour of Amsterdam

The second scenario also focusses on the reuse of salvaged goods. In this case discarded materials from harbour companies; this can be anything from production left overs to packaging waste. This second scenario has been chosen since the second largest waste flow in the Netherlands is the industry. The harbour of Amsterdam is a place where the building & construction flow and the industry flow meet. It's the place where materials are brought or produced, resulting in a lot of production or packaging waste. On top of that the design location for the graduation project used to be part of the blooming harbour of Amsterdam; it is in fact still connected to the water which means transporting the found materials can happen over water produces three times less CO2 than transport over roads (Bureau Voorlichting Binnenvaart, n.d.).

Scenario 3 | Reuse in situ

In this scenario the materials will come from the project location itself; the Van Gendthallen. These materials could come from the transformations made to the existing building; removing the walls separating the different halls or replacing the windows. Since the components in this scenario are very directly related to the design of the Van Gendthallen, I have chosen to not elaborate on this scenario in the paper as my design isn't that far, but this scenario could and should however be revisited and research further during the design process.

Demands from the design

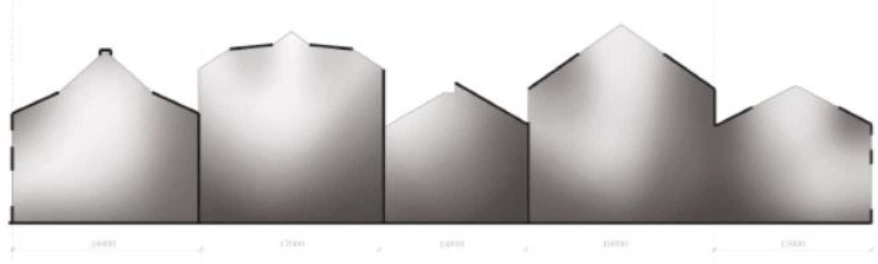
To further narrow down the research, another requirement of the described materials has to do with the architectural implementation. The Van Gendthallen are very large vacant halls, which is also a listed building. The city of Amsterdam wants to promote the creative industry and study shows that every year over 300 people are looking for workplaces (Bakker, 2012). These ateliers are often realised in these type of vacant buildings, but the problem with this is the lack of organisation. There are a lot of small scale companies, but there's almost no possibility for upscaling. Upscaling can be achieved if we start looking at the value chain of a creative product; the entire process from the idea, to production, to distribution (Stipo, 2011).

Although the current design trend in the Netherlands is reusing the existing stock, this mainly focusses on the transformation of offices. And there are a lot of successful transformations to be named; but redevelopment of vacant large scale buildings is a subject on its own. There are some main problems that need to be addressed in these type of buildings:

- Daylight
- Sound
- Fire safety

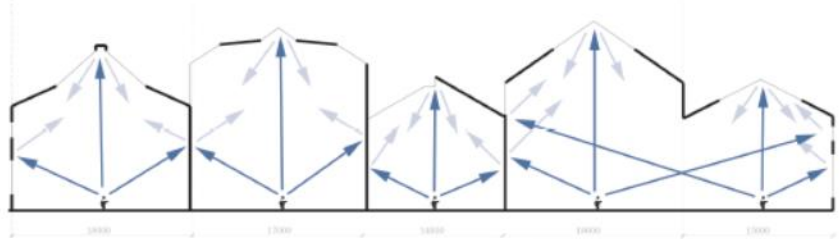
Although these problems apply to most vacant building of a large scale; for this research paper the Van Gendthallen has been chosen as an example; to match the graduation project. The research could however be used for further research towards redeveloping these type of buildings.

Daylight in the Van Gendthallen
Daylight enters the building through the windows in the longitudinal facades and through the roofs. The ratio façade to building area is very little; most of the light that enters the building comes from the skylights. But because of the height of the halls the light doesn't reach the ground floor which makes the halls seem dark.



(De Graaf & Berning, 2014)

Sound in the Van Gendthallen
The Van Gendthallen are big and empty spaces constructed out of hard materials (metal, stones), which causes sounds to echo.



(De Graaf & Berning, 2014)

Fire safety in the Van Gendthallen
Fire safety might be one of the biggest problems for redeveloping large buildings. Due to the size, fire safety cannot be guaranteed. Dividing the building into several fire compartments isn't an option either as this compromises the flexibility which is one of the main advantages these type of buildings have over other buildings.

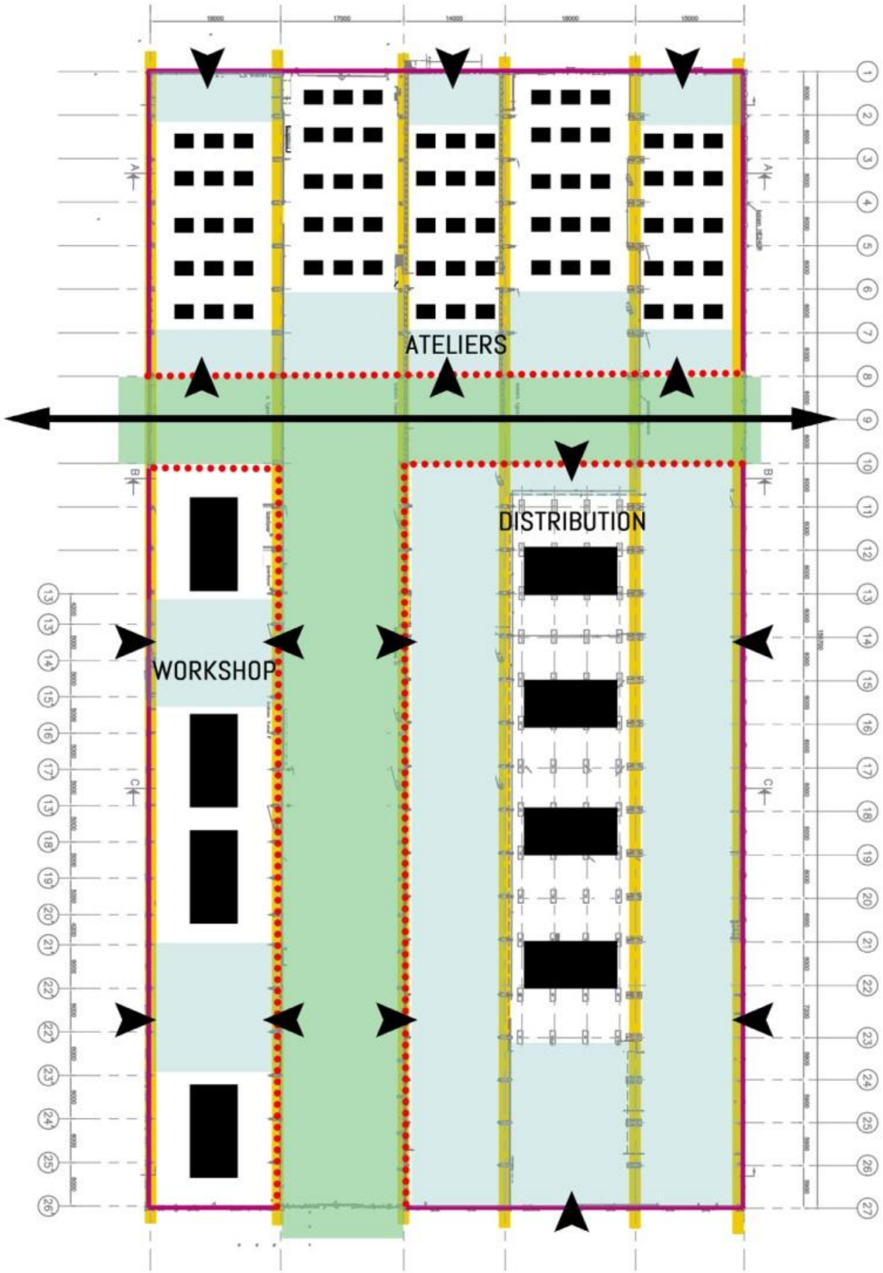
For the design both the guidelines the conclusions from the following reports will be followed:

- De Kievith, I., Van Ouwekerk, M., Van Leeuwen, N., De Haan, H., & Van de Geyn, B. (2008). *Brand! Veiligheid in broed- en vrijplaatsen in Amsterdam*. Rotterdam: Drukkerij Tripiti.
- VROM. (2007). Handreiking grote brandcompartimenten. Den Haag Ministerie van VROM.

For the graduation project the Van Gendthallen will transform into a urban interior with separate small scale ateliers (cell structures are prohibited) placed around an exhibition space and several supporting functions. The design asks for ateliers that can function as a showcase of how to use reclaimed goods; this could be from structure, to façade or even on the interior scale (partition elements, platforms, furniture).

Hypothetical design

In order to understand how the materials can be implemented a hypothetical design for the Van Gendthallen has been made. With the help of this design the architectural applications will be further described. On the image on the right the design for a creative chain incubator can be seen. In this design the halls have been opened up in order to provide more daylight and to generate shorter escape routes. This does mean three new facades have to be realised (red dotted lines). The design is divided into three sections to represent the three main stages of the design process; generating ideas, the creation and the distribution. The distribution section of the Dutch Design Dock will focus on the customer experience; it will be a place where visitors can see the process and get inspired by the possible applications of reused materials. It should also be a place to relax and contain supporting functions such as a restaurant, exhibition hall, small shop and maybe even a small theatre.



Hypothetical design for the Van Gendthallen

The economic aspect of reuse

Even though these products are at the end of their life, that does not mean they have completely lost their value. The products, even as waste, are still part of the economic flow. Although the value might have decreased, if a company wants to discard them it will actually cost them money. In Amsterdam there is the system of Big Bags. A Big Bag can only contain one cubic meter of waste and it costs €150 to have such a bag picked up (Amsterdam, 2015). Another example is the value of scrap aluminium which still has a value of €0,85 per kg (Krommenhoek Metals., 2015).

The problem with waste are the legislations. Laura Rosen Jacobson mentions in her paper that law states that waste becomes the property of the one that has taken care of the demolition (Rosen Jacobson, 2014). Besides the fact that it is somewhat difficult to obtain waste; legislations are also the reason why it's difficult to design with these materials. These state the requirements materials or building parts have to meet. With new materials these requirements can be guaranteed; in fact if you need to meet a certain type of requirement there are tons of examples of material compositions to meet these. This is different with reclaimed materials; of these materials it is unsure what the exact values are and therefore it's difficult to guarantee that they will meet the requirements.

This however is a case of research; if enough research is done towards the reclaimed materials it can be proven that it will work. A good example of difficulty with reusing materials to make sure they meet the structural and building physical requirements is fire safety. Fire safety might be one of the strictest rules; which also affects the economical side of the design. Constructing a fire resistant façade is one of the most expensive things to design. Besides the sustainability aspect, designing with reused materials is often also due to an economical aspect. Reused materials are cheaper than new ones; could using reclaimed materials be a solution for constructing these expensive parts?

4. METHODS

In order to answer the research question of this paper *'What role can reclaimed materials that are both available in large quantities and within the coming years play in the redevelopment of vacant large scale buildings?'* so precisely and completely as possible in the give time; the research has been divided into several methods.

Literature

The biggest part of this paper will be based on literature research; this research has been divided into several topics that will both contain general research for the graduation project as well as specific topics for the thematic research paper:

Case studies

As part of the literature research, several examples of realised buildings have been studied. The projects chosen for the case studies have been chosen from three leading books in the research, although these books also contain examples of buildings consumer waste; the case studies focussed on projects using waste from the industry.

- Bahamón, A., & Sanjinés, M. C. (2010). *Rematerial: From Waste to Architecture*. W.W. Norton & Company.
- Addis, B. (2012). *Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling*. Taylor & Francis.
- Hinte., E. V., Peeren., C., & Jongert., J. (2007). *Superuse: Constructing new architecture by shortcutting material flows.* Rotterdam: 010 Publishers.

This has been done to get a better idea of the current process; what steps are usually taken. What are the most common materials; their origin and new application. What can we conclude from these projects and what's there to learn, what direction should the research go. This part of the research can be found in the appendices.

Research of the location

Research towards the location will be both done in the form of literature research, analysis and site visits. The literature part will focus mostly on the city of Amsterdam; concerning the vacancy and waste flows.

The analysis will focus on the Oostenburgen islands and the Van Gendthallen itself; the context of the graduation studio. What's the DNA of the location, what is wanted or needed on the location?

Mapping

The scenarios mentioned in the framework will be mapped. Like the oogstkaart (Studio., n.d.) the maps will show the vacant offices for the first scenario and the found materials for the second scenario.

Research by design

A second method applied in this research paper is research by design. Research by design can be done using a large variety of methods. For this graduation project the method used will be sketching. It is important to design what can be made using the materials found. But also the other way around; it is important to design what the location needs and use this as a guideline for searching for materials.

Choosing materials

In order to determine which found materials will be further research, certain guidelines have to be formulated. These guidelines will consist of both general criteria and the potential architectural applications:

Criteria

Available in large quantities
The Van Gendthallen is a building of more than 12.000 square meters; this means there is a lot of material needed to redevelop this building. Designing with reclaimed materials can be a difficult process in itself; in order to simplify this the first criteria is 'availability in large quantities'.

Available within the coming years
Since a lot of materials are needed for the Van Gendthallen; besides knowing if they will be available in large quantities; materials are needed that will be available within the next five to ten years. It's unrealistic to wait for a specific beam that might or might not be salvaged from a building the will be demolished over twenty years.

Ready to reuse
To further simplify the design and building process the materials have to be ready to reuse. Some minor processing might still be needed, such as cleaning or refurbishing, but the focus of this paper is using materials that can be reused as is. Not materials that go into the recycling process to create brand new products.

Innovative applications possible
Most reference projects use the same kind of materials; the 20 foot cargo container is a good example of this and has resulted in an entirely new architectural category of its own. Although it's unlikely there will be very out of the box implementations of reclaimed building materials; it would be interesting to see if it's possible to create a new type of application.

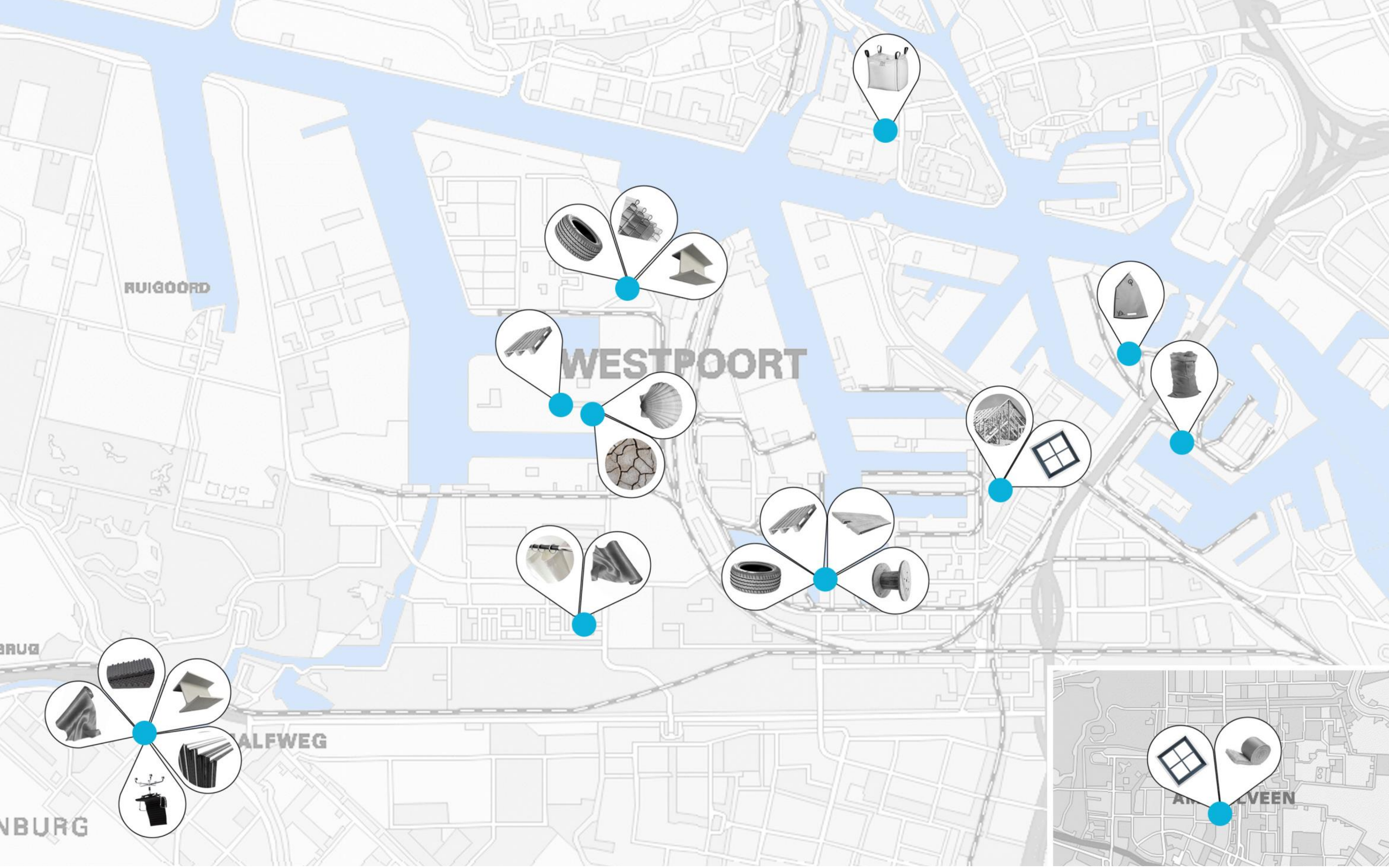
Potential architectural application

Vacant large scale buildings are the context of this research paper. In the framework the main problems with these buildings have been described; which is ironically their size. In order to help with this bigger problem; the architectural implementations of these materials have to benefit the redevelopment of these large halls. The possible architectural applications have been narrowed down to the following three categories:

Structure
Since these historic halls are often on a scale of their own it's often necessary to create multiple layers in these buildings to make in economically attractive to redevelop. To which extend can the found materials play a role in realising a secondary structure in these halls?

Façade
Another option in redeveloping these large scale halls is dividing then halls into different compartments, maybe even adding outdoor spaces to the programs. Even though this goes against the flexibility these buildings have to offer; it's often done to reduce the size of the complex and make it more approachable for the human scale. The Hallen in Amsterdam are a good example of this. By dividing the halls into separate building parts; it's necessary to create façade elements. Even though it's an overall reuse of an building from the 1900s, the newly build parts do have to follow the current demands of the bouwbesluit. How could these materials be implemented in the creation of an façade?

Interior
What seems to be a success in redeveloping large scale halls is treating the building as if it is one large urban landscape. Within this landscape several volumes are built that can relate more to the human scale; these volumes could follow the same principles as the structure and façade applications. Besides these volumes, these urban interiors often contain other architectural elements that help scale the building. These could be moveable partition elements or platforms and even furniture. To which extend can the found materials be used in the creation of an urban interior?


RUIGOORD
WESTPOORT
BRUG
HALFWEG
NBURG
AMSTELVEEN

5. RESULTS

The appendices show the mapping of the scenarios and the scoring of the found materials. In this chapter the highest scoring materials will be discussed.

General architectural implementations

This part will elaborate on the architectural implementations of the found materials for both scenarios. For each scenario the found materials have been scored based on the criteria mentioned (appendices) which results in a top three of materials per scenario.

Background information containing the current practice and properties of each chosen material will be given. A description will be given on how these materials can be dismantled if necessary; this will be done on the terms of component or element reuse. Lastly, an overview will be given of the architectural implementations on the subjects of construction, façade and interior.

These architectural implementations are possible design solutions. They are the result of case studies, brainstorming and research by design. This doesn't mean that these implementations are the only options there are; that's not the case. This could be seen as a working document that could be at the basis of further research. This catalogue gives an idea of the possibilities, it does not present the sole best solutions.

Chosen materials

The materials that will be further described in this chapter are the result of a rating based on the criteria and the possible architectural implementations; they had the highest score. This does not mean that the other materials do not have any potential; that is not the case. But in order to dig deeper into the possible implementations only the five materials with the highest scores will be discussed.

The top three materials derived from office renovations are:

1. Carpet Tiles (24)
2. Doors (22)
3. Windows in frame (18)

The top 3 materials derived from the harbour of Amsterdam are:

1. Pallets (24)
2. Jute Bags (23)
3. Dragline (23)

Reclaimable materials

Scenario 1 | Carpet Tiles

Background information

Carpet tiles are an invention from the Amsterdam based company Heuga. They originally made carpets for rent, but stains on sections of these carpets was a reoccurring problem that prevented the carpet from being rented again. Using tiles was the solution for this problem; reducing their waste. Now a days carpet tiles can mostly be found in commercial buildings. During the 70s and 80s more and more commercial buildings have been made and due to the column structures of these buildings, using carpet tiles became a common practice (Focusfloors, 2013).

Options for reuse

The square carpet tiles consist of multiple layers of nylon and bitumen and have a width of 50cm. Carpet tiles do not have to be dismantled in order to be reused. It can however be cut into different shapes and sizes if necessary.

Architectural Applications

Construction

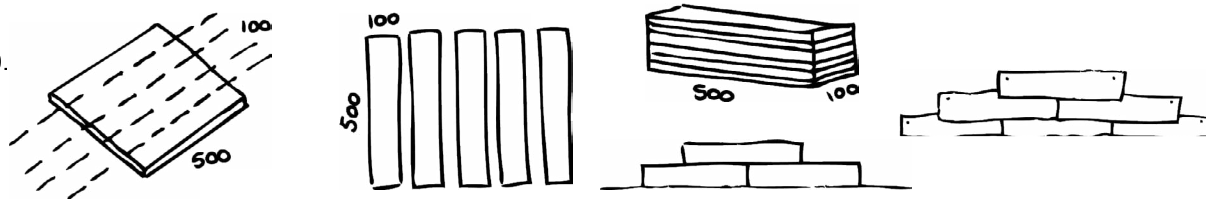
- Stack tiles as is
- Create bricks out of the tiles; then stack
- Stack and glue cut out tiles and fill with sand?

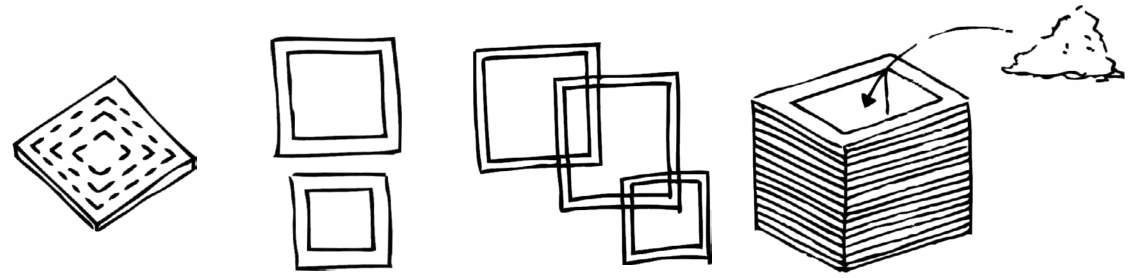
Façade

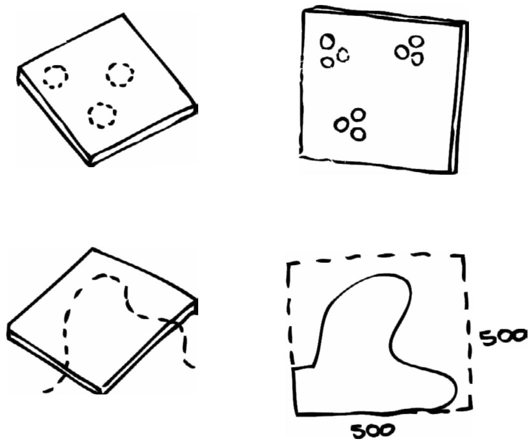
- Use the tiles as sheets in a cladding system or as roof tiles
- Interlace tile frames to create a half transparent element
- Tiles can be perforated in order to play with daylight

Interior

- Tiles can be perforated and used as decoration
- Sheets can be rolled and used as furniture
- Sheets can be folded and put together using bolts as furniture







Lucy carpet house, Rural studio (2002)

Scenario 1 | Doors

Background information

Within the general office, the individual workplaces are separated by system walls and these walls will contain doors. These doors are mostly made out of HPL (High Pressure Laminated) and are available in multiple sizes; but the most standard option is 1000 mm width and 2105 mm high (Hopman, n.d.).

Options for reuse

Doors do not necessary have to be dismantled before reuse; hinges and doorknobs might have to be removed or replaced first. As most doors are made from channel chip plates it might not be the best solution to cut the doors; but it could deliver interesting options for façade implementations.

Architectural Applications

Construction

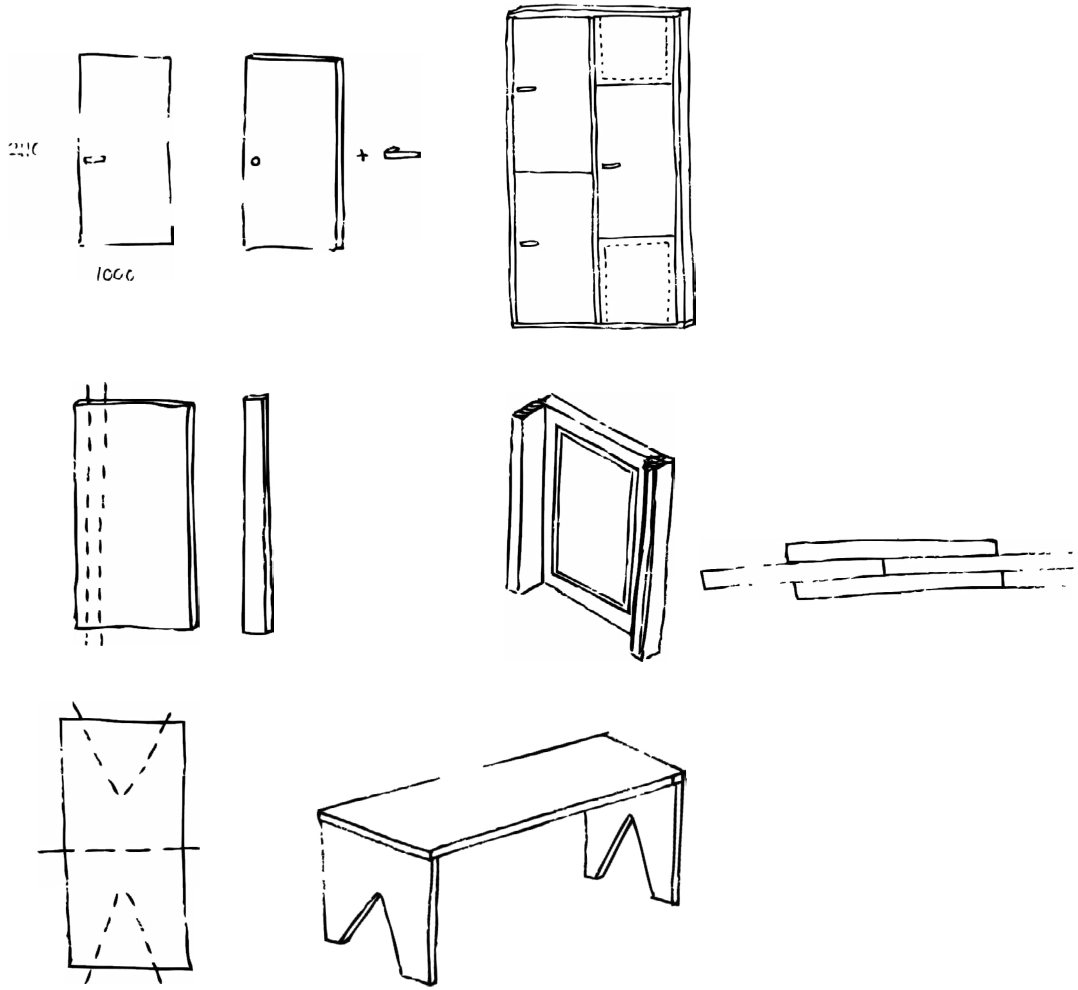
- Combine doors as column
- Combine doors to wall element

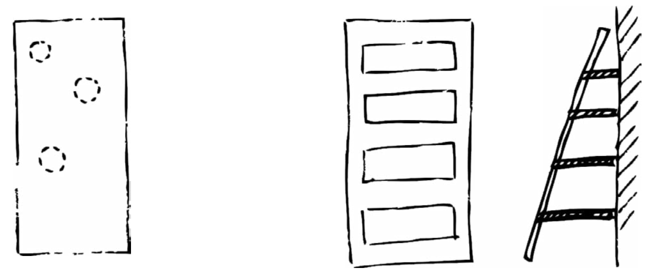
Façade

- Use doors as cladding/ wall
- Use sheets as cladding
- Use perforated doors to create a half transparent element
- Use half doors as shading element

Interior

- Doors can be perforated and used as decoration
- Two doors can be transformed into one table
- Doors can be transformed in to storage element





Scenario 2 | Pallets

Background information

Euro pallets as the name suggests are used on the entire continent of Europe to help with the transport of goods. The pallets have a deposit value of approximately 10 euros. If the pallets are broken, they lose their value all together (Pallet Recycling Nederland, n.d.).

Options for reuse

Euro pallets are made of pinewood and have a HT treatment (prevent insects, etc.) and have standard dimensions (1200 x 800 mm with a thickness of 140 mm). The maximum static load is 2000kg (Pallet Recycling Nederland, n.d.). Pallets do not necessary have to be dismantled before reuse; but it can be of advantage to the design freedom.

Architectural Applications

Construction

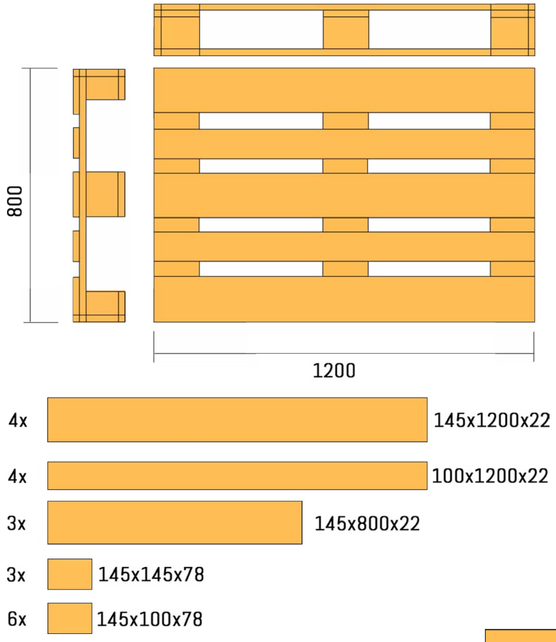
- Stacking pallets as columns
- Interlocking pallets as wall element

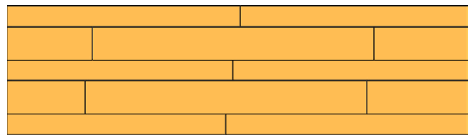
Façade

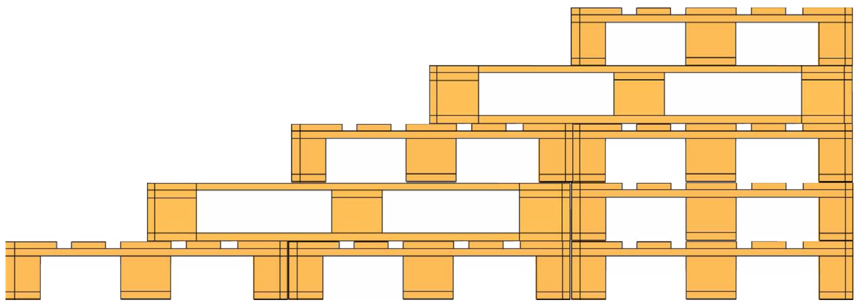
- Connect pallets as façade element
- Use sheets as cladding

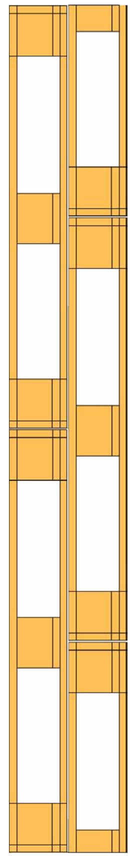
Interior

- Stack pallets to create a platform
- Combine pallets with cut pallets to create furniture









Scenario 2 | Jute Bags

Background information

Jute bags have been and are still considered to be one of the main packaging materials for goods during transport. This is due to the unique combination of properties; it's strong, durable and it's able to ventilate (NNZ, n.d.). The jute bags found in the harbour of Amsterdam are used for transporting cacao until they are further distributed. The bags are cut open and the beans are transferred to big bags..

Options for reuse

The jute bags are available in different sizes; but they are most often made to hold up to 50kgs of goods. These jute bags have already been cut open; which results in a fabric sheet of 1100 x 1200 mm (NNZ, n.d.). The fabric sheets can either be put back together, or cut in different shapes and sizes.

Architectural Applications

Construction

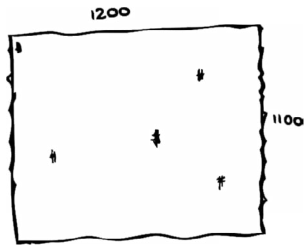
- Filled the new bags with sand and stack the elements

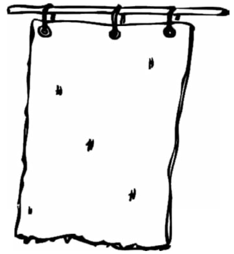
Façade

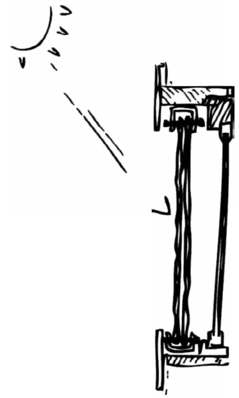
- Fabric can be used as shading
- Sheets can be hung in a frame
- Fabric strips can be weaved

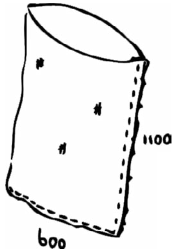
Interior

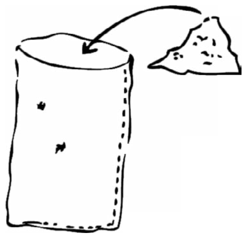
- Filled with wool or other fabrics the bags can be used as pillows
- Sheets can be used as curtain
- Sheet can be used as decorative element
-

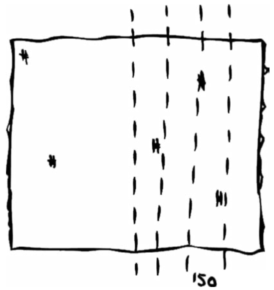


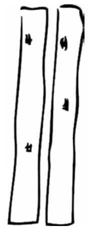


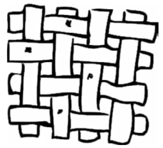


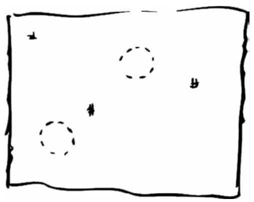












Scenario 2 | Draglines

Background information

Draglines are available in two different types; with or without a metal framing. Draglines have a width of 1000 mm, a height of 100 mm and the length varies between 4000 and 12000 mm. The draglines form the harbour of Amsterdam are used to protect the quays (Lekkerkerker, 2015).

Options for reuse

These draglines do not have to be dismantled, they do not contain a metal frame. The draglines from Maja Stuwadoors are often damaged and do need to be processed. The draglines can be used as is depending on the size or cut.

Architectural Applications

Construction

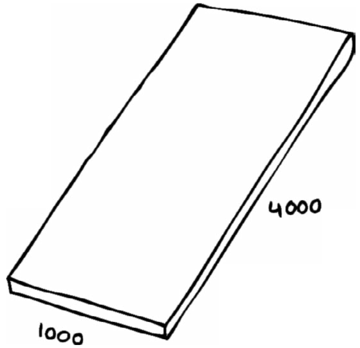
- Combine draglines to create columns
- Layer draglines to create loadbearing wall
- Use as beams

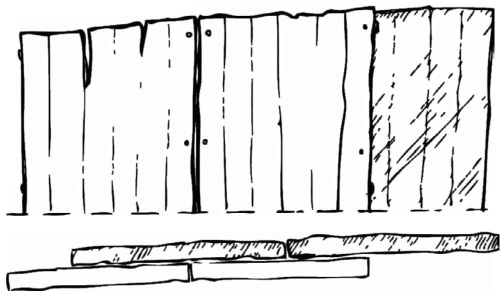
Façade

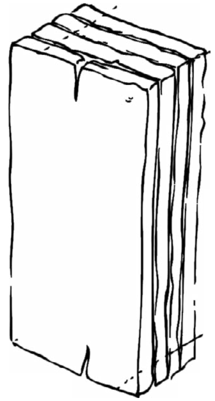
- Use strips as cladding

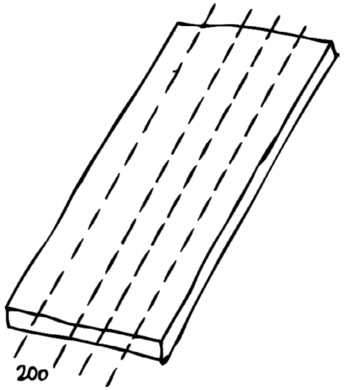
Interior

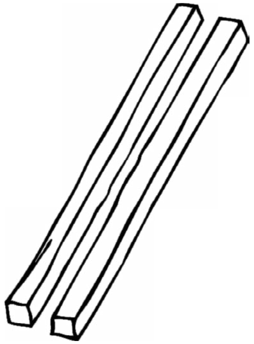
- Use perforated draglines as decorative elements
- Use perforated draglines as storage element
- Cut dragline into table pieces

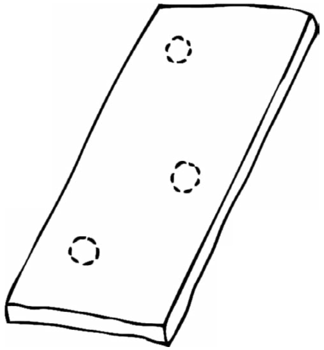












Architectural implementations in the design project

In the chapter of the theoretical framework the demands from the design are specified which has been translated to a hypothetical design for the Van Gendthallen. In this design the halls have been divided into three different fire compartments around a newly created outdoor space. This means three new facades have to be created that will function as fire resistant walls.

Due to regulations it's very unlikely that these facades can be made using the five materials mentioned earlier. But this doesn't mean these materials cannot be used all together. Besides creating a fire resistant façade, it's also advisable to create an interior that's not highly flammable or will contribute to the spread of a fire easily. The reclaimed materials from the research can be used in this way.

Besides the limitations towards the amount of closed of square meters, there are also restrictions towards the amount of connected closed of spaces. There's a maximum of two; cellular structures are prohibited. The partition wall between these two closed of functions must at least be fire resistant for 20 minutes.

If applicable the specification towards fire safety are given for the found materials; based on these numbers an example of a partition wall has been designed.

Scenario 1 | Carpet Tiles

Although carpet tiles are not made out of stone and concrete and will therefore not be accepted as a material for fire-proof wall. The carpet tiles by Interface are qualified as Bfl s1 (Interface, n.d.). Bfl s1 stands for a very limited contribution to the fire, it's hardly inflammable (Mooiman, n.d.). Carpet tiles might not qualify for the build of a fire-proof wall, but in the concept of treating the Van Gendthallen as one large fire compartment; there might be no need to create such a wall. It is however advisable to have the materials of the interior contribute to the fire as little as possible. A construction/wall made out of carpet tiles could be a real option for this; especially if these tiles are used as a whole. The minimum depth of a fireproof wall is 20cm; where these tiles would form a wall of 50cm depth.

Scenario 1 | Doors

If reusing doors can contribute to the fire safety of a building depends on the fire resistance of the doors themselves. If available; fire resistant doors, could be a solution to the creation of a fireproof wall. Most doors used in system walls are 39 minutes fire resistant or 34 minutes in case the door contains glass (Hopman, n.d.).

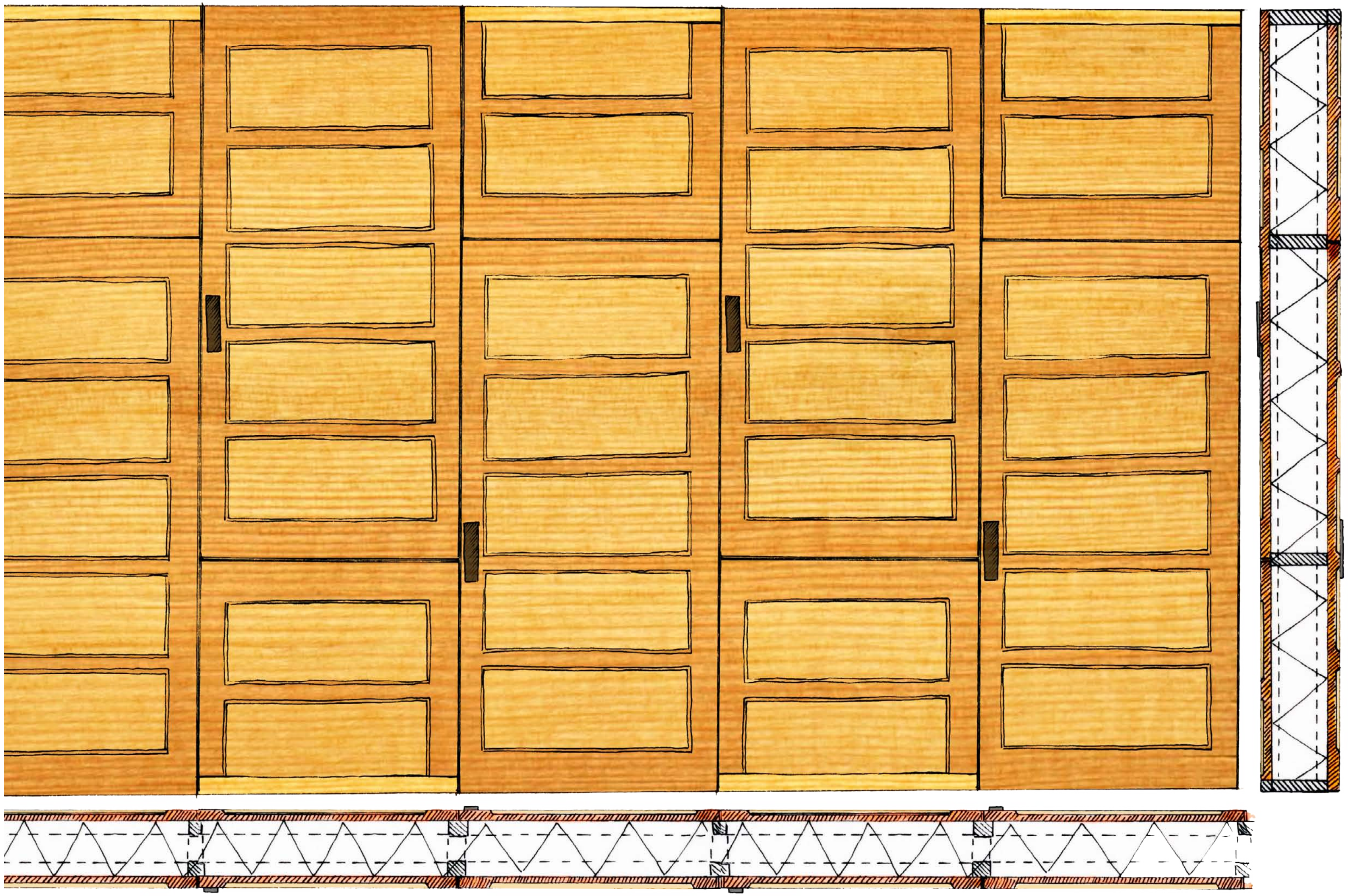
Scenario 2 | Pallets

Since pallets are three dimensional non solid elements it's hard to determine the fire safety of an object on its own. The pallets are however made of pinewood which has a fire rate of 0.67mm per min; this means that the slats of a pallet are completely burned up after half an hour. Covering the pallets (as wall structure) with for example gypsum boards (12mm) on either side of the construction increases the fire safety. The guideline for gypsum boards is as follows (for two boards on top of each other at the side of the fire) 2 x 12 x 1,6 = 38min (Gemeente Utrecht, n.d.).

Scenario 2 | Draglines

The draglines available are made out of hardwood; which has a fire rate of 0.45mm/min for a density of 600kg/m3 (Truijens, 2009). The draglines used have a density of at least 1000kg/m3 (Lekkerkerker, 2015). After half an hour 13.5 mm off the wood will be burnt; this leave a dragline with a thickness of 86.5 mm. If a wall is made out of two layers of draglines this might also help prevent the spread of a fire.

Possible design for a partition wall.
There are a lot of examples where doors have been implemented in the creation of a wall. Repurpose (2014)



6. CONCLUSION

Each year around 60.000.000 tonnes of waste is produced in the Netherlands; of which 40% is building and construction related (Rijkswaterstaat Leefomgeving, 2010). Sending this waste to the landfill or the incinerator isn't an option anymore in an era of material scarcity. We have to change our view of waste; waste is just stuff in the wrong place as Duncan Baker Brown and Stewart Dodd state.

The goal of this paper is to research what role waste materials can play in the redevelopment of vacant buildings. This has been studied by literature and case studies and has been translated to finding possible architectural implementations.

The research is set in Amsterdam as this city if the main contributor of both building and construction related waste as office vacancy in the Netherlands. Instead of searching for materials from new building projects and demolition projects; the search has been narrowed down to materials that are available in large quantities and within the coming years. This has led to two scenarios; salvaged materials from office renovations and reusing waste materials from the harbour of Amsterdam.

To keep the research manageable the first scenario is based on a combination of literature research and assumptions. All vacant offices have been mapped by building year and square meters. The biggest contributor is the office from the 80s. All these offices are most likely different and due to tunnel vision at the beginning of the research there wasn't enough time to literally research these vacant buildings. Instead the 'found materials' are based on studies towards renovations of these type of offices and other literature. Out of these data the materials that are most likely to be found in an office have been determined (furniture not included).

For both scenarios the found materials have been scored on the criteria (quantity, flow, ready to reuse and innovative applications) and possible architectural applications (structure, façade and interior).

An example of using a reclaimed material is the carpet tile. Carpet tiles can be found in numerous offices and are easy to remove; they can be stacked to create columns or wall elements. They can be cut into strips and function as cladding.

Although the scenarios have been set to keep the research manageable, this also marks the limitations of the research. The two scenarios described in this research aren't the only possible resources for waste. On top of that for the scenario of office renovations all offices have been considered to be the same (qua materialisation). This has been done because I was looking for generic solutions and materials. On top of that I've now considered that each office will need both an interior and exterior renovation; but this might not be the case. For a more realistic research a specific office could be picked and analysed/mapped, considering the real renovation options.

A third scenario, the Van Gendthallen, should also be researched during the coming design period. Each interference with the existing building could deliver materials to reuse.

To conclude, waste materials can play a role in the redevelopment of large scale buildings. In fact the design process has to be changed, the materials become one of the first steps in the process. Although building regulations will prevent these materials to be used in the creation of f.e. a fire proof wall, that does not mean that these materials cannot be used in architectural implementations. Most materials can be used to create structures or façade elements, but they are better suited on places that do not have these extremely high requirements. The design solutions mentioned are in no sense the only options, the aim of this paper was to give an insight in the possibilities.

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8. APPENDICES

A. Glossary
B. Current process
C. Scenario 1 | Office Renovation
D. Scenario 2 | Harbour of Amsterdam

A. Glossary

Component

A product containing multiple elements. For example a window; this component contains a glass element, a wooden element, etc.

Creative Chain Incubator

A workplace for the creative industry that is based on the value chain of a creative product. From conceiving the idea, to the production to the distribution. This will ensure upscaling of small scale companies

Delft Ladder

Variant of the Ladder of Lansink from the 1980s on the options of waste treatment.

Element

A product made out of one material; for example a piece of wood.

Footprint

The measure of human demands on the earth. For example if everyone would live like the Dutch we would need 3.6 earths to maintain in our lifestyle.

B. Current Practice

To understand the possibilities (and problems) of designing with reclaimed materials, the current practice has to be studied.

- What is the current process
- What are the most commonly reused materials
    - Are there current guidelines towards reusing these materials
    - What is the environmental impact not reusing these materials.
- What are the most common origins of the materials
- What are the most common applications
-

This has been done through literature research and case studies.

Reusable building materials

Bob Falk and Brad Guy describe in their book '*Unbuilding: salvaging the architectural treasures of unwanted houses*' the type of materials you are most likely to find. They also mention if there are any restrictions towards the reuse of these materials. The following section is a summary of their findings on most commonly found materials from building demolitions (Bob Falk & Brad Guy, 2007):

Electrical fixtures | Easy to remove; vintage pieces are highly desirable.

Heating and air-conditioning equipment and other appliances | Mostly only valuable if it's not older than five years and depends on local demand for these products. Condition, colour and brand are important for these appliances.

Plumbing Fixtures | One of the most recovered items; pay attention to toilets with a high-flow systems as these might be prohibited now by law.

Cabinetry, casework, and stairs | Often one of the first things to be salvaged. Old customized kitchens might be difficult to resell, as they do not match the now standardized sizes. Stairs are only worth the effort is ornate or from a specific period as needed in the design.

Doors windows and shutters | Doors are easiest to resell if they come with their original frame. Quality if very important, mostly the older the better. Hollow-core doors are not worth the effort. Windows are more difficult to remove and if the frames contain single layer glass and lead based paint; they are not worth salvaging.

Finished wood flooring | Hardwood flooring, unless damaged, always worth salvaging; same goes for wider flooring panels. Beneficial to using reclaimed flooring is the length, older floors are often made out of pieces of 3,5 meters. Do expect at least a loss of 10-15% of the total amount due to dismantling.

Tile, vinyl, and carpet flooring | Ceramic & Porcelain tiles are difficult to remove; only worth if it's one of a kind or has historic value. Carpet is typically not salvaged unless in good condition.

Ceilings and interior walls | Drywall, lath & plaster is not reusable. Wooden panelling is desirable, same goes for pressed tin ceiling elements.

Insulation | There are three types of insulation; loose fills are difficult to recover. Batts are only worth it if they are clean and in a good shape. Rigid foam only if the size is large enough.
Wood | Wood sidings were one of the highest grade products to be made, this means long lengths (without knots) could be found.
Brick | Depends on the quality of the brick and the ease of mortal removal Cement based mortar (white /grey appearance) is difficult to remove, Lime based mortar (yellowish, soft key test) is easy to remove; often found in pre-World War II buildings. Extruded bricks with holes cannot be reused.
Stucco | Durable & long lasting siding material, difficult to remove and not salvageable.
Roofs | Slate and clay roofs are worthwhile to salvage. Lumber or solid wood sheeting is not worth salvaging.
Wood framing | Desirable to salvage, but depends on the length of the pieces. Anything above a meter might could be reused.

Environmental impact of materials

The scheme on the right gives an overview of what happens with the most common building materials once they enter the waste stream. As can be seen, most materials can be either reused or recycled. This is especial of benefit to the environment when it comes to the materials that release toxins when incinerated or end up on the landfill. .

Material		Waste Process	Specifications of waste prosess	Reuse options	Recycle options
Wood	General	Incineration	Benzene & Dioxins released		
	Tropical Hardwood	Cutting		Smaller pieces	Plates
	Europian Hardwood	Incineration	Benzene released		
		Landfill			
		Cutting		Smaller pieces	Plates
	North American Softwood	Incineration	Benzene released		
		Cutting		Smaller pieces	Plates
		Landfill			
	Europian Softwood	Incineration	Benzene released		
		Cutting		Smaller pieces	Plates
		Landfill			
Bio	Cork	Grinding & Heating			Insulation plates
Stone	Natural Stone	Cutting		Smaller pieces	
		Bonding with resin			Composit
	Clay	Wetting	(unles combined with concrete)	As is	
		Landfill			
	Gypsum	Demolition	Gypsum and Anhydrite has to be seperated from concrete	NO	NO
		Landfill			
	Lime stone	Demolition & Seperation	Connected by concrete based mortar or clue	Difficult	
		Grinding to granulate	High percentage of lime		Not possible for concrete production
		Grinding to granulate	High percentage of lime		Only in road construction
	Ceramic Bricks	Demolition & Seperation	Bricks used with lime based mortart	As is	
		Demolition & Seperation	Connected by concrete based mortar or clue	Difficult	
		Grinding to granulate			Concrete production or foundation roads
		Grinding	Filtering the ceramic and the sand		Production of new bricks
	Ceramic Tiles	Salvaging	Tiles are hanged; easy to remove	As is	
	Ceramic Rooftiles	Salvaging	Tiles are hanged; easy to remove	As is	
	Concrete (General)	Salvaging	Only if designed for dismantling	As is	
		Grinding to granulate	Reinforcement steel is removed		Concrete production or foundation roads
	Concrete (Cellular)	Salvaging	Only if designed for dismantling	As is	
		Grinding to granulate			Not suitable
	Concrete (Foam)		Has to be seperated from foils		Possible
	Glass (General)	Salvaging	Difficult; often destroyed	As is	
	Glass (Non- coated)	Melting	Seperated by sort (colour)		Completely
	Glass (Coated)	Melting	Coatings have to be removed upfront		Difficult
		Grinding to granulate			Road construction
		Landfill			
	Asbesthos	Removal & Processing	Has to be done by specialist	NO	NO
		Left behind	If intact, left in place; marked and covered by finish		
	Rockwool	Salvaging		Only leftovers	
		Recycling	Costs more energy then the orginal production		Rockwoolplates
	Glasswool	Incineration			
		Landfill			
Metals	Steel	Salvaging		As is	
		Melting	Blast furnace; less energy than in primairy production		Production of new steel (up to 12%)
		Melting	Electric ovens; costs more energy		Production of new steel (up to 100%)
	Steel (coated)	Melting	Has to be sorted first		Difficult due to high melting point
		Landfill	No significant effect on eath; iron levels are high		
	Lead	Melting			Easy due to low melting point
	Zinc	Melting			YES
	Aluminum	Melting	Only 5-10% of the energy of primairy production needed		Production of new aluminium
	Copper	Melting	Only 10-40% of the energy of primairy production needed		Production of new copper
Plastics	PE & PP	Melting	Thermoplast; toxins can be released		Production of new
		Incineration	Release of H, C and O		
	PC	Salvaging		As is	
		Melting			Production of new
		Incineration	Release of H, C and O		
	PS	Salvaging	As insulation material	As is	
		Recycling			Production of new
		Incineration	Release of H, C and O		
		Landfill	Danger of styreen leakage; soil polution		
	PVC	Salvaging		As is	
		Griding to granulate	Can only be used as core; atleast 30% virgin materials needed		Production of new
		Incineration	Release of chloride, hydrochloric acid and dioxines		
		Landfill	Not degradable; possible leakage of phthalates which treatens drinking water		
	PUR	Salvaging	PUR is considered harzardous waste	As is	
		Recycling	PUR is considered harzardous waste		In new insulation plates
		Incineration	Release of hydrogin cyanide (HCN)		
	Bitumen	Recycling			New roofing or asphalt
		Landfill	Considered harzardous waste		

Common applications

For this part several projects have been analysed. For each project the reused materials have been stated and tried to find the following information of each material:

- riginal application
- The distance to the building site
- Years in use
- New Application

In total .. projects have been researched; six of them will be shown as example of how this has been done:

- Big Dig House
- Liquorish Bar
- Pittsburgh Glass Center
- Racine Art Center
- Random Road
- Studio 320

In total .. projects have been researched; but it was very difficult to find the same kind of information for every project. Some projects were well documented and described all the main types of information sought for; other projects just stated a list of reused materials without any explanation of how.

Although the research towards the case studies has not been completed, some conclusions can be drawn from these projects.

- Over 80% of the materials were derived from buildings slated from demolition
- For most projects, the materials are harvested on another location than the building project. Some even from other continents.
- There isn't a real perforation towards the new applications; in fact reusing building materials isn't that innovative. Most reclaimed materials have been reused in their original application.

The most important conclusion drawn from the case studies until now is that reusing salvaged materials has mostly been done on small scale projects. There are only two examples of larger scale dwelling projects; using materials that come from one certain project. And even for these projects the search for materials has been very specific. It seems the projects only use reclaimed materials, because they happen to be found at the time or they did a specific search for a kind of material coming from the design. For the graduation project we're looking for materials that are highly available and research on how to implement these instead of looking for one of a kind things.

BIG DIG HOUSE

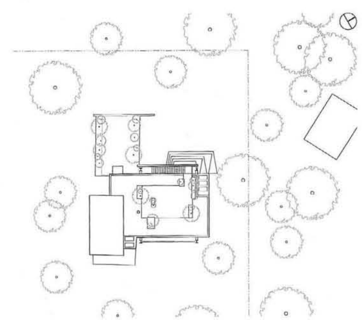
General Information	
Name of the project	**Big Dig House**
Location	Bird Hill Road 8, Lexington, MA, USA
Built	2006
Architect	Single Speed Architects
Program / function	Single Family House
New or renovated	New
Percentage or amount of reclaimed materials used.	600.000 lbs

Reclaimed Materials	
Type of material	**Steel Beams**
Original application	I-93 Roadway tunnels
Application Category	Other Structures
Original Location	Boston Central Artery
Distance to building site	13 miles
New Application	Structure
Application Category	Structure / Columns / Beams / Core
	300.000 lbs
Reuse or Recycle	Reuse
Type of material	**Concrete Inverset panel**
Original application	Temporary ramp to bridge
Application Category	Other Structures
Original Location	I-93
Distance to building site	13 miles
New Application	Floor
Application Category	Floor / Wall / Ceiling
Reuse or Recycle	Reuse
Type of material	**27 Inch Girder**
Original application	Walls of Storrow Drive
Application Category	Other Structures
Original Location	Storrow Drive
Distance to building site	11 miles
New Application	Roof structure
Application Category	Structure / Columns / Beams / Core
Reuse or Recycle	Reuse

PROJECT DESCRIPTION

As a prototype building that demonstrates how infrastructural refuse can be salvaged and reused, the structural system for this house is comprised of steel and concrete discarded from Boston's Big Dig utilizing over 600,000 lbs of salvaged materials from elevated portions of the dismantled I-93 highway. Planning the reassembly of the materials in as if it were a pre-fab system, subtle spatial arrangements are created. These materials however are capable of carrying much higher loads than standard structure, easily allowing the integration of large scale roof gardens. Most importantly, the project demonstrates an untapped potential for the public realm: with strategic front-end planning, much needed community programs including schools, libraries, and housing could be constructed whenever infrastructure is deconstructed, saving valuable resources, embodied energy, and taxpayer dollars.

ReMaterial | From waste to Architecture
www.ssdarchitecture.com/
www.archdaily.com/

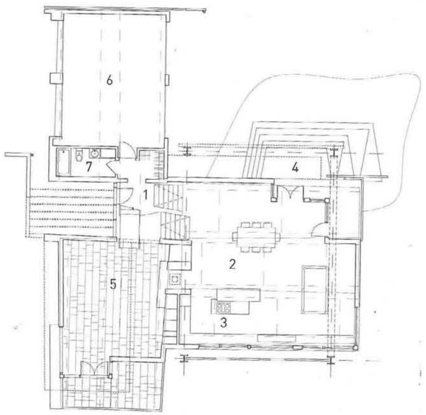


Location | Bird Hill Road 8

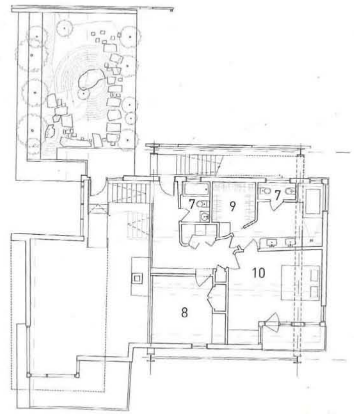
Big Dig House | Exterior

Salvaged materials

Construction of the building



Ground floor



Second floor

Big Dig House | Floorplan

LIQUORISH BAR

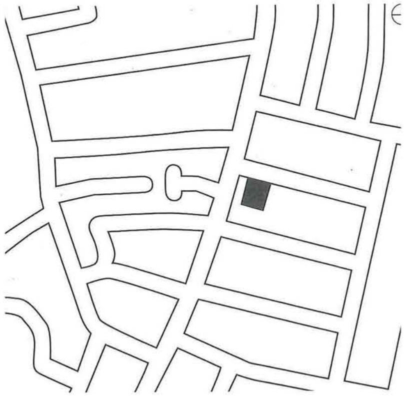
General Information	
Name of the project	Liquourish bar
Location	East Dulwich, London, UK
Built	2005
Architect	Nissen Adams
Program / function	Bar / Restaurant
New or renovated	Both
Percentage or amount of reclaimed materials used.	

Reclaimed Materials	
Type of material	**Wood**
Original application	Floor
Application Category	Other structures
Original Location	West Pier, Brighton
Distance to building site	50 miles
New Application	Doors / Table tops
Application Category	Interior / Cladding / Furniture
Reuse or Recycle	Reuse
Type of material	**Teak**
Original application	Table tops of labaratory
Application Category	Exisiting Building / Structure
Original Location	
Distance to building site	
New Application	Top of the bar
Application Category	Interior / Cladding / Furniture
Reuse or Recycle	Reuse

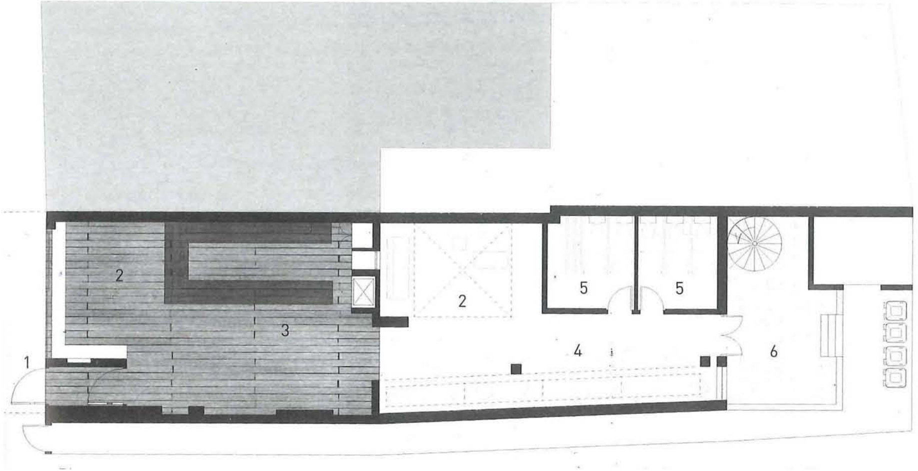
PROJECT DESCRIPTION

The Liquorish bar and restaurant in Dulwich, a conversion of an existing shop space and an extension with a 10m long roof light. The wood used in the design of the bar came from the Palace Pier in Brigthon and is implemented in the door and table tops. The bar is made from wood originally used as table tops in a laboratory.

ReMaterial | From waste to Architecture
www.benadamsarchitects.co.uk/



Location | London



Liquorish Bar | Floorpaln

Liquorish Bar | Exterior

Liquorish Bar | Exterior

PITTSBURGH GLASS CENTER

General Information	
Name of the project	Pittsburgh Glass Center
Location	Pittsburgh, PA, USA
Built	2002
Architect	Forty Eighty Architecture
Program / function	Cultural Center
New or renovated	New 15%, Renovation 85%
Percentage or amount of reclaimed materials used.	94% (of shell & structure)

Reclaimed Materials	
Type of material	**Corrugated Glass**
Original application	Façade cladding
Years in use	> 55 years
Application Category	Exisiting Building
Original Location	Fieldhouse Slippery Rock University
Distance to building site	40 miles
New Application	Façade cladding
Application Category	Exterior / Façade / Cladding
Reuse or Recycle	Reuse
Type of material	**Aluminum battens & mounting hardware**
Original application	Façade cladding
Years in use	> 55 years
Application Category	Exisiting Building
Original Location	Fieldhouse Slippery Rock University
Distance to building site	40 miles
New Application	Façade cladding
Application Category	Exterior / Façade / Cladding
Reuse or Recycle	Reuse

PROJECT DESCRIPTION

The Pittsburgh Glass Center is a non-profit arts organization devoted to teaching and promoting glass art; including studios and shops for glassworking as well as offices, a gallery space, classrooms, and seminar rooms.

The project consists of the renovation of an existing 1489 m^2, two-story masonry and concrete structure, along with a 230 m^2 addition and site development for parking. About 94% of the project's shell and structure was reused. These materials, either from the existing building or purchased from recycling vendors, include doors, windows (reused as interior windows), sinks, brick, and stone.

All new construction materials were evaluated and specified for recycled content and local manufacturing or extraction. As a result, 51% of the new building materials, by cost, were recycled, and mostly manufactured and/or harvested within 500 miles of the project. Of the new wood used for the project, 73% was certified to have come from sustainably managed forests.

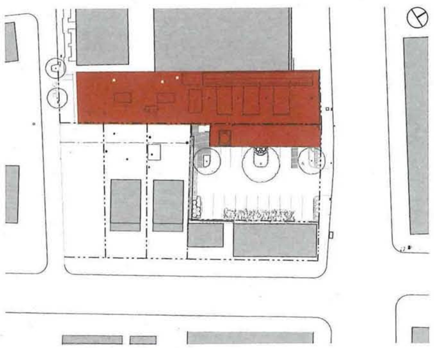
Corrugated glass

A prominent feature of the project is the corrugated glass façade of the addition. The design team was fortunate to learn of the renovation of an existing fieldhouse on the campus of Slippery Rock University, 40 miles north of Pittsburgh. That renovation included the removal a glass wall system consisting of hundreds of corrugated glass panels and related aluminum battens, joint-connection hardware, and mounting hardware. The team was able to reuse not only the glass panels but also the aluminum battens and custom mounting hardware. The new design was then set up to require the least amount of panel cutting, and all other pieces related to the wall system, including structural steel framing and roll-up, full-glazed garage doors, were adjusted to the panel system module.

Diversion of Construction & Demolition Waste

Concrete from the demolition of parts of the existing building was recycled. All metals, plastics, gypsum, glass, carpet, and ceiling tiles from demolition were delivered to recycling centers. About 80% of all construction waste, by weight, was diverted from the landfill.

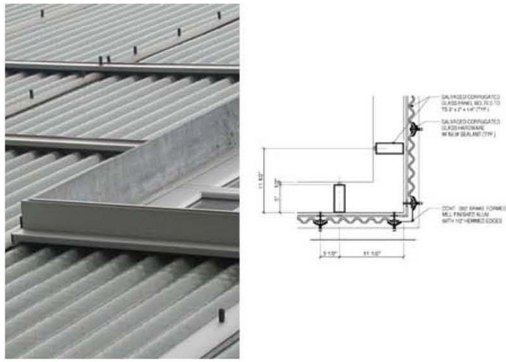
http://aiatopten.org/



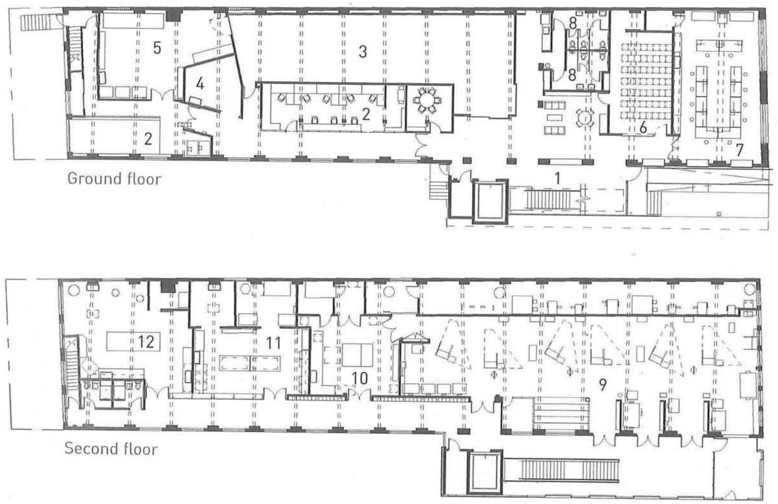
Location | 5472 Penn Avenue, Pittsburgh, PA

Pittsburgh Glass Center | Extension to existing building

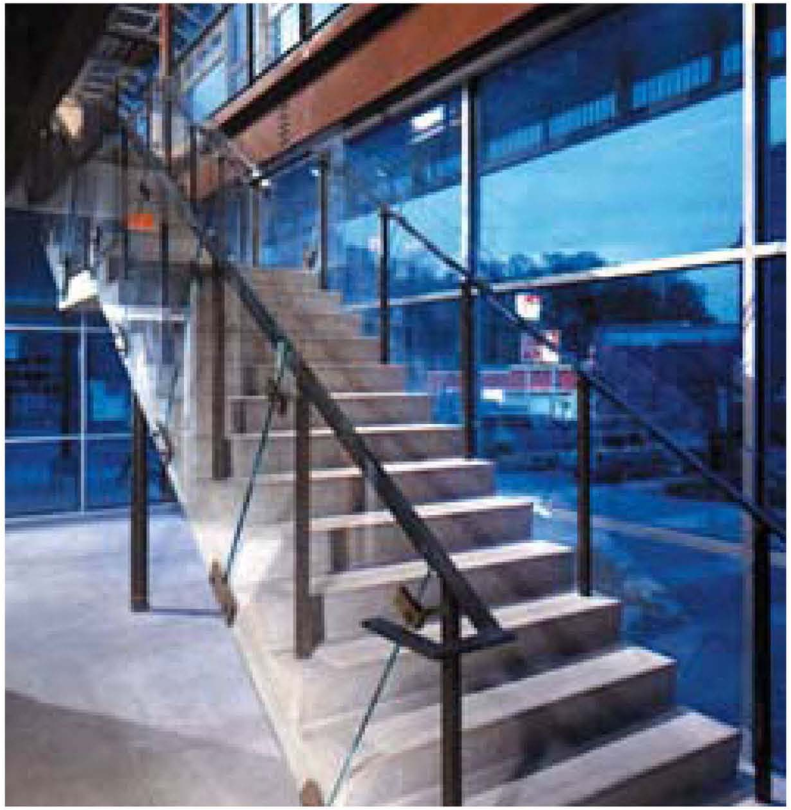
Detailing of corrugated panels



Pittsburgh Glass Center | Detail



Pittsburgh Glass Center | Floorplans



Pittsburgh Glass Center | Interior

RANDOM ROAD HOUSE

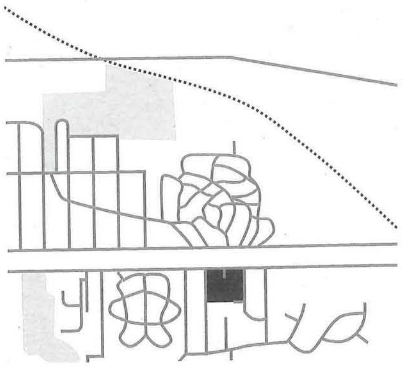
General Information	
Name of the project	Random Road
Location	Lawrence, KS, USA
Built	2002
Architect	Dan Rockhill
Program / function	Single-family house
New or renovated	New
Percentage or amount of reclaimed materials used.	

Reclaimed Materials	
Type of material	**Maple Wood**
Original application	Floor ofbasketball court
Application Category	Exisiting Building
Original Location	Kansas City
Distance to building site	40 miles
New Application	Floor & Worktops
Application Category	Floor / Wall / Ceiling
Application Category	Interior / Cladding / Furniture
Reuse or Recycle	Reuse
Type of material	**Sequoia Wood**
Original application	Slats of a cooling tower
Application Category	Other structures
Original Location	Kansas City
Distance to building site	40 miles
New Application	Lattices
Application Category	Exterior / Façade / Cladding
Reuse or Recycle	Reuse
Type of material	

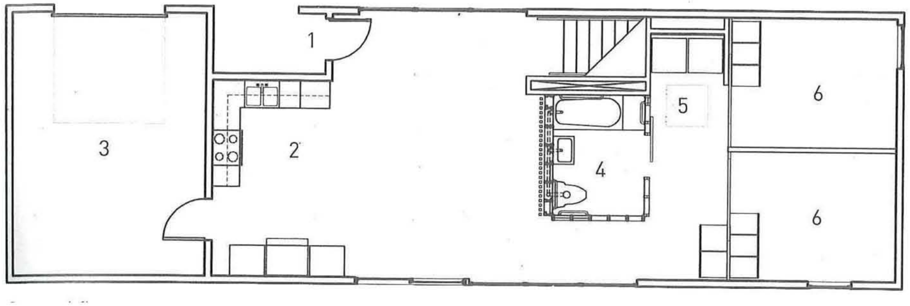
PROJECT DESCRIPTION

The fourth house in the city of Lawrence, and the second for Tenants to Homeowners, 1603 Random Road was designed and completed in the spring of 2001. The three bedroom, two bathroom house includes a fully accessible interior (support for a chair rail was provided), with second floor amenities designed to meet the needs of a residential care provider. The stacked bathrooms on each floor are clad in translucent polycarbonate, which adds a dynamic translucency to the interior volume. In addition, the interior is marked by the recycled gymnasium flooring salvaged from a demolition site in Kansas City. On the exterior, the entire house is skinned in maintenance free corten steel, while a former cooling tower is recycled to create the exterior screen element on the two long façades.

ReMaterial | From waste to Architecture
http://www.studio804.com/2001-random-road.



Location | 1603 Random Road, Lawrence



Random Road | Floorplan

Random Road | Exterior

Random Road | Lattices from sequoia wood

STUDIO 320

General Information	
Name of the project	Studio 320
Location	Enumclaw, WA, USA
Built	2005
Architect	Hybrid Architects
Program / function	Temporary Housing
New or renovated	New
Percentage or amount of reclaimed materials used.	

Reclaimed Materials	
Type of material	**Orange Container**
Original application	Cargo container
Years in use	12 years
Application Category	Other structures
Original Location	Europe
Distance to building site	5000 miles
New Application	Structure
Application Category	Structure / Columns / Beams / Core
Reuse or Recycle	Reuse
Type of material	**Yellow Container**
Original application	Cargo container
Years in use	17 years
Application Category	Other structures
Original Location	Asia
Distance to building site	5000 miles
New Application	Structure
Application Category	Structure / Columns / Beams / Core
Reuse or Recycle	Reuse
Type of material	**Plywood**
Original application	Bleachers
Years in use	50 years
Application Category	Other structures
Original Location	Enumclaw Highschool
Distance to building site	2 miles
New Application	Interior
Application Category	Interior / Cladding / Furniture
Reuse or Recycle	Reuse

PROJECT DESCRIPTION

At 320 square feet, the unit can house one person or a couple comfortably, with a great room that is three-quarters of its total space, plus a separate bathroom and sleeping area.

This particular project has been built for a rural client who has a large farm property with a pleasant retreat area that can now be enjoyed at night. This project is a fairly low-impact application on this riverside plot. The foundation is built of a few pre-cast concrete footings, and the roof will evolve into intensive green fern-based roof.

Interiors are designed to last; the plywood in this model is re-used, from the fifty year old bleachers of a local high school.

ReMaterial | From waste to Architecture cargocollective.com/hybridarchitecture/c320-Studio

Studio 320 | Exterior

Studio 320 | Interior

Studio 320 | Floorplan

RACINE ART MUSEUM

General Information	
Name of the project	Racine Art Museum
Location	Racine, WI, USA
Built	2003
Architect	Brininstool & Lynch
Program / function	Museum
New or renovated	Renovation
Percentage or amount of reclaimed materials used.	

Reclaimed Materials	
Type of material	**Steel & Concrete structure**
Original application	Structure
Application Category	Exisiting Building
Original Location	Racine
Distance to building site	0
New Application	Structure
Application Category	Structure / Columns / Beams / Core
Reuse or Recycle	Reuse
Type of material	**Limestone**
Original application	Façade Cladding
Application Category	Exisiting Building
Original Location	Racine
Distance to building site	0
New Application	Façade Cladding
Application Category	Exterior / Façade / Cladding
Reuse or Recycle	Reuse
Type of material	**Car Tires**
Original application	Tires of cars
Application Category	Left Overs / Surplus
Original Location	
Distance to building site	
New Application	Floor
Application Category	Floor / Wall / Ceiling
Reuse or Recycle	Recycle

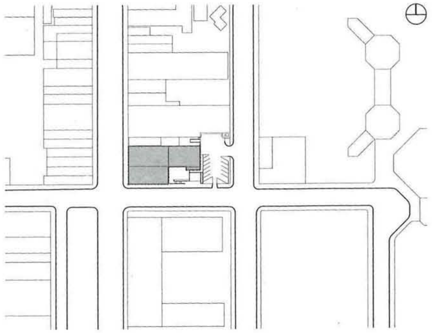
PROJECT DESCRIPTION

To create a new headquarters of the museum in Racine the architects used a group of buildings originally constructed in the mid-nineteenth century. Although the building had little architectural interest it was decided to keep the structure and outer volumes visually intact, while making major contributions to the finishings and facades.

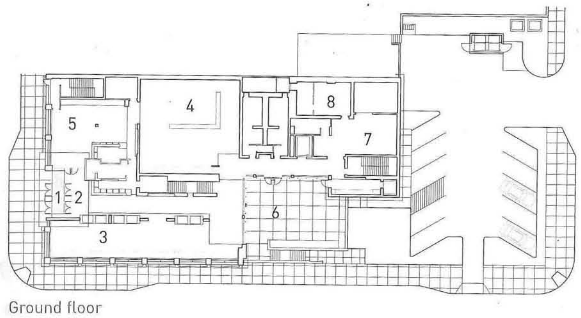
One of the most interesting aspects is the reuse of the old limestone cladding, which was dismounted, reconfigured and applied to the outer walls.

The interior floors are made with recycled tires and all the wood ir reconstituted or derived form sustainable woords. The other chosen materials - glass, steel, aluminum - are recyclable or reusable.

ReMaterial | From waste to Architecture



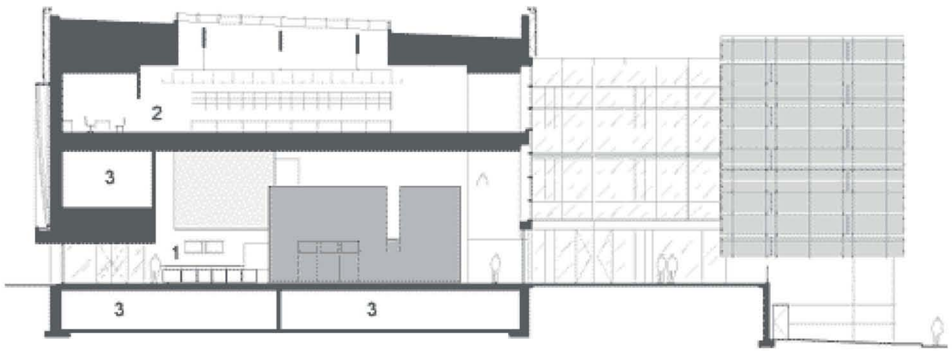
Location | 414 Main Street, Racine



Racine Art Museum | Floorplan

Racine Art Museum | Exterior at night

Racine Art Museum | Limestone cladding



Racine Art Museum | Section

D. Scenario 1 | Office Renovation

The second scenario focusses on using materials from office transformations. As mentioned in the introduction within the city of Amsterdam 17% of all offices are vacant; this makes Amsterdam the place with the highest office vacancy (Rijksoverheid, 2012). The city of Amsterdam has an interactive online map showing the office vacancy; with the help of this tool I've mapped all offices that are completely vacant (Gemeente Amsterdam, 2015). This can be seen in image X, where the offices have been categorized by building period. The size of the dots on the map matches the amount of vacant square meters.

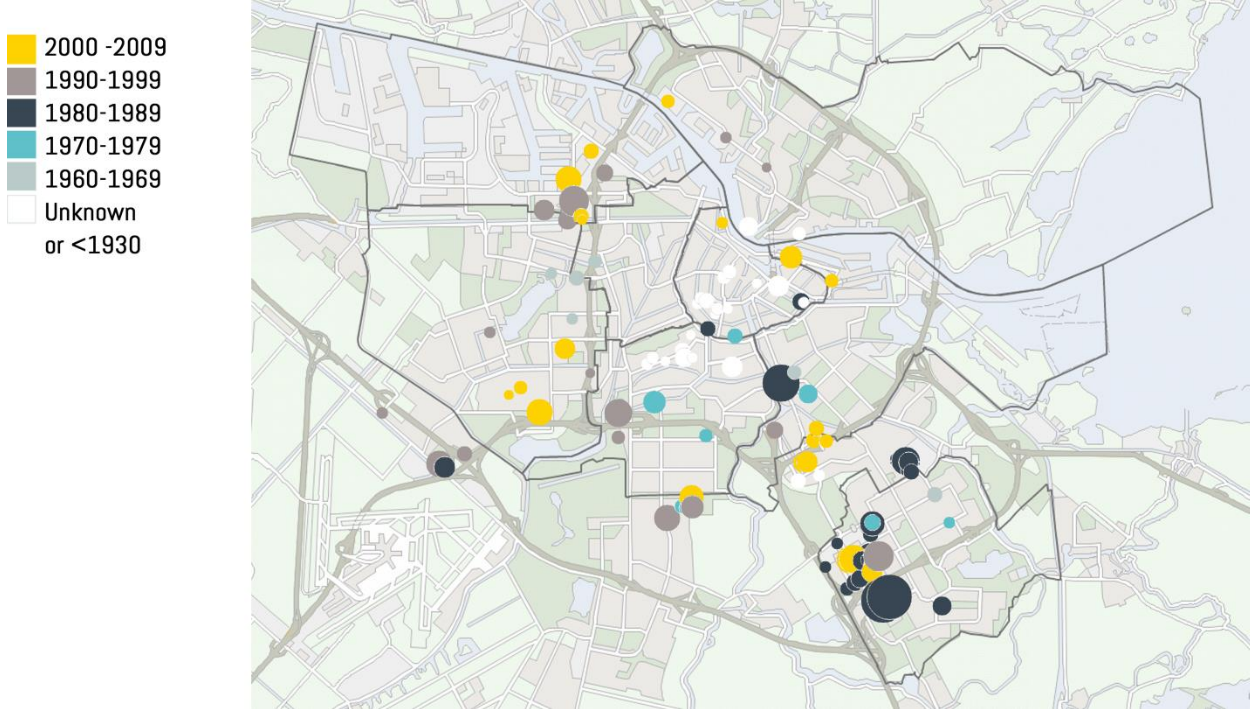
For each decade the total amount of m2, the amount of vacant buildings and the amount of vacant buildings over 10.000m2 have been put together in a graph. The graph clearly shows that most vacancy is present within buildings from the 1980s. On the next page an overview of these vacant buildings is given. A research by the Amsterdam municipality also mentions that the period between 1975 and 1995 contains the largest vacancy (Lagae., Veelen., & Turpijn., 2010). A report on different office types in the Netherlands also describes the typical type of offices when it comes to the façade and construction (Van Meijel, 2013):

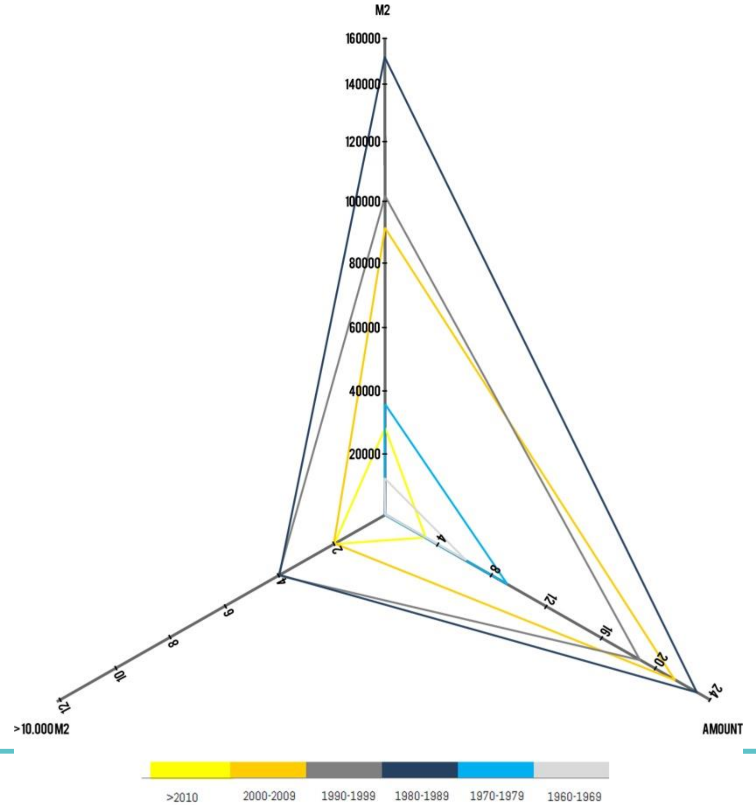
1960-1975

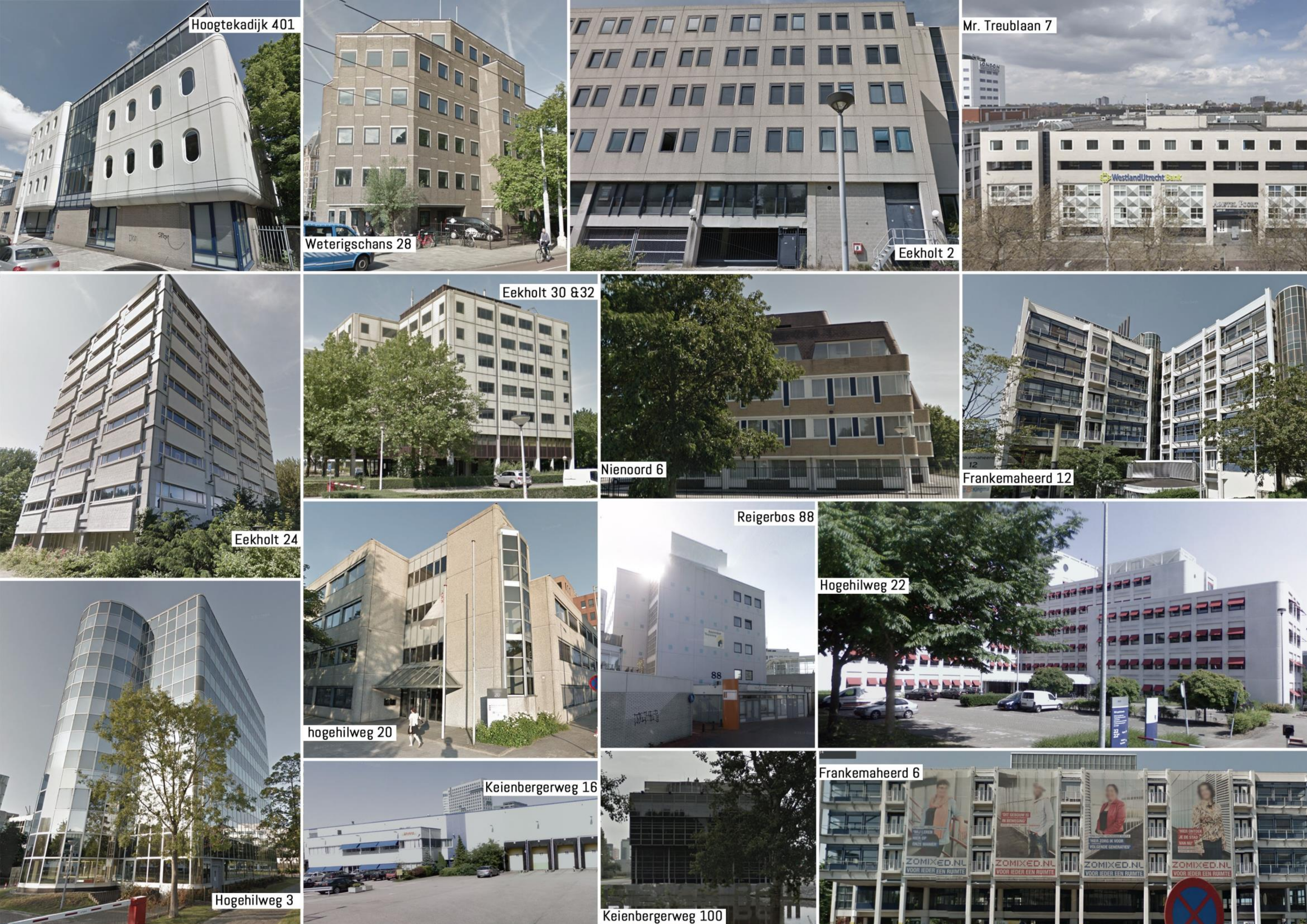
Façade: insulating the façade is uncommon. Windows are often single layer glass in steel frames; the windows can be opened. Floors & Construction: Square grid floors

1975-1990

Façade: more attention for climate and insulation. Often windows that cannot be opened (Sick Building Syndrome) Floors & Construction: Cassette floors






Hoogtekadijk 401
Weterigschans 28
Eekholt 2
Mr. Treublaan 7
WestlandUtrecht Bank
Eekholt 24
Eekholt 30 &32
Nienoord 6
Frankemaheerd 12
hogehilweg 20
Reigerbos 88
88
Hogehilweg 22
Hogehilweg 3
Keienbergerweg 16
Keienbergerweg 100
Frankemaheerd 6
ZOMIXED.NL
VOOR IEDER EEN RUIMTE

If we compare the facades of the vacant offices in Amsterdam; we can create three main categories: prefab concrete facades, brick facades and curtain wall facades. Although we can't know for sure, but it does look like most windows shown in the images cannot be opened.

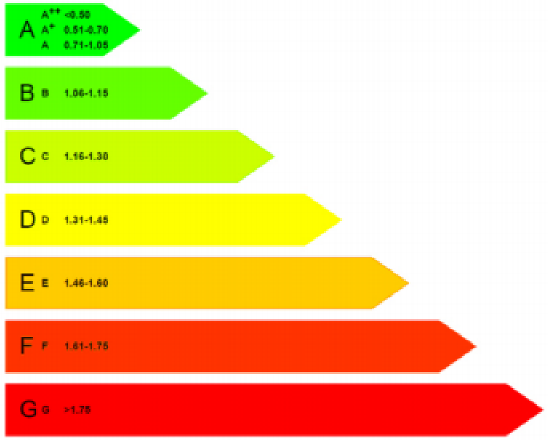
The report by Lagae (2010) mentions that vacant buildings from this period are considered to have no special character and are often in mono-functional areas; which makes the location a problem for redevelopment. The non-openable windows are the biggest problem which often requires an interference in the current façade; either replacing the windows, but an entire façade transformation is not excluded.

This report also includes a concept to transformations of office buildings from this period (in which they state that the windows are un openable); they describe two different type of transformation levels: the minimum and the maximum level. In the minimum case the only demolition work is on the façade and only around the windows; in the maximum case the installations, the entire façade and the interior is demolished (Lagae. et al., 2010).

The report also says that because of the problems with the façade and the locations there are very little to no good references for transformations of offices for the 80s. We can at least conclude that the windows of these buildings have to be replaced and that this is a possible reclaimable element.

Besides the fact that un openable windows lead to the sick building syndrome, the energy performance of these buildings is another reason for transformation. The first building regulations (Bouw Besluit) are from 1992 and this document does not contain any requirements towards energy performances for office buildings. In the Bouw Besluit of 1995 there are values mentioned; the EPC for offices was 1.9, the EPC is currently 0.8. The energy performance of 1,9 of 1995 already places a building in the lowest ranking (G). The buildings from before this period are likely to be worse (as it was uncommon to insulate the façade until the 70s).

All the vacant offices from this period in Amsterdam are most likely to all be different when it comes to the construction of the façade or the interior design. The research therefore focusses on the most commonly accepted values for office buildings from the 80's.



Figuur 1: Classificatie EPA-U Energielabel

A research by BBN shows the transformation needs for offices from the period 1980-1989 with a reasonable energy reduction of 60%. They set the following guidelines for their research (Lagae. et al., 2010):

- 18.000 m2 BVO
- 7.200 m2 BGO (façade)
- 35% openings
- 10 building layers
- RC-value façade 1,3 m2K/W
- Double glass, U-value 3,3 W/m2K
- Cavity brickwork façade accessible
- High degree of separation between construction and infill

W/E Advisers has also done a research towards zero energy offices and they take the following information as reference for a building from the 1980s (W/E Adviseurs., 2011):

- Floor: RC-value 0,25 m2K/W
- Facade: RC-value 1 m2K/W
- Roof: RC-value 1,3 m2K/W
- Glass: U-Value 4,4W/m2K (both single u=5,8 & double u=3 were used in the 1980s; 4,4 is the average)

For this research we'll assume that most facades are either made with prefab concrete, brick or contain a curtain wall system. The windows are considered to be un openable and have an average U-value of 4,4 W/m2K, and the windows take up to 35% of the façade.

The repurpose team (2014) focusses on the reuse of building materials. They currently work on two different office renovations; the Rabobank in Utrecht and the CBI office in The Hague. On their site they mention reclaiming the following materials:

Rabobank Office, Utrecht
Carpet tiles
Ceiling elements
System walls
Reflective façade elements

CBI Office, The Hague
Lighting from staircase
Granito window sills
Carpet
Doors

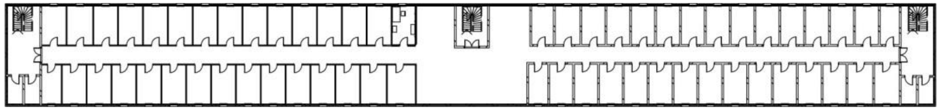
Combining the information from repurpose, BBN & W/E Advisers we can speculate what kind of materials will be available from renovations of 80s office buildings.

Façade renovation
Windows
Brickwork
(Prefab) Concrete elements
Curtain wall elements
Insulation ?
Doors

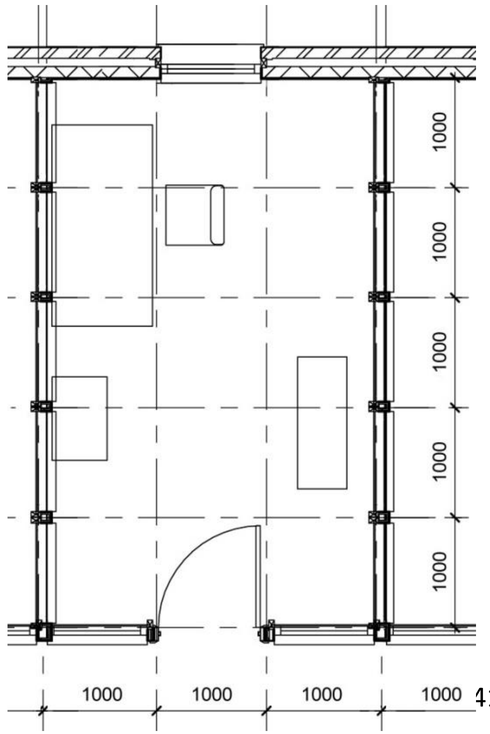
Interior renovation
Ceiling elements
System walls
Carpet tiles
Doors
Window sills
Lighting

In order to know how many meters of system walls and the amount of doors there could be available; the research focusses on the absolute maximum; offices containing only workspaces for one person. According to NEN 1824(Agterberg, De Heer, Verkerke, & Kete, 2008) the minimum workspace is 8m2. To determine how much of these materials could be available a hypothetical office design has been used, based on the study by Lagae. Van Meijel (2013) also describes the building trend in the 1980s, due to the economic recession the rental office was introduced. Renting an office wasn't that big of a risk for a company and the best structure for this principle was the shallow cellular office with centre aisle was the best option for this.

The average vacant office from the 80s in Amsterdam has 6700m2 BVO over an average of 5 building layers. This results in a building floor of 1340m2 ; which results in a longitudinal building of 12x112 meter. Very simplistically and extremely this could be translated to the following type of office.



A floor (1340m2) could then contain 60 offices of 15m2; which results in at least 60 doors, 120 glass system wall plates and 300 gypsum system wall boards. 3600 Carpet tiles, 60 radiators and 120 lights per floor.



Reclaimable materials derived from office renovations

These numbers could then be recalculated towards the amount of reclaimable materials per square meter; which could then be multiplied by the total amount of vacant square meters (155.100m2).

		Name	Parts	Sort	Former Application	Dimensions *	Amount per 15m2 Workroom		Amount per m2	Amount over 155.100 m2	
Interior	Element	Carpet Tile		Textile	Flooring	500 x 500 mm	*total tiles*	60	4	620400	carpet tiles
		Window Sill		Stone	Window Sill		*(one window per room)*	1	0.067	10340	window sils
		Radiator		Metal	Heating		*(one radiator per room)*	1	0.067	10340	radiators
	Component	Ceiling	Framework	Metal	Ceiling	24 x 3000 mm	*length mm*	65000	4333.333	*672100000*	mm framework
			Gypsum Plates			600 x 600 mm	*total gypsum plates*	42	2.800	434280	gypsum plates
			Lighting	Metal & Other		600 x 600 mm	*total lights*	2	0.133	20680	lights
		Walls	Framework	Metal	Walls	100 x 3000 mm	*length mm*	40000	2666.667	*413600000*	mm framework
			Glass	Glass		1000 x 3000 mm	*total glass plates*	2	0.133	20680	glass plates
			Gypsum Board			1000 x 3000 mm	*total gypsum plates*	5	0.333	51700	gypsum plates
		Doors		Wood	Doors	1000x2110	*total doors*	1	0.067	10340	doors

* dimensions of new products for reference

		Name	Parts	Sort	Former Application	Dimensions *	Amount		Amount per m2		
Exterior	Element	Brick		Stone	Façade	210 x 100 x 50 mm			75	5816250	bricks
		Prefab Concrete		Stone	Façade				0	0	
		Insulation sheet		Plastic	Insulation	1200 x 600 mm			1.4	108570	insulation sheets
	Component	Windows	Framework	Wood & Metal	Façade		*(one window per room)*	1	0.016666667	10340	window frames
			Glass	Glass				1	0.016666667	10340	glass
		Curtain Wall	Framework	Metal	Façade				0	0	
			Glass	Glass					0.5	38775	glass plates
			Plates	Wood & Metal					0.5	38775	closed plates

Matching the materials with the criteria

The possibly reclaimable materials as listed above have been scored on the criteria mentioned in the methodologies. For the scoring I have assumed that these buildings will need a total renovation; but since it is a onetime event per building and it's not sure if and when these buildings will be renovated, they have all scored a 0 (unknown) on the criteria of flow. Looking at the different sub scores it can be concluded that the materials derived from the interior are most likely to be highly available and ready to reuse. Due to the potential architectural implementation the scores shift a bit more towards the materials from exterior renovations.
The five materials with the highest score are:

- Carpet tiles (24)
- Doors (22)
- Windows in frames (18)
- System walls (17)
- Bricks (17)

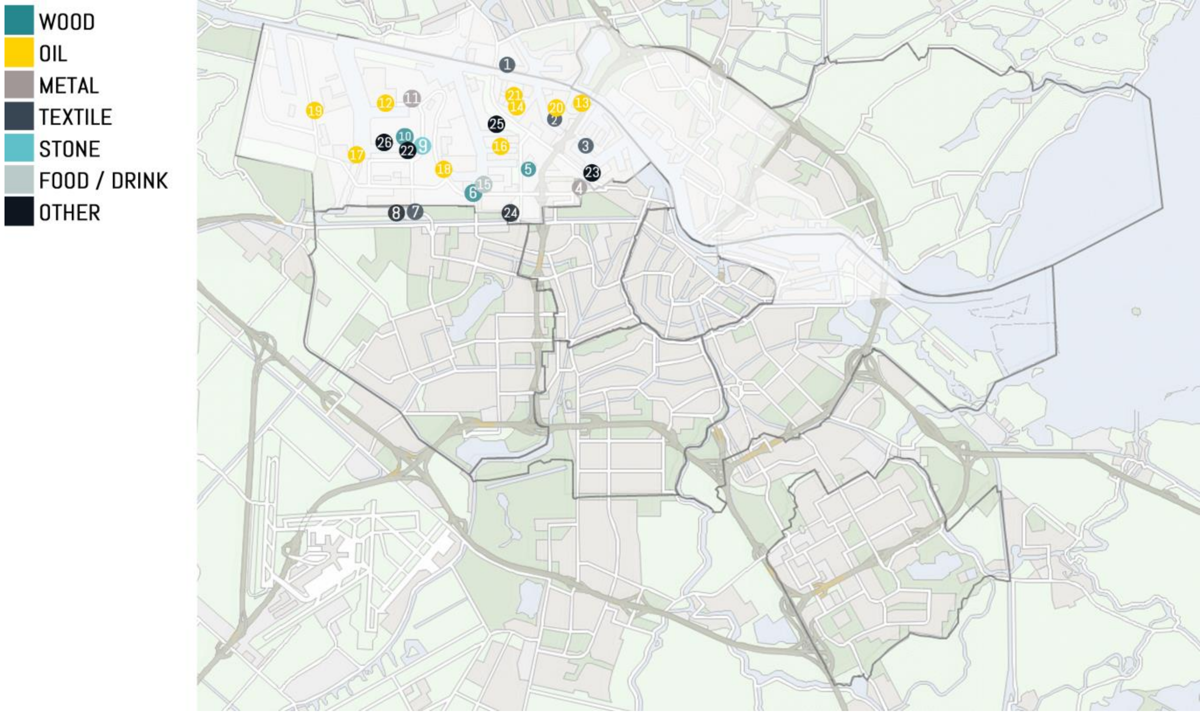
The only reason brick has received a high score is because of the architectural implementations. As mentioned in the chapter on the current practice; brick are only able to be reused if they can be easily separated from the mortar. This means a lime based mortar had to been used, but this isn't common practice after the early 1900s. Bricks are therefore excluded from this research.

SCORES OF THE MATERIALS

			General Criteria					Potential Architectural Implementation					
		Name	Large quantaties	Flow	Ready to reuse	Innovative	*Subscpore*	Construction	Façade	Interior	*Subscore*	Total Score	
Interior	Element	Carpet Tile	5	0	3	4	*12*	3	4	5	12	24	NR. 1
		Window Sill	3	0	3	3	*9*	0	3	2	5	14	
		Radiator	3	0	3	1	*7*	0	0	2	2	9	
	Component	Ceiling	5	0	3	1	*9*	1	2	2	5	14	
		Walls	5	0	3	1	*9*	2	3	3	8	17	NR. 4
		Doors	4	0	4	3	*11*	3	4	4	11	22	NR. 2
		Air Ducts	3	0	2	1	*6*	0	0	2	2	8	
Exterior	Element	Brick	5	0	1	1	*7*	4	4	2	10	17	NR.4
		Prefab Concrete	3	0	2	1	*6*	3	4	2	9	15	
		Insulation sheet	2	0	2	2	*6*	0	3	2	5	11	
	Component	Windows	3	0	4	1	*8*	2	4	4	10	18	NR. 3
		Curtain Wall	3	0	3	1	*7*	1	4	1	6	13	

Scoring
0 Unknown
1 Very Low
2 Low
3 Middle
4 High
5 Very High

Nr 1	Carpet Tiles	24
Nr 2	Doors	22
Nr 3	Window in frame	18
Nr 4	System Walls	17
Nr 4	Bricks	17

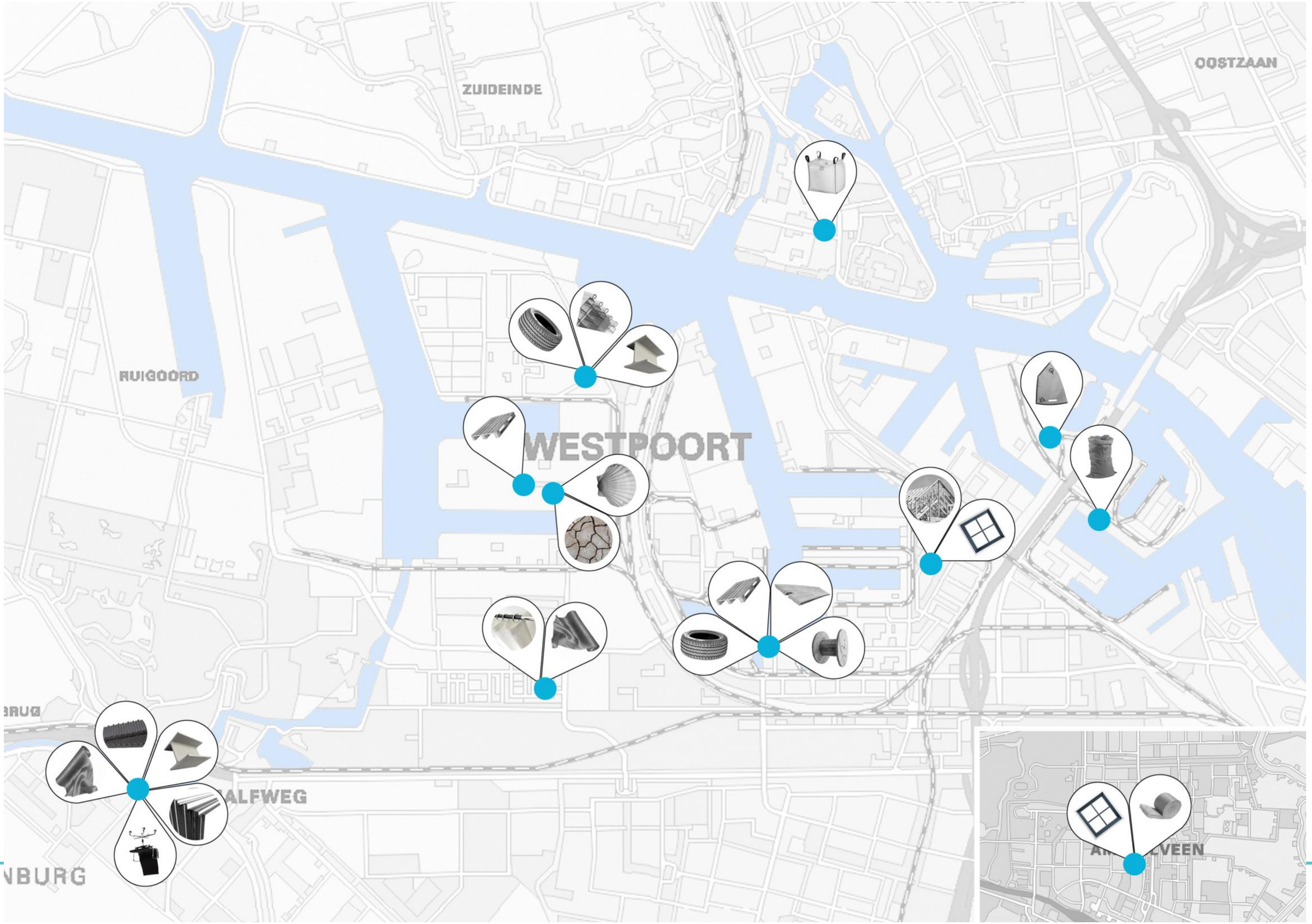


E. Scenario 2

The second scenario focusses on the harbour of Amsterdam as the design location used to be part of this area a long time ago. A second reason to focus on this scenario is the fact that the reclaimable materials could be transported to the location over the water, reducing CO2 by transport.

This scenario is based on the research paper by Laura Rosen Jacobson and a study to waste flows in Amsterdam west called ‘Superlokaal’ by Studio Elmo Vermijs. The research of Laura focussed on the reuse of waste products of the Merwe Vierhavens in Rotterdam; the research states that the method could be used on any other large harbour area. A result of her research is the use of oil drums as that one of the most commonly found waste products. Amsterdam is the largest gasoline harbour in the world; and takes care of 35% of the annual transhipment of oil (Port of Amsterdam, n.d.) we could therefore assume that the waste materials coming from the oil companies in the Merwe Vierhavens are likely to be found in the port of Amsterdam as well. Since there has already been a research towards the reuse of these type of waste materials, this scenarios focusses more on the study by Studio Elmo Vermijs. They mapped several companies in the Amsterdam area and looked the materials they discard. Their study combines these discarded materials with the knowledge available in the area (schools) and the people.

For this research paper the companies have been mapped and listed to determine the type and amount of waste each company produces.


ZUIDEINDE
OOSTZAAN
RUIGOORD
WESTPOORT

Materials derived from the harbour of Amsterdam

The waste flows derived from the harbour of Amsterdam based on the study by Studio Elmo Vermijs; which documented the waste from eleven different companies.

	Sort	Name	Origin	Former Application	Amount	Flow	Extra Information
Element	Glass	Glass Plates	Sargo, Amstelveen		Low	Non Consistant Flow	Reclaimed from demolition Amstelveen College
	Plastic	Sailcloth	HCSS	Cutting Leftovers	Middle	2x year	Large pieces
		Tires	Forkliftcenter				
		Shoveltires	Maja Stuwadoors	Protection Quay	Middle	2x year	
		Polycarbonate	Forkliftcenter				
		Foam	Ahrend	Leftover office furniture			Large consistant quantities
		Insulation	Sargo, Amstelveen	Insulation	Low	Non Consistant Flow	Reclaimed from demolition Amstelveen College
	Stone	Shells	Hanson		High	1x year	Not used in concrete mixture
	Earth	Clay	Hanson		High	1x year	Not used in concrete mixture
	Metal	Steel (?)	Forkliftcenter				
		Curtain Rails	Vision Arena	Cutting Leftovers	Middle	1x year	
		Steel (?)	Ahrend	Leftover			Large consistant quantities
	Textile	Big Bags	Norit, Zaandam	Transport Carbon Production	High		
		Jute Bags	Coterell	Cacao transport	1000	per day	Cut open
		Curtain	Vision Arena	Leftovers	Middle	1x year	Also complete rolls with outdated designs
		Fabric	Ahrend	Leftover office furniture			Large consistant quantities
	Wood	Dragline	Maja Stuwadoors	Protection Quay	High	2x year	Often damaged
		Trespa plates	Ahrend	Leftover office furniture			Large consistant quantities
Component	Glass	Window in frame	Sargo, Amstelveen	Window	Middle	Non Consistant Flow	Reclaimed from demolition Amstelveen College
	Wood	Trusses	Beelen	Construction	Middle	Non Consistant Flow	Farms along the A1 and A9
		Windowframes	Beelen	Façade	Middle	Non Consistant Flow	Farms along the A1 and A9
		Pallets	Maja Stuwadoors	Leftovers	High	2x year *	
		Cable reels	Maja Stuwadoors	Leftovers	High	2x year *	
		Pallets	Struykverwoo	Transport Paving Stone	350	month	
		Office Furniture	Ahrend	Leftovers			Large consistant quantities

* Minimum

Matching the materials with the criteria

The discarded materials from the harbour of Amsterdam, as listed above, have been scored on the criteria mentioned in the methodologies. Looking at the different sub scores it can be concluded that the ready to reuse criteria plays a big role in the selection.

The five highest scoring materials are:

- Pallets (24)
- Jute Bags (23)
- Dragline (23)
- Cable Reels (21)
- Window in frame (20)

SCORES OF THE MATERIALS

			General Criteria					Potential Architectural Implementation					
			Quantaties	**Flow**	**Ready to reuse**	**Innovative**	*Subscore*	**Construction**	**Façade**	**Interior**	*Subscore*	Total Score	
Scenario 2	Element	Glass Plates	2	0	3	2	*7*	1	3	3	*7*	14	
		Sailcloth	3	2	4	3	*12*	0	4	3	*7*	19	
		Tires	0	0	3	2	*5*	1	4	3	*8*	13	
		Shoveltires	3	2	2	2	*9*	1	3	3	*7*	16	
		Polycarbonate	0	0	4	2	*6*	2	4	4	*10*	16	
		Foam	0	0	3	3	*6*	0	1	4	*5*	11	
		Insulation	2	0	4	1	*7*	2	4	4	*10*	17	
		Shells	4	1	1	3	*9*	0	0	1	*1*	10	
		Clay	4	1	1	3	*9*	0	3	0	*3*	12	
		Curtain Rails	3	1	3	3	*10*	1	1	3	*5*	15	
		Steel	0	0	4	1	*5*	5	1	1	*7*	12	
		Big Bags	4	0	3	3	*10*	0	3	4	*7*	17	
		Jute Bags	5	5	3	3	*16*	0	3	4	*7*	23	NR. 2
		Curtain	3	1	4	2	*10*	0	3	4	*7*	17	
		Fabric	0	0	3	2	*5*	0	3	4	*7*	12	
		Dragline	4	2	3	2	*11*	4	4	4	*12*	23	NR. 2
		Trespa Plates	0	0	3	2	*5*	2	4	4	*10*	15	
	Component	Window in frame	3	0	5	1	*9*	2	5	4	*11*	20	NR. 4
		Trusses	3	0	5	1	*9*	4	2	1	*7*	16	
		Windowframes	3	0	4	1	*8*	2	4	4	*10*	18	
		Cable Reel	4	2	4	2	*12*	3	3	3	*9*	21	NR. 3
		Pallets	5	4	4	2	*15*	3	3	3	*9*	24	NR. 1
		Office Furniture	0	0	3	1	*4*	0	0	4	*4*	8	

Scoring

0	Unknown
1	Very Low
2	Low
3	Middle
4	High
5	Very High

Nr 1	Pallets	24
Nr 2	Jute Bags	23
Nr 2	Dragline	23
Nr 3	Cable Reel	21
Nr 4	Window in frame	20

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