UP CYCLE AMSTEL

THIS BOOK CONTAINS CONTEXT FOR A CIRCULAR AMSTEL-STAD

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Gemeente Amsterdam

3XN GXN

TU Delft

Colophon

In 2015, the City of Amsterdam prepared a Vison and Action Agenda for the circular economy. Today, the City is finding new ways of integrating circular economy into urban planning as the Netherlands aim to become fully circular by 2050.

These two books are recommendations based on tools and context analysis.

The TOOL book is prepared by GXN to outline political frameworks and describe concrete goals, methods and tools for working with circular economy in urban planning and design in Amstel.

The CONTEXT book is prepared by students at the GXN visiting professorship at TU Delft Faculty of Architecture and the Built Environment, 2018/19 to outline a case study for upcycling in Amstel.

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METHODS

Methods

Construction chain, Upcycling methods, Upcycling framework

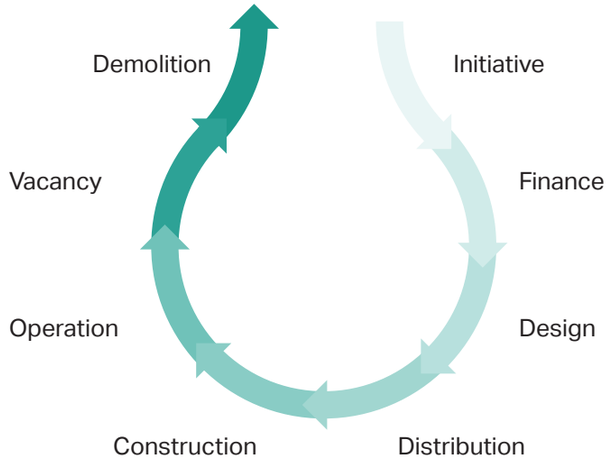


Image The diagram shows how the different phases follow each other, untill the final phase has been reached: demolition.

The Construction Chain

Chaging the value chain to create structural change

The construction chain as we know it now is a finite process. Usually this process ends when the building is not meeting its requirements anymore and is demolished. This section explains how the chain works and how to extend it.

Every construction process starts with an initiative. In many cases an initiative arises from the need of a (new) building or function, simply because that specific building or function is lacking, or because the existing building does not meet its requirements any longer.

When the initiative has been defined, a financial plan is needed to fund the project. In some cases the initiating party takes the responsibility for funding the initiative. In other cases external financers are also involved. If there are enough parties to support the initiative financially, the design process can be started. Together with engineers and advisors, architects create a design.

When the design is approved by the client and the municipality, a contractor can take on the job and start bringing all needed materials to the site. This process is called distribution. In the meantime, construction can start. All materials and elements are brought together on site and assembled.

When construction is finished, the building is ready for operation and maintenance until it no longer serves its purpose.

By then, it will inevitably sit empty. In many cases, this will result in demolition of the building. When it has been demolished, the plot is freed up for a new initiative and the construction process can start over again. For many years, this linear process has repeated itself over and over and in most cases continue to do so today.

Image The total demolition entailed a 50.000 m² buildling that released roughly 45.000 tons of ruble. About 25% of this ruble is reused on site for construction means. The total process takes 9 months and will be finished at the end of 2018.

Demolition

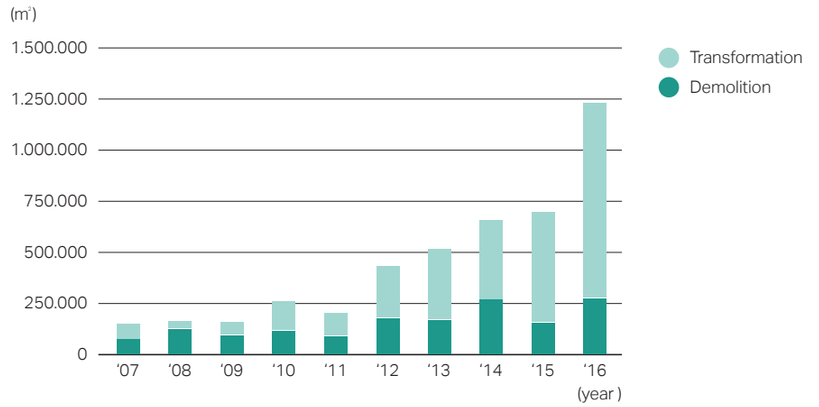
An insight into the vacant office market

When we look at the office market, we actually see a gradual increase in demolition projects over the course of the last decade. This decrease is caused by the increasing demolition and transformation of office buildings.

In 2016 more than 250.000 m² of office space was demolished. The result of a demolition job is lots of rubble. In some cases part of the rubble is reused on site for new building purposes, but in many cases the rubble is downcycled and used as filler for roads.[1]

One of the largest demolition companies in the Netherlands is currently demolishing a former office building of the ABN-AMRO bank after it had been vacant for 12 years.

The total demolition entailed a 50.000 m² building that released roughly 45.000 tons of rubble. About 25% of this rubble is reused on site for construction means. The total process takes 9 months and will be finished at the end of 2018.



Definitions

Upcycling, Re-use, Downcycling, Contaminating, Wasting

Process	Quality	Definition
Increasing the quality and/or value through the use of the material. E.g. by growing algae out of CO_2 and using it to produce new materials or making a computer chip out of old copper cladding.		UPCYCLING
Reusing materials at similar value. E.g. taking a facade panel from a facade and mounting it onto another facade without modification.		RE-USE
Reusing materials at lower value. E.g. taking a structural concrete floor and using it as a wall in a new building or shredding jeans to use as insulation for a new house.		DOWNCYCLING (cascading)
Contaminating one element by irreversible contact with other. E.g. by glueing old bricks permanently together with cement (instead of chalk). Using composite materials that can never be taken apart again.		CONTAMINATING
Using crushed concrete rubble as foundation for new roads. Burning end-of-life products for energy production. Or as a last resort, putting waste in landfil.		WASTING (landfill / incineration)

Definitions

Circular cheat sheet

Understanding the definitions and impacts of materials, energy and the environment is key to enabling urban upcycling at scale.

Embodied energy
The energy that is needed to produce products or buildings we call embodied energy. We use it to determine the effectiveness of recycling. Different materials need different amounts of energy to produce, so have different amounts of embodied energy.

Environmental stress
Problems with waste lead to problems with our climate. Man-made climate change is amongst the largest challenges today, and environmental stresses become an important metric for evaluating problems with waste, re-use, and up-cycling.

Incineration
Incineration is the combustion of waste materials. It is often promoted as recycling process, because it produces some energy, but is in fact one of the best examples of failing circularity. It is the least prefered end-of-life process in the material cycle.

Greenwashing
Sometimes the promotion of something environmentally friendly overshadows the real environmental profit. Pretending to do something sustainable, but in reality do much more harm than good. A green vertical garden on very unsustainable buildings is the most obvious example.

Landfill
Today most construction waste ends up in landfills or as crushed road fill. In the perspective of circular economy this needs to change. We need new strategies for re-using and upcycling materials and better ways of managing our waste. In the case of landfil we strongly advise keeping materials separated to enable future upcycling and re-use.

1. Negotiating

2. Inventory

3. Harvesting

4. Distribution

5. Documenting

Upcycling Methods

From negotiation tools to material passports

There are many methods to consider to advance upcycling. These methods vary from negotiating to documenting materials by means of material passports. They are used before, during or after construction projects.

This section will highlight some methods that one should be aware of when thinking about upcycling. In particular, five methods will be discussed:

1. negotiating
2. inventory
3. harvesting
4. distribution
5. documenting

There might be more methods that engage with upcycling, but in our opinion these five are unmissable. Each description will be accompanied by an explanatory scheme and an interview with a stakeholder that is actively engaging in that specific method.

Interview with Owen Zachariasse

Delta Development Group

"The best scenario is when stakeholders are on one side of the table and the problem is on the other side."

Owen Zachariasse works as consultant at Delta Development. As a developer Delta Development has grown from project pioneers in sustainable development to specialists in Cradle to Cradle optimized real estate.

"However, Cradle to Cradle is not our main driver", Owen explains. "Our desired outcome is broad based value creation. For us it is also important to maximize value creation in the local community. Secondly, we look at what's valuable for the ecosystem. Incorporating public space in their developments as much as possible is also important. The tenants of a building should be in charge of what happens to the public surroundings. They will notice a decrease in quality, not the people at the municipality looking at the numbers."

Upon being asked what distinguishes Delta Development from other real estate developers, Owen replies: "Bizarrely, not much. We add a new element to real estate development which enables us to approach the building from a unique perspective. We use a lot of the same tools and tactics. I believe firmly that if you want to get to a place where you have an accepted agreement between two people, you have the fundamentals correct. That is real estate development. People understanding the outlines of the deal."

So what is important when entering a negotiation? "Meet the client on their home turf and make your plans as understanding as possible. Then, when you reach an understanding, you can present the designs. After the "fantastic, I love that" moment, which is the critical part of the process, then you start discussing the costs. All of this is important for succesfull negotiation."

Owen firmly believes in negotiating from a principle standpoint, instead of from a position standpoint. When stakeholders try to align their principles, they have a better chance of getting to an understanding. He continues: "The underlying principles are not being discussed many times and that is leading to everyone hitting a wall. The best scenario is when stakeholders are on one side of the table and the problem is on the other side. And a common source of information is a good way to look at these principles."

Negotiating

Methods

Before, during and sometimes after a construction process, negotiations take place that can allow for the introduction and clarification of circular commitments.

Negotiating parties, such as municipalities, developers, architects and builders, might well have their own goals they want to see achieved in the project and certain compromises often need to be made to reach an understanding.

In a situation where an architect wants to design a building, consisting of upcycled materials, he will need to convince his client that this is a good idea. Measures such as costs, total value, environmental impact, and increased flexibility of the resulting building are all elements that can play their part in these negotiations. In such cases, it can be very helpful to know how upcycling can be translated into realistic measures for creating short, medium, and long term value.

In cases where developers seek to develop a plot in an urban area, they will likely need to negotiate with the municipality on many matters. The municipality sets rules for building height and density, for example, and energy efficiency requirements, but might be able to relax some of these rules, if the developer is willing to make other concessions.
In a scenario where the municipality already has an idea for that specific area and wants to create a circular example out of that area, it is likely that the municipality will make a deal with the developer: the developer can build higher and denser, but needs to invest in circular measures. For example: the building needs to contain a certain percentage of upcycled materials or the public space around the plot needs to be upgraded with circular measures.

These examples show that each stakeholder has their own set of measures to use during a negotiation. It can therefore be very useful to know what these measures are in advance and how they can be leveraged to advance circular design and construction.

Interview with Merlijn Blok

Metabolic

"There might be a lot of value inside buildings. Having an indication of this value, the material types and logistics helps in opening up the conversation around future reuse."

Metabolic is a consulting and venture building company that uses systems thinking to tackle global sustainability challenges. Their work is strongly guided by the principles of system thinking, collaborating, practicality and empowering others.

With regards to a circular built environment, Metabolic is engaging in making material inventories. Merlijn explains: "By providing insights into the amount of materials inside buildings that are up for demolition or transformation, we want to try and predict the built environment better. We want to measure the circular built environment in an integral manner and visualize the impact. In addition, we want to start and engage in a conversation. There might be a lot of value inside buildings that are up for demolition, so let's see if we can do something with it." He continues: "Per region we try to create an overview of what projects will take place during a certain period. The timelines of construction projects, transformation projects and demolition projects are then all 'connected' to see if matches in supply and demand can be made."

So how do you come up with these insights? "In collaboration with SGS Search we use building specifications, cost estimates and other bottom-up studies as a reference to roughly calculate what the amount of building materials in a certain building type is. This comprises information on roughly 500 building elements and 50 materials, which allow us to give indications on how much square meters or kilograms of a component or material is inside a building." He emphasizes: "It is important to note, that we do not claim to portray the real numbers. We haven't actually been inside the building. We create a model of what it could potentially be to start the conversation about the actual opportunities for urban mining.

Metabolic is all about collaborating and working together with government institutions for example. "We are also trying to find out what the annual material streams are for entire regions. What is the impact and value of these streams? Knowing this gives us the possibility to create a better match between supply and demand, so that we can reduce the impact of the built environment in general."

Inventory

Methods

For designers and builders wishing to work with reused and upcycled materials, it is necessary to know what materials or components are available. This is why inventories are made.

Making in an inventory means getting an overview of the amount of materials and components that can be harvested from a certain building on or near a site. The quality and value of these items are also evaluated. Two known methods for making an inventory will be described here.

The first method is based on the use of key figures and formulas. Depending on the parameters, the quantities of the different types of materials can be determined. This method can be applied fairly easily, if the right information (such as?) is available.

The second method is more precise and hands-on. It requires a person going on site and into buildings to measure and/or count components that might prove interesting. It will inevitably be quite labour-intensive and time consuming.

There isn't necessarily a best method, since the desired outcome can vary. If the goal is to acquire a rough number of the amount of concrete within an office area, the first method would be preferable. However, if the goal is to find out the exact amount of windows in a certain building in that area, rough numbers are not enough. In that case, an on-site inventory needs to be made in order to get exact numbers.

For architects and builders who want to engage in upcycled materials, it is important to know the measurements and quality of the materials that are to be reused. It is therefore important to also take pictures of the harvestable materials and items and determine the assembly of these components.

Interview with Sanne Verhoeve

Superuse Studios

"In 10 to 20 years we expect reause to be part of every tender, of every building design."

The founders of Superuse Studios were one of the first to create an online marketplace for redundant and second hand materials. They called it Harvestmap. All materials, ranging from small quantities to continuous flows of (industrial) leftovers are represented. The goal of the marketplace is to bring supply and demand together and increase the reuse of redundant materials.

Sanne explains: "We prefer to harvest materials when we already know how the material will be reused. The reason we do this, is because there is a large volume of supply of rest materials available, that is constantly changing. Thanks to our network, we are up to date on the ongoing demolition projects and other sources for reused materials."

So what is important when harvesting materials? "There are quite a few things you should take into account, but it is not always possible (and necessary) to apply them all. Focus on large amounts, to make it logistically more feasible; focus on financially valuable materials. This is necessary to still make a revenue after all the consulting, disassembling and transportation has been done; try to use materials that can be customized, to make reusing them easy; if possible, try to reuse materials within the same organization. Many times there are possibilities for internal storage and reuse."

There is one precondition: "With regard to limiting the CO_2-emission, we take into account the fact that the ecological gain of reusing can be greater for materials where the production process has a large CO_2-emission (such as for steel) than for materials based on renewable raw materials (such as sustainable wood for example). For this reason, for example, it can be ecologically justified to transport steel from a greater distance than wood."

So what's up next? "In 10 to 20 years we expect reuse to be part of every tender, of every building design, and that dismantling and pre-demolition take place prior to any demolition project. We also believe that material passports will support and enable the reuse of materials. Lastly, we think that suppliers of building materials will rent out building parts instead of selling them, keeping manufacturers responsible for their own products during the waste phase. This way the (raw) materials will return to the manufacturer."

Harvesting

Methods

Harvesting describes the process of salvaging components and materials from buildings. Instead of demolishing a building entirely, the reusable materials are carefully removed and separated.

To do this in an effective way, material knowledge and knowledge on the assembly of these materials is necessary. How are they connected to other building parts? Will they break if taken apart? This information help determine the potential reusability and therefore also the value of harvestable materials.

Harvesting the materials can be done in different ways. Some harvesting projects require machinery, but others can be done by hand with simple tools. The choice of tool depends on the building and materials. Interior parts of a building, such as windows and doors, cabinets, installations and ducts, furniture, cables and lighting etc. can be harvested by people without the need for heavy machinery. However, if heavy structural elements need to be extracted, machines are necessary for lifting, turning and placing. In this case, professional companies such as demolition companies can be hired to do the job.

Instead of only taking on traditional demolition jobs, we see that some demolition companies are starting to get involved in harvesting jobs. Demolition is not always what the client wants and some cases have shown that harvesting a building instead of demolishing it is financially more interesting because of the re-sell value of harvested materials.

Interview with Michel Baars

New Horizon

"We are not a demolition company that needs to get rid of their waste, we are a supplier that supplies products."

They harvest reusable materials from buildings at the right moments: during renovation, transformation or demolition processes. The circular economy is no hype for them, they truly believe it is the new economic model.

What distinguishes New Horizon from other demolition (or harvest) companies, is their market approach and distribution method. "There is a market where there is a demand for products. We deliver our harvested materials to distributors and manufacturers and approach the distribution process from their perspective. That's why we incorporate out distribution system within their existing systems. We are not a demolition company that needs to get rid of their waste, we are a supplier that supplies products."

If the harvested materials are reused for construction purposes anyway, why not storing them temporarily? Michel replies: "There are a few reasons why not to do this. If I want to store my product, that means my product has to be picked up from the harvest site and brought to the storage site. But then, it also has to be picked up again from the storage site and be brought to its final destination. In the meantime I have to pay for transport, a storage place, insurance etc.. I don't want that." He continues: "Also, in many cases, too many actions are required to make the material suitable for immediate reuse. A window frame has to undergo 6 steps before it can be reused properly. That's too labour intensive."

So what happens to these materials after they have been distributed? "Our partners from the Urban Mining Collective create new products out of our materials. We set a standard based on the best practices of that moment. We trust each other on that we all have the same goal. We want to be innovative." The Urban Mining Collective is already quite a large group of companies. "Yes, and we are still growing. We want to add designers and builders to the group and discuss circular design processes."

I also heard that you want to bring a new circulair product on to the market every month, is that right? "Yes, so I guess we have to hurry!"

Distribution

Methods

Bringing the materials that come from a harvest location to the construction site requires a logistical plan.

In some cases, materials or items might be needed on short notice. In other cases, they might not have a place to go yet, in these cases, if the materials come in great numbers, a lot of storage area is needed. If the materials are large and heavy, the necessary machines to handle them must also be available. All these factors need to be considered when deciding what to do following a material harvest.

There are three ways to handle these harvests:

1. The harvested materials are brought to a (temporary) storage place. This can be a location nearby the harvest location, or nearby the location where they are to be reused. the last option is usually preferable to save on extra transport cost (and time).

2. The harvest is distributed to a manufacturer who will re-sell the materials. For example, a manufacturer of wooden window frames buys the harvested window frames and repairs and refurbishes them. In some cases, this can be done easily, resulting in a product ready to be sold again.

3. If the harvested materials do not have a destination yet, they can also be sent off to an (online) marketplace. Here they can be sold when someone is interested. Marketplaces for building materials buy the materials and re-sell them to any interested buyer either online or in a store.

Interview with Pablo van den Bosch

Madaster

"There is a physical reality and a digital reality. The physical reality is always too late."

It is Madaster's mission to eliminate waste by providing materials with an identity. The Madaster Platform is designed as a public, online library of materials in the built environment and facilitates registration, organisation, storage and exchange of data.

Building owners, contractors, developers or architects. Anyone can use the platform and store the information online. Madaster analyzes the information and connects extra information from other databases to that building file, such as material certificates, quality and material price: "We have information on hundreds of thousands of materials."

Why do this? "The supply chain in the building sector is long and traditional. Products usually last a long time, so the need for renewing is little." Therefore it is important to document what materials there are now and in what state: "Documenting is cheap, because it's so easy. All the big contractors use our platform."

"We also want to prevent information on materials falls in the hands of commercial enterprises. Therefore, we carefully focus on privacy, security and continuity." "As owner, you have to allow other people to look into your own information. You decide what information you want to make visible." Pablo believes that digitalizing is necessary to make a large transition possible and, on long term, to prevent the raw materials from depleting: "There is a physical reality and a digital reality. The physical reality is always too late." During demolition jobs, most of the times it is not clear what the material quality or value is. It is therefore harder to decide what to do with the material, than when this information is available.

Madaster believes in cooperating with other stakeholders: "We want to cooperate with everyone and go global to realize the transformation of the economy. We are vision driven, not business driven. We are transparent."

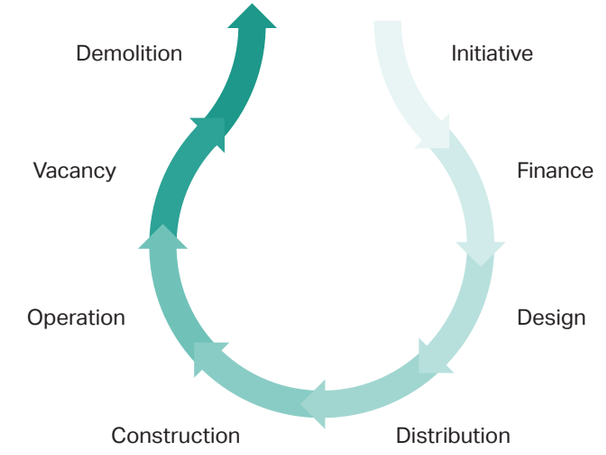
Documenting

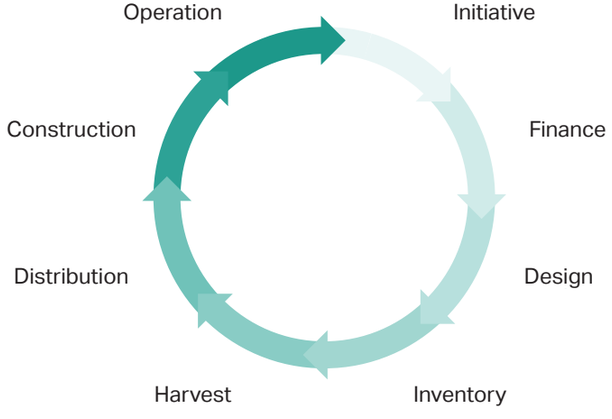
Methods

In order to make sure that important information about materials is not lost, resulting in loss of material value, buildings and components can be given a passport.

This material passport contains information on the material such as its type, age, how it's assembled etc. All the information combined can give the material an estimated value,
The reason for creating these passports is reducing the overall loss of materials. During demolition jobs the materials are usually demolished and thrown on piles, after which the materials are called 'waste.' Within the circular economy, one of the main goals is to create less waste. It is therefore important that these materials do not end up in some kind of waste pile. If they have an identity, a passport, they can be tracked.

The information stored in this material passport can help building owners, architects, builders, developers and other stakeholders decide what to do with the materials that are stored in a building, once the building is up for demolition or transformation.





A new construction chain

From linear to circular

Knowing more about the construction value chain and the methods for working with circularity and upcycling allows us to rethink the building cycle. How can the linear process be turned into a circular one?

If we wish to efficiently use the methods explained above, we need to rethink the construction chain. Some of these methods need to be added in the existing chain in the form of a phase. Some existing phases need to be replaced or removed.

Starting with the inventory phase, this phase should be inserted after the design phase. During the design, the architect decides the concept and outlines of the design. However, if he wants to know what materials he can use, he needs to know what is available. Therefore, the method of inventory is used. In reality, this phase will probably run parallel to the design phase.

Next is the harvesting phase. When it has been decided which materials and components will be reused for the design, they need to be harvested. In some cases, the materials might already be harvested from a building and stored in a warehouse or demolition site. In other cases, the material still needs to be harvested from the donor building. Lastly, the phases of vacancy and demolition need to be removed from the existing chain, since demolition has actually been replaced by harvesting. These changes allow for a circular building process, where waste is eliminated from the chain and buildings parts are given a longer lease on life.

Image The conventional, linear building process can be made circular by adding in the phases of inventory and harvesting.

STAKE HOLD

Stakeholders

Stakeholder analysis

	initiative	finance	design	inventory	harvest	distribution	construction	operation
municipalities	●	●	●					
owners	●							●
developpers	●	●						
investors	●	●						
owner-users	●	●						
banks		●						
architects			●	●				
designers			●	●				
engineers			●				●	
climate advisors			●				●	
material scouts			●	●				
material experts			●	●	●			
harvest experts					●			
demolition companies				●	●	●	●	
distribution companies						●		
transportation companies						●		
suppliers						●		
managers			●	●	●	●	●	
contractors							●	
subcontractors							●	
tenants								●
end-users								●

Image This table outlines in which phase the different stakeholders are active. Some stakeholders can appear in multiple phases, some in only one.

Stakeholder analysis

From developers to architects

Now that we know the chain, we need to know the players. This section aims to explain what stakeholders are around and in which phase of the building cycle they are active.

Many stakeholders can take the initiative to start a building process: municipalities, developers and investors, but also private clients such as so-called owner-users. Municipalities can initiate an urban planning project, wherein developers are asked to develop specific plots or redevelop buildings.

The financing is usually done by different kinds of investors. However, the municipality and banks can also take on the role of additional financer. In large projects, there usually is more than one financer.

After financing has been settled, the design can take off. In most cases, architects take on this job, but they get help from additional designers and engineers, as well as experts on climate installations and materials. During this phase, designers can also start 'scouting' for harvestable materials. Scouting for materials is already part of the inventory phase. Experts such as demolition companies can be involved to decide on what materials are suitable for upcycling.

Materials are harvested by experts, such as demolition companies. Increasingly some demolition companies have started to take this role of disassembling instead of demolition more seriously.

During distribution, demolition companies, transportation companies and suppliers work together on bringing the harvested materials to the material bank or construction site. In some cases, this process can be managed by a specific stakeholder.

When the material arrives at the construction site, contractors and subcontractors can do their job. Demolition companies can still be involved as an advisor, because of their knowledge of (dis)assembly.

When construction is finished, the end-users, such as tenants can start using the building. The building owner usually is responsible for maintaining the building.

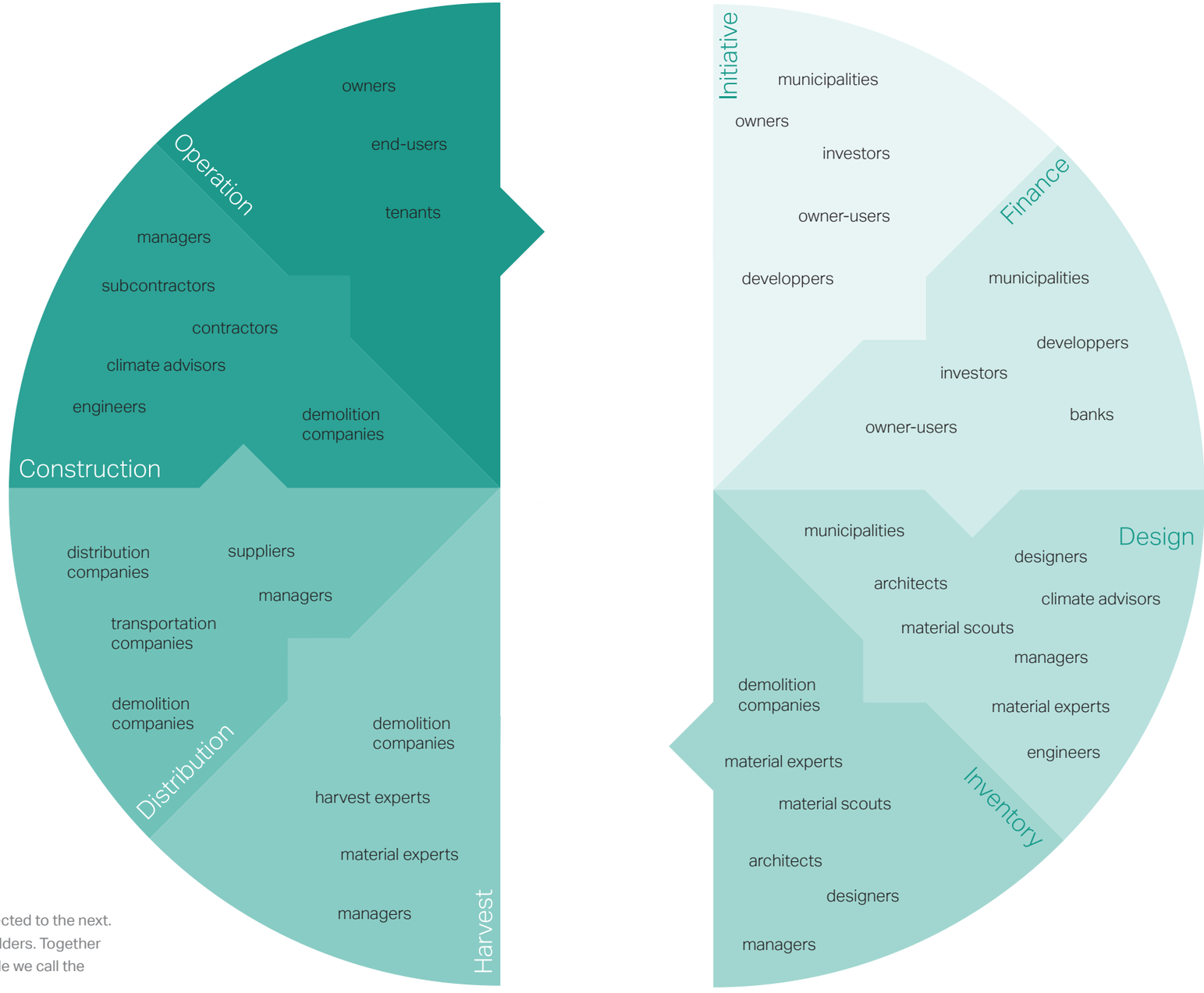


Image Each phase is connected to the next. The same goes for stakeholders. Together they form a continuous cycle we call the building chain.

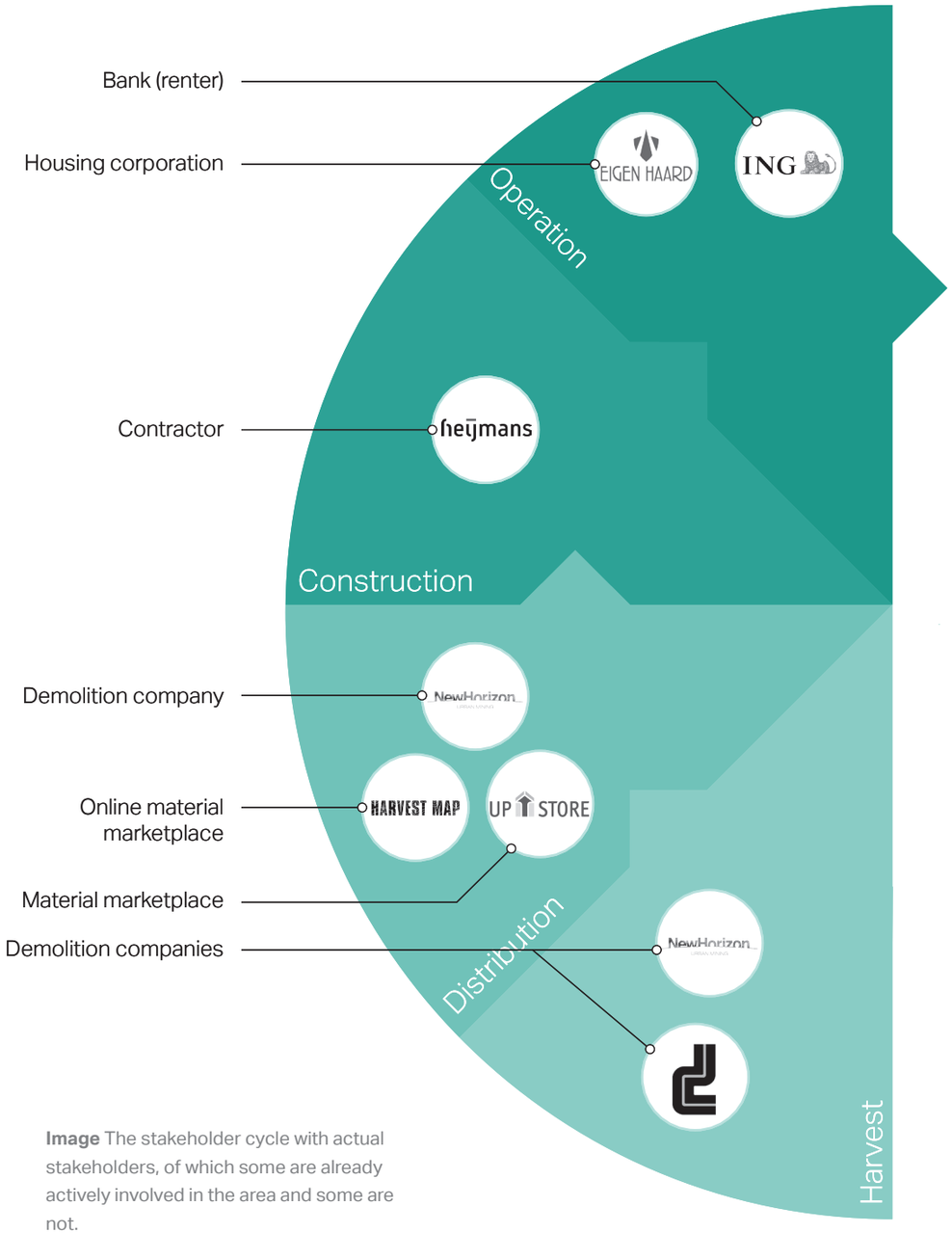
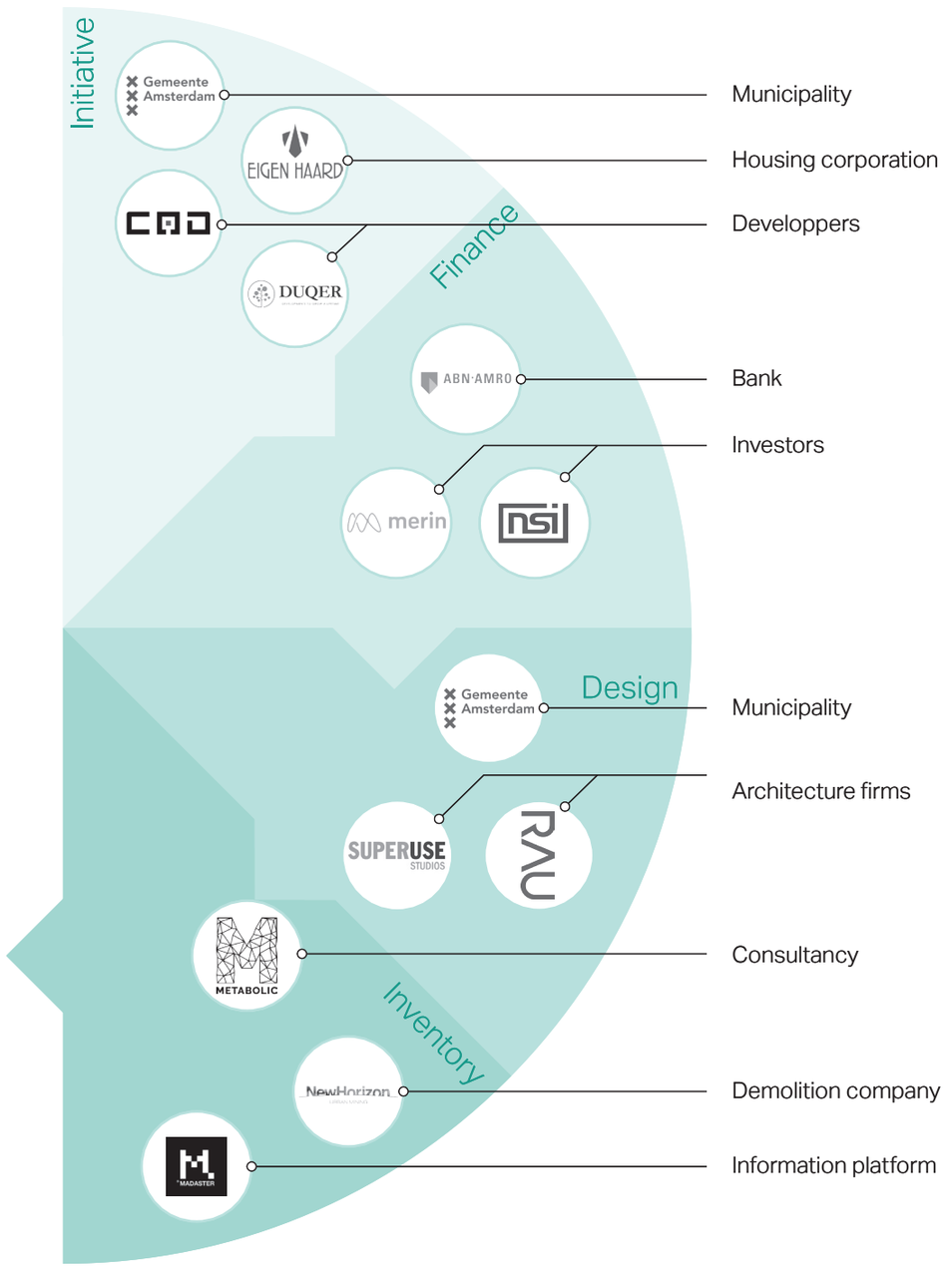
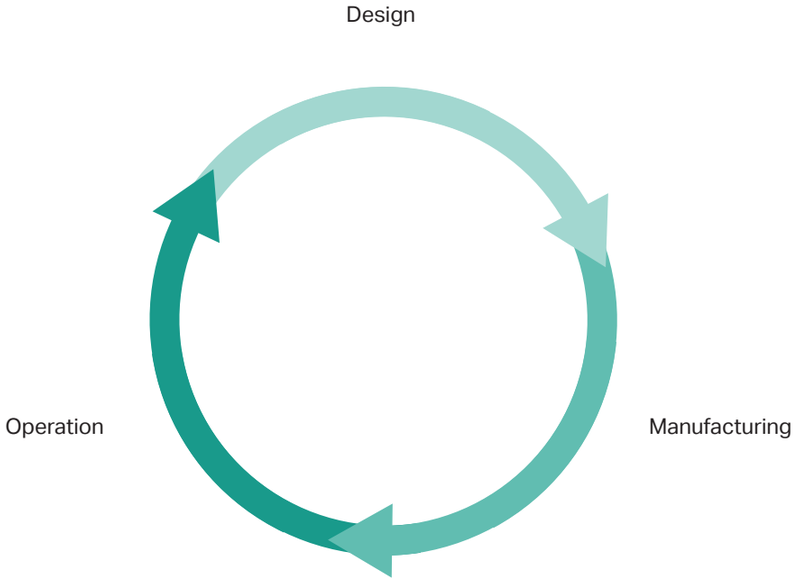


Image The stakeholder cycle with actual stakeholders, of which some are already actively involved in the area and some are not.



DRIVERS



Design for Disassembly

Driver overview

Design for disassembly means that buildings are intentionally designed for material recovery. This means that all pieces of the building can be taken apart after the building has reached the end of its lifecycle. Products in the building can then be directly re-used in another building. Alternatively, the materials can be recycled without downcycling as the materials are not contaminated.

Contamination of materials
Too often materials are glued together in a way that they can no longer be separated again. This contamination of raw materials is downcycling and usually results in the product becoming landfill after its initial use. Design for disassembly is tackling exactly this problem, but on a building scale. Great focus lies on keeping the materials separate by using reversible mechanical connections instead of chemical connections with glue.

All buildings are temporary
Design for disassembly can already be found in stage design and temporary exhibition buildings. For example, in the Circle Pavilion at the 2017 Dutch design week in Eindhoven. The materials used to construct the pavilion were borrowed and after disassembly all materials were returned in their original state to their original owners. Of course design for disassembly makes sense for temporary buildings. But we need to realise that all buildings are temporary. We need to stop building them like they are permanent. After 50-100 years they will most probably be taken down. We need a strategy to handle the materials that come free when that happens. Design for disassembly allows those precious materials to be re-used instead of being incinerated or landfilled. This material reuse results in significant energy savings and the reduction of CO_2 emissions.

Adaptability
The adoption of design for disassembly means looking differently at the materials we use and the way these materials are joined together. One of these changes is the building-wide adoption of reversible connection. This opens the door for the next step in adaptable buildings. The clear benefit is that the building can be altered in layout and function during its years of operation allowing it to change with the requirements of the market. This means an office building could easily become a residential building without excessive demolition costs and the creation of waste. In a circular economy the elements can be sold again for re-use or the parts can be sold as raw elements for recycling.

Project Circle House
Location Copenhagen
Year 2018
Owner Lejerbo
Architects Lendager Group, Vandkunsten, 3XN architects
Photo Helene Høyer Mikkelsen

Design for Disassembly

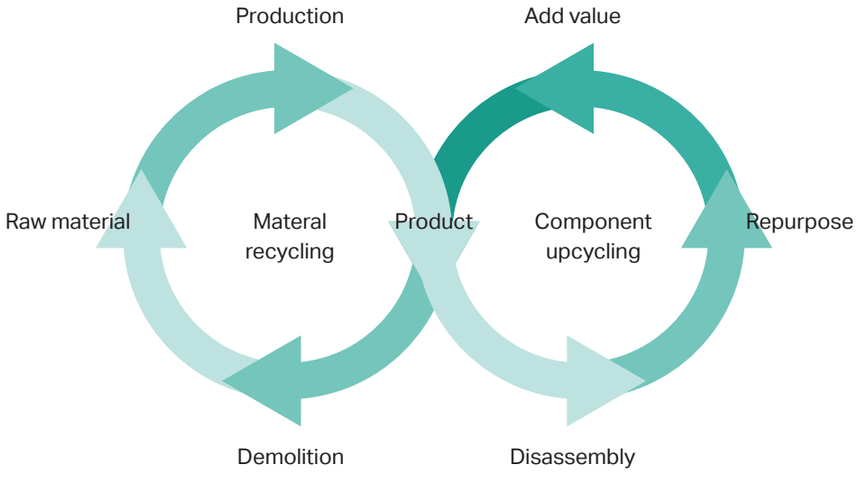
Case study

Circle House project consists of 60 general housing units in Lisbjerg outside Aarhus, which is expected to be completed in 2020.

In addition to serving as housing, Circle House is a scalable demonstration project that can give the building industry new knowledge about circular construction. Circle House consists of a range of building systems that can be assembled, disassembled and reassembled into other buildings while keeping their economic and aesthetic values intact.

The objective is that 90% of the materials being used for the buildings, can be reused without losing significant value. A wide range of materials can be used in the project, the key is the approach of the principles of design for disassembly and circularity. As it is the system that is crucial, great architectural freedom is achieved for material selection in circular construction. The project will be built in the new residential area 'Lisbjerg Bakke', located in the north of Aarhus, currently undergoing a sustainable development plan. The residential typologies are a mix of 2 and 3 story terraced houses and 5-story tower blocks. The super structure of the 3 different typologies is built from the same 6 concrete elements, optimized for a quick construction, disassembly and reuse.

In order to transform the building industry to a circular building practice the entire value chain of the industry needs to be engaged. The Circle House project involves more than 30 Danish companies across the entire industry. The Circle House project aims to develop, propagate and anchor knowledge about circular construction in the industry. As an example of this the architectural development of the project was made in as a so called 'collaboration studio', a joint team consisting of four companies with sustainability as their foundation, Vandkunsten, Lendager Group and 3XN Architects with the professional facilitation and coordination by GXN Innovation.



Component Upcycling

Driver overview

Component upcycling is a way of adding value to demolition waste. In some cases, recycling processes can achieve this aim, but must be balanced against energy and water savings that can be made by avoiding reprocessing materials to a virgin state.

Upcycling is a way for designers to directly reduce the volume of demolition waste entering the waste stream; and more broadly, material volumes in the global construction market. In current demolition and waste-handling practice, components suitable for preservation at demolition will typically be those that still contain functional and technical value and therefore possess possible resale value.

The term is used to define recycling with a non-diminishing value and is typically used when the term recycling is taken to include reprocessing to a material with reduced performance requirements, i.e. downcycled[2]. The primary aim of component upcycling is to refashion and integrate discarded components and materials into a new range of diverse products with open-loop cycles[3]. As a result, the value of the components or materials keep equal or higher than the original state.

There are clear formal distinctions between recycling, upcycling and remanufacturing; however, there is a relative absence of research exploring systemic benefits of upcycling as an effective design and waste management tool.







Project Nordic Built Component Case
Location Copenhagen
Year 2016
Owner Vandkunsten
PhotoVandkunsten

Component Upcycling

Case study

By means of 1:1 mock-up prototypes, The Nordic Built Component Reuse project explores new practices for reuse of dismantled building components and materials.

Project aims
The project takes aim at all product stages - sourcing, rehabilitation, design integration, construction and marketing – and explores new ways to organise, tender, and trade in reused building components. It is the premise and aim that future construction practice must enable resource-preserving strategies, including:

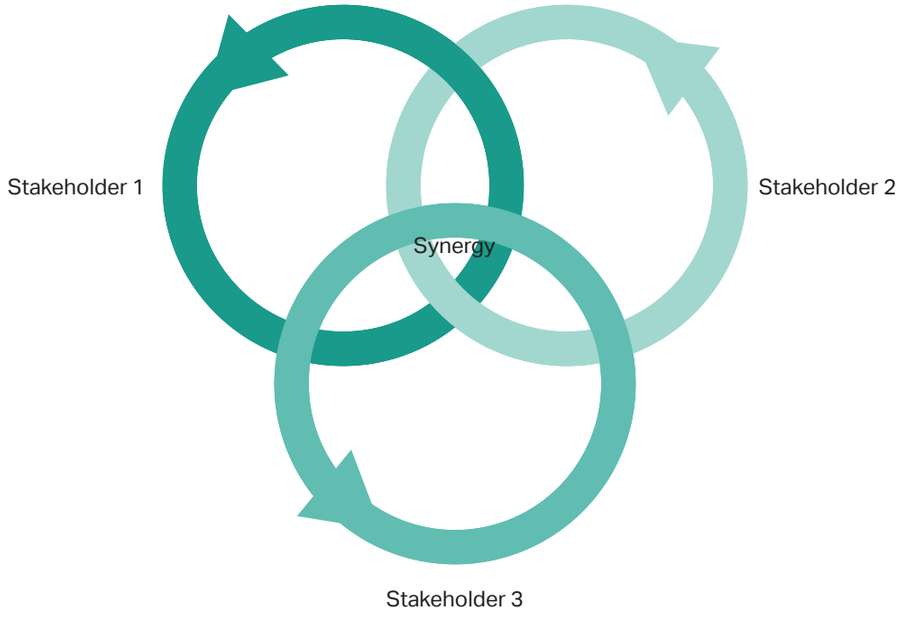
1. Repurposing building waste from demolishing, dismantling, and refurbishment.

2. Reversible construction principles known as Design for Disassembly (DfD).

Methods
1:1 work has formed the core work and led to data, discussions, exhibitions, lectures, and publications. The transformational journey from 'waste materials' at hand to valuable new components was investigated through an array of methods. First, we investigated the current market status through interviews with industry experts. Based on specific properties and availability of large material groups, the team then used the Sfc-system to categorize waste components and map their potential applications. Then the team selected and applied Design for Disassembly principles and iterative, architectural design methods to develop multiple novel architectural concepts for facades and interior wall systems. from scrap materials groups of brick, concrete, soft flooring, steel, and wood.

Results
The physical results of the project are the 20 full-scale prototypes made from five groups of transformed materials and components.

Theoretical results were made through double sets of comparable LCAs as well as extensive workflow charts conducted for key prototypes. All but the concrete concepts had strong LCAs. Prototypes have been broadly assessed for cultural and commercial value. In the commercial assessment of concepts ease of construction was compared with the cultural value for Genbyg customers.



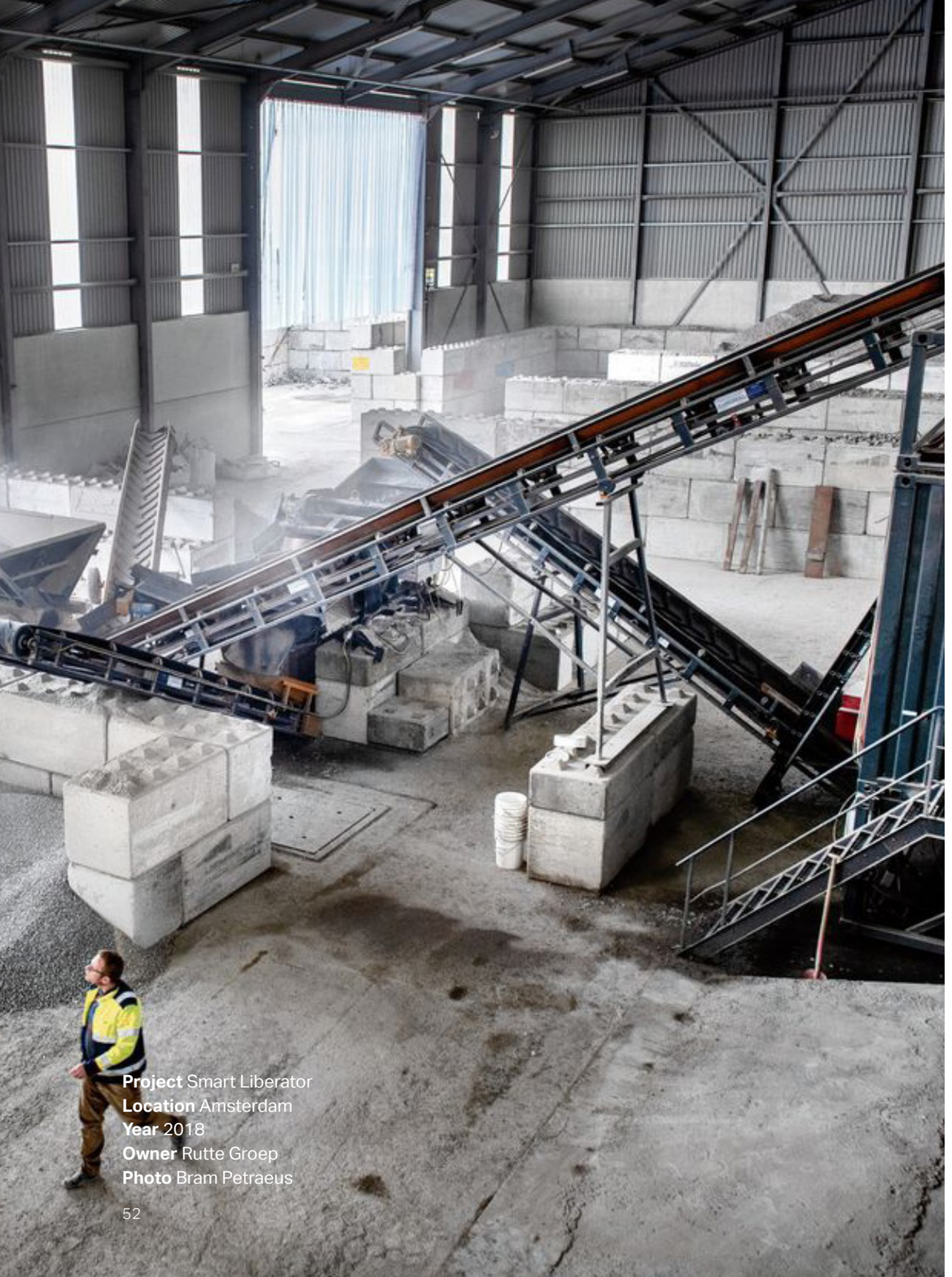
Stakeholder Synergy

Driver overview

Synergy is the interaction between two or more organizations, to produce a combined effect that is greater than the sum of their separate effects.
A well-known form of synergy is mutualism. Two stakeholders perform services for each other that they can't carry alone.

In the built environment we see an increase in stakeholders that want to participate in the circular economy. Builders, demolition companies, architects. Many are willing to rethink the building process as it is. However, they do not and can not do it alone.

These types of synergy, where a waste stream becomes a resource again, turn out to be environmentally as well as financially interesting. Therefore they have potential to be upscaled and have a great impact. We need these types of synergies if we want to really transform our current economy. We need to think circular and team up with stakeholders that can help synergise.



Project Smart Liberator
Location Amsterdam
Year 2018
Owner Rutte Groep
Photo Bram Petraeus

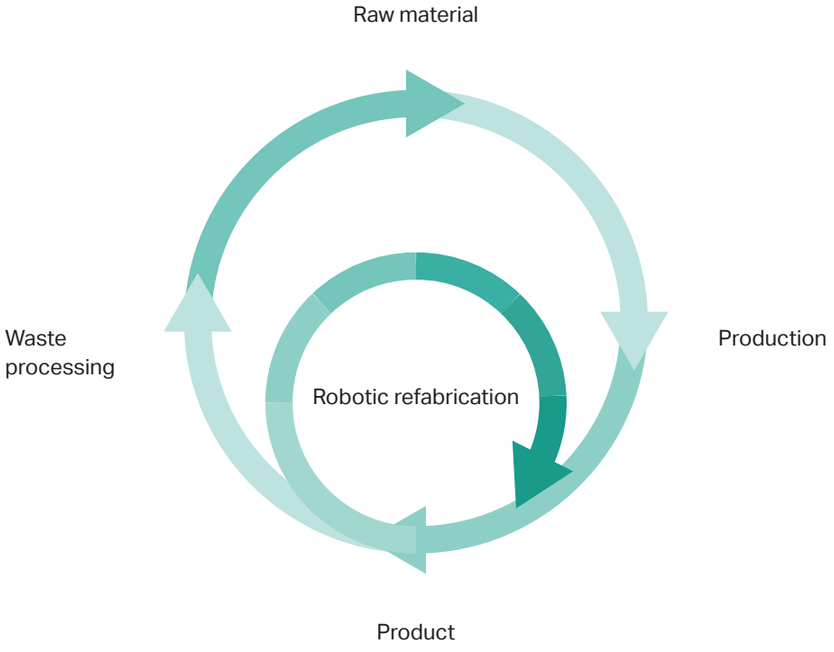
Stakeholder Synergy

Case study

A great example of how stakeholders are collaborating in a mutual fashion is the Urban Mining Collective.

This collective of companies, of which most are active in the built environment, is trying out new solutions to minimize building waste. Where a demolition company has to get rid of large amounts of concrete waste, a cement and concrete factory has to buy new cement constantly. What if this supply and demand can be connected somehow?

That is what New Horizon and Rutte Groep did. They developed a machine called the 'Smart Liberator,' with which they can "free" cement out of old concrete. The old cement, now called "freement," is reusable and therefore fully circular. They have calculated that if this innovation would be used worldwide, the total amount of CO_2-emissions would be reduced by 9%.



Robotic Refabrication

Driver overview

Robots are promising to be a solution to the fact that waste comes in such a variety of shapes, sizes, qualities, etc The great advantage is that robots can adapt their method fast and automatically.

Fabrication today is an efficient factory business. The production of materials and products happens in fabrication chains that are simple because the supply of raw materials is constant and the materials are always the same. The big difference with refabricating recycled materials is this process should constantly work with different materials.

Most materials that are being recycled today are materials that can be made into a raw material, so they can enter the fabrication cycle again, like paper or most metals. Cars are being recycled for 97% today in The Netherlands, because their materials are easy to melt into raw materials again.

The challenge of recycling is much bigger for materials that cannot be made into a raw material, or require a large amount of added energy to become a raw material again.

In a circular economy, production should not be a cycle of materials to products to materials, but production should also be smart and robust enough to work with available parts or elements of materials.

Reusing bricks, for instance could potentially lower the environmental stress, because it would lower the CO_2 emissions of firing the bricks. The bricks should then be processed and cleaned as whole bricks. If the bricks are crushed, processed and fired into new bricks than the total environmental stress will be the same. The cleaning and processing of bricks is very intensive so it would be necessary to do this in a robust factory process. Robots could learn how to adapt to different pieces of bricks. Robots could sort the bricks or place them in a specific way that the odd shape would be corrected.

Project Circular Experience
Location Amsterdam
Year 2017
Client ABN AMRO
Architect Studio RAP
Photo Studio RAP

Robotic Refabrication

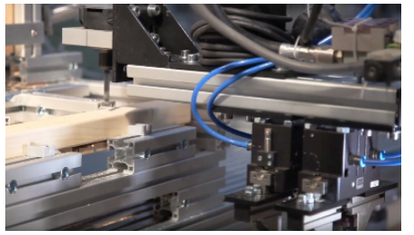
Case study

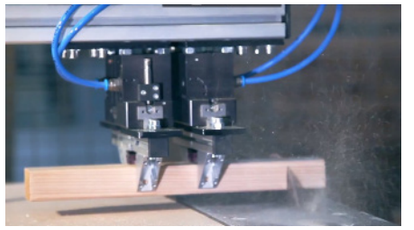
All waste management robots from Zenrobotics and BHS, both show great examples of dealing with material sorting in the recycling industry.

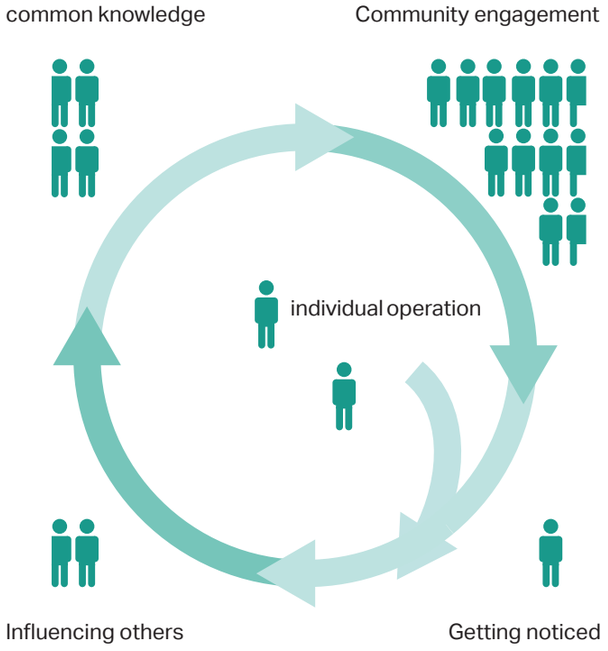
The combination of image recognition and robots make this process very powerful. The adaptability of the multiple axis robot strengthens the intelligence of the machine learning algorithms.

The production process for the curved wall in the Circular Pavilion also shows a similar process. This one is not so complex in the waste that it handles, but it shows a more complex way of assembly. The manufacturing process worked with two types of wood in two types of sizes. All individual wooden strips are shortened to the right size. The robot picks up the wood, drills the holes, shortens them, adds the dowels and then places them on a unique position.

Most processes in the building industry are designed simple, because they have to be understood and produced by people. And human labour is getting more expensive every day. This makes complexity very rare in these methods of assembly. The addition of robots to take over these tasks will give a chance to new craftsmanship and complexity.







Community Engagement

Driver overview

For the large part circular economy and a construction in general is implemented around end-users without actively involving them. With community engagement the building users will be much more involved in the circular economy.

Lack of participation can result in users feeling less attached to their buildings and less aware of maintenance and proper use. Without citizens to enhance and implement the processes of circular economy, it can never be fully adapted into society, there needs to be a way to stimulate people to enter into the transition. Community engagement can involve users in the design and operations of buildings, and allow them to become better aware of circular approaches and see the relevance of circular economy directly in their lives.

By actively displaying techniques and possibilities in a hands-on approach, a whole community can get involved in the circular processes. This could be seen in a way where people can interact with the building, in groups or individually. With the interaction they could learn about the subject. Seeing other people work actively with circular projects could engage additional users to do the same. One approach to community engagement is circular Living Labs, here people rent spaces for their small companies or start-ups, with added requirements to build up spaces, and communities around them, which embody circular economy. These spaces thus also come to hold great demonstration value.

Project The People Pavilion
Location Eindhoven
Year 2017
Client Dutch Design Week
Architect Bureau SLA, Overtreders W
Photo Overtreders W

Community Engagement

Case study

The people pavilion.
A great example of making a product without damaging or wasting any materials and showing every single joint in an educational and clear manner is the Peoples Pavilion at the Dutch Design Week of 2017. For this project the creators 'borrowed' the materials from all different companies to give it back afterwards. For the facade system, they involved the citizens of Eindhoven to collect their plastic waste so it could be turned into a facade system. In this way, the citizens could contribute to the pavilion at a circular approach and also get emotionally attached to it, because it was their waste hanging at the facade. With a project like this a community could be involved in the process to get them consciousness about the circular economy needs.

By bureau SLA, Overtreders W, Arup

Hof van Cartesius
With this example of Hof van Cartesius you notice that small start-ups can work with each other to realise a circular construction. People can rent a space in this courtyard, the only requirement is that everything is able to be reused. With this idea the owner, Charlotte Ernst, stimulate and motivates people to work with circular principles. The community together will therefore motivate outsiders to do the same. In this case ,the thought of circular economy can be carried out towards others by word of mouth. Where in the end a whole big group will have the combined goals to work toward a circular economy.

By Charlotte Ernst, RHAW Architecture

Section Two: Case Study

Case building

To archive upcycling for urban areas we should integrate these methods into the construction value chain:

Amstel III: case building
Urban development goals and planning

Hullenbergweg 1-3
Map materials, quantities and qualities.

Material Inventory
Building material inventory

Area analysis

Governing bodies from the European Union to the City of Amsterdam have advanced concrete frameworks for ac

Amstel III: area analysis
Analysis if upcyclable materials

Case study
Circular area development

Energy analysis
28% energy reduction via upcycling

Stakeholder engagement

Based on an analysis of current initiatives and best case studies, we advance 5 key drivers of urban upcycling:

The Amstel III: stakeholder loop
Who are actively engaging locally?

Connecting the dots
Scenario for stakeholder engagement

Phased engagement plan
Engagement during construction chain

Section two

CASE BUILD

Case Building

Amstell III, Hullenbergweg, Material Inventory

Amstel III

Spatial vision and development plan

The transformation of the Amstel III area is defined by the municipality through a spatial vision. This vision will guide the developments of the buildings to work towards a vivid area where people want to live and work.[4]

Three Ambitions for Amstel III
The municipality aims to give the area a creative innovative identity by attracting new residents, small offices, and start-ups, ideally in the circular economy sector. Three overall ambitions guide the development:

- Inviting new citizens
- Connecting slow transport
- Healthy & sustainable green areas

Inviting new citizens
Following the vision of the municipality of Amsterdam, the area of Amstel III will transform from mainly an office area to a mixed-use urban district. Therefore, this location is inviting new citizens to live in the area, being supported by the needed facilities. Nowadays there is a lot of vacancy in the area (15% of the offices) and to manage this vacancy the municipality wants to develop an economically strong, multifunctional and vivid area. Therefore it's needed to invite a new population, in the first phase mainly consisting of students and young professionals.

Connecting slow transport
The area is well connected with train and car to Schiphol, the city centre and other big cities. The metro will make a 24/7 connection to the city centre. In residential areas, the vision is to make slow transport more important at the neighbourhood level. A hierarchy is needed in streets to make it livable.

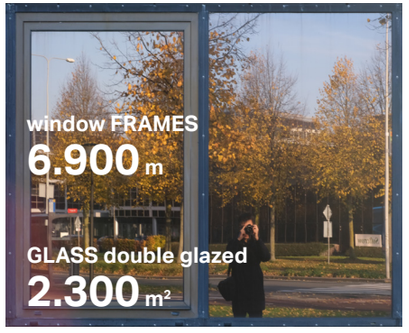
Healthy & Sustainable green areas
Within a vivid district, the aim is to get people moving, sports facilities outdoors and indoors will support this goal. With the area being well connected to green parks in the surrounding and city gardening it will be a healthy and sustainable city district.

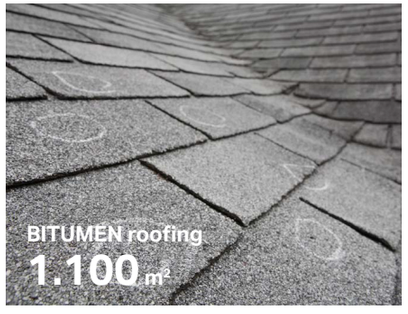
Adding program
To be sure to reach those goals set by the municipality program needs to be added to the area. This includes the following:

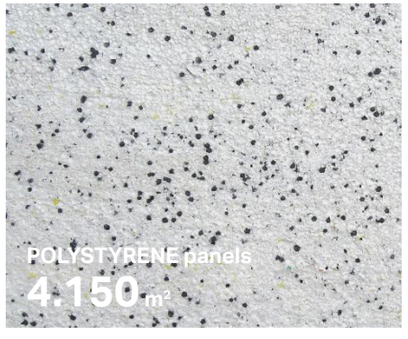
- 45% Houses
- 45% offices
- 10% service

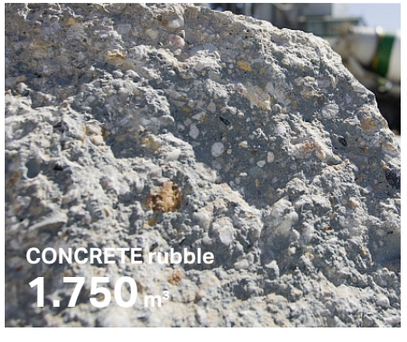
Of which the houses will be:

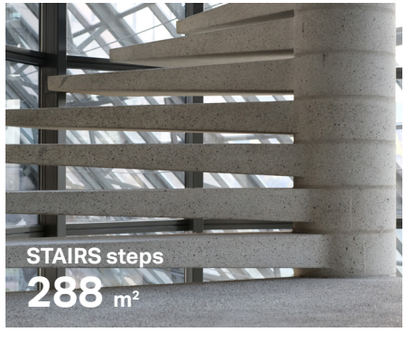
- 40% social housing
- 40% mid-range housing
- 20% high end housing











Hullenbergweg 1-3

Building case study

To show the potential for the Amstel III area we took one building, the Hullenbergweg 1-3, and took it apart to see what materials are inside. This gives an indication of the materials that can be harvested from it when it gets demolished.

The Hullenbergweg 1-3 is one of the many office buildings in the Amstel III area. It was constructed in 1988 with a concrete structure. The facade is cladded with granite panels in a standard dimension The windows are built with a curtainwall system and the back of the building features a large glass atrium. Based on the old drawings, site visits and a three dimensional modelling we analysed the building and split it into the different materials.

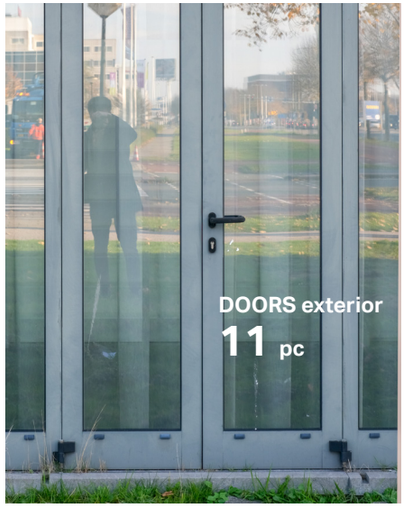
Harvesting

The materials that come from the building in two groups The first group is the amount of raw material that can be harvested. This includes concrete, double glazing, polystyrene, granite etc. The second group is based on products. In case of the Hullenbergweg there are three high-quality staircases, including 288 steps, and 4 elevators that have a high potential for re-use. The next pages display the amounts of materials that have potential for re-use.

Hullenbergweg 1-3

Hullenbergweg 1-3

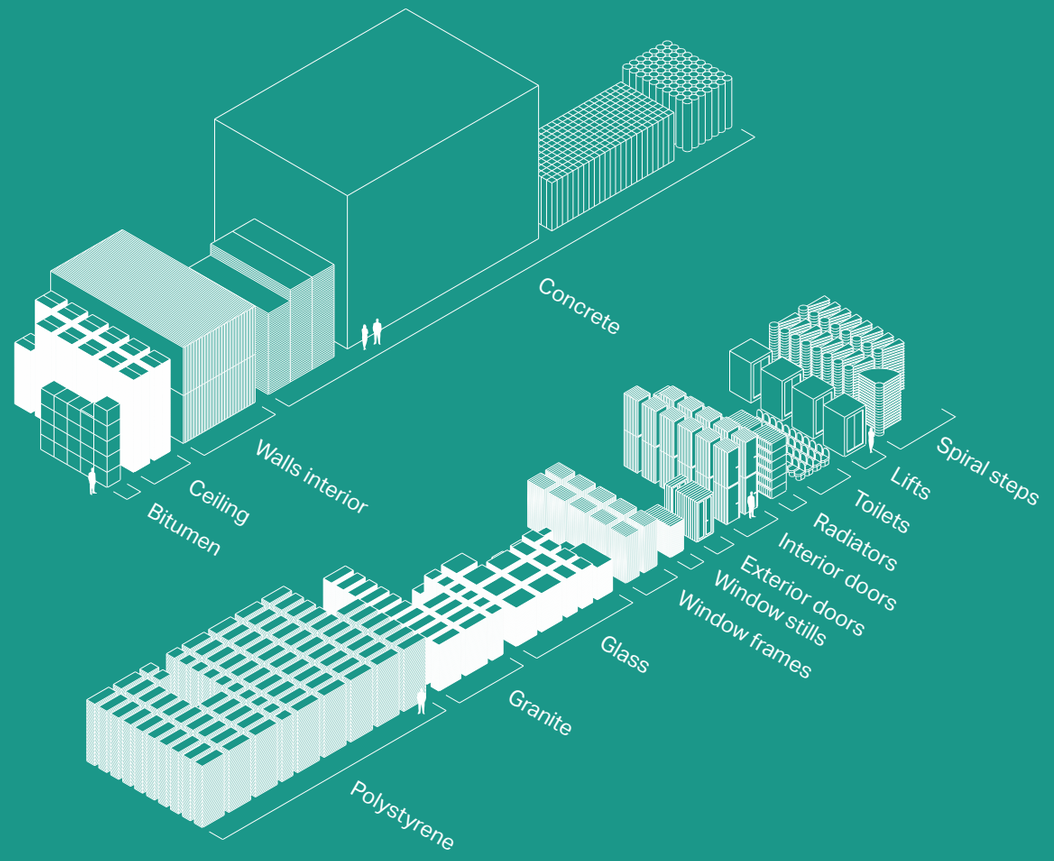
Mapping materials, quantities, and qualities



Material Inventory

Building material inventory

The Hullenbergweg building dissected into its different parts. Images are in relative scale to each other



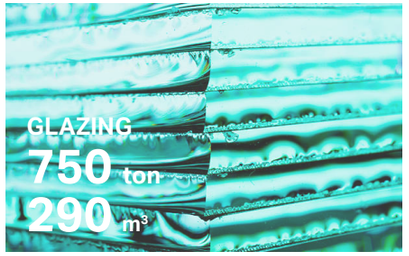
Material volume for upcycling

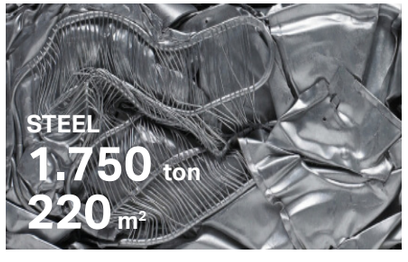
Concrete		1.750 m^3
Granite panels	1.750 m^2	52 m^3
Polystyrene	4.100 m^2	330 m^3
Double glazing	2.300 m^2	45 m^3
Bitumen	1.100 m^2	21 m^3
Ceiling	6.300 m^2	125 m^3
Walls interior	3.650 m^2	365 m^3
Window frames	6.900 m	50 m^3
Lifts		4 pc
Toilets		41 pc
Doors exterior		13 pc
Doors interior		228 pc
Radiators		240 pc
Spiral steps		288 pc

AREA ANALYS

Area Analysis

Amstell III , Case study , Energy Analysis





Amstel III

Analysis of materials ready for upcycling

To show the potential for the whole area of Amstel III we combined our data from the Hullenbergweg 1-3 with the data from Metabolic[5]. This gives an indication of the possibilities in re-use in Amstel III.

Currently there are 26 buildings in Amstel III that will be redeveloped in the future or are being redeveloped at this moment. Some of these buildings will be demolished, others will be transformed. In both cases, they can be potential harvest locations. They have been marked green on the map. When calculating the materials in the area we only took the raw materials into account. The data of Metabolic allowed us to also give an indication of the amounts of steel, gravel and brick walls in the area.

Material passports
In the development of Amstel III the introduction of material passports could give insight into the stock of materials. The data from these passports gives the material harvesters, architects and constructors the possibility to develop their projects in with the available stock of materials. Reducing production costs, transportation costs and CO_2-emissions.

Potential harvest locations

Current density
Left map shows the Floor Space Index (FSI) number of the Amstel III area. The office zones in the east are denser than the average FSI of the area at 1.3.

Potential density
Plots of low density here are assumed to be expanded to a higher density (twice the original but not more than 2.7) during the transformation.

0 - 0.6
0.6 - 0.7
0.7 - 1.0
1.0 - 2.0
2.0 - 3.0
3.0 <
Unknown

The FSI in Amstel III

Case Study

Circular area development

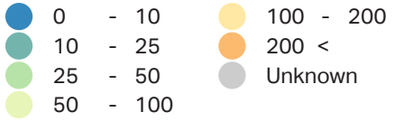
It is challenging to analyse the opportunities for circular economy at in a region, because the opportunities are usually not confined within a single project. The following case study for the Amstel III area shows how we propose to concretise an upcycling vision a region where demand for materials is visible.

Developing plan model
According to data from the municipality, the average FSI (Floor Space Index) of Amstel III is 1.3. For the convenience of calculation, we assumed that plots of low density should be expanded to a higher density (twice as high as the original but no more than 2.7), which is similar to the situation of some residential projects that have already begun in Amstel III.

Demand for materials
The estimation of material demand for the transformation is based on a calculation model of a uniform high-rise building with aluminium window frames[6]. Based on the assumption for the scenario estimates materials needed in the Amstel III area for the intended transformation.

Buildings without re-use
This map shows the embodied energy needed to densify the Amstel III area to the assumed scenario in traditional dem- olition and construction way. This is in line with the ambitions of the municipality for this neighborhood.

Buildings with re-use
This map shows the same assumed transformation as the map above but with the reduction of the embodied energy of the harvested materials from the current structures.



Embodied energy in TJ(10^{12}J).

Energy Analysis

Embodied energy savings of 28% through upcycling

When harvested materials from the Amstel III area are re-used, there is a potential for saving energy. If all materials harvested from Amstel III are re-used, their embodied energy can be subtracted from the total energy needed for transformation of the area. This translates to potential energy savings of 28.1%.

Material sources
Rather than build with completely new materials, there are options for us to reuse materials by harvesting from the original site. Since we estimated the material stock for the office and business buildings in this area, we can estimate the total amounts of material we have for the whole area.

Potential of energy reduction
Since the energy consumption caused by building use can be control to a certain extent by building standards and regulations, it is reasonable to focus on the embodied energy of construction materials. To get an overview of how much embodied energy we could save by reusing the materials, we used a embodied energy list for each material per kilo[7] and set up a model to estimate the total weight of each materials in buildings of Amstel III area.

Estimation of energy reduction
For estimation we chose 26 buildings from our harvesting site. Combining our own building case study result with the estimation from Metabolic, we got the total amounts of the main construction materials in these buildings. When looking into the developing scenario, these materials are available for reuse. For new building types, different materials meet the needs of construction to varying degrees. For example, demolition materials can offer nearly 100% bricks for new buildings but for concrete this number goes down to around 30%. As a result, we summed up the ideal embodied energy in completely new built buildings (516.7TJ, 1TJ=106J) and buildings with re-used materials (371.5TJ), which means we can save 28.1% embodied energy in an ideal situation.

Practical challenges
Different ways of recycling or reusing can be applied to add specific characteristics to the area, which can affect the energy consumption. Possibilities for storage and transportation which can lead to different cost are also important factors which can determined the result.

STAK
ENGA

Stakeholder engagement

Stakeholder Loop, Connecting the Dots, Engagement Plan

The Amstel III Stakeholder Loop

Who are actively engaging locally?

In addition to mapping out the area, it is also interesting to map out the different stakeholders in the area. Who are actively engaging in the Amstel III area and why? What are their goals? This chapter will explore a potential scenario that could, or maybe should, take place in order to upscale urban upcycling in the Amstel III area.

As chapter two outlined before, there are many different types of stakeholders in the area. It is interesting to replace these general stakeholders with actual stakeholders from the area and create a scenario. This scenario is fictional of course, yet potentially realistic.

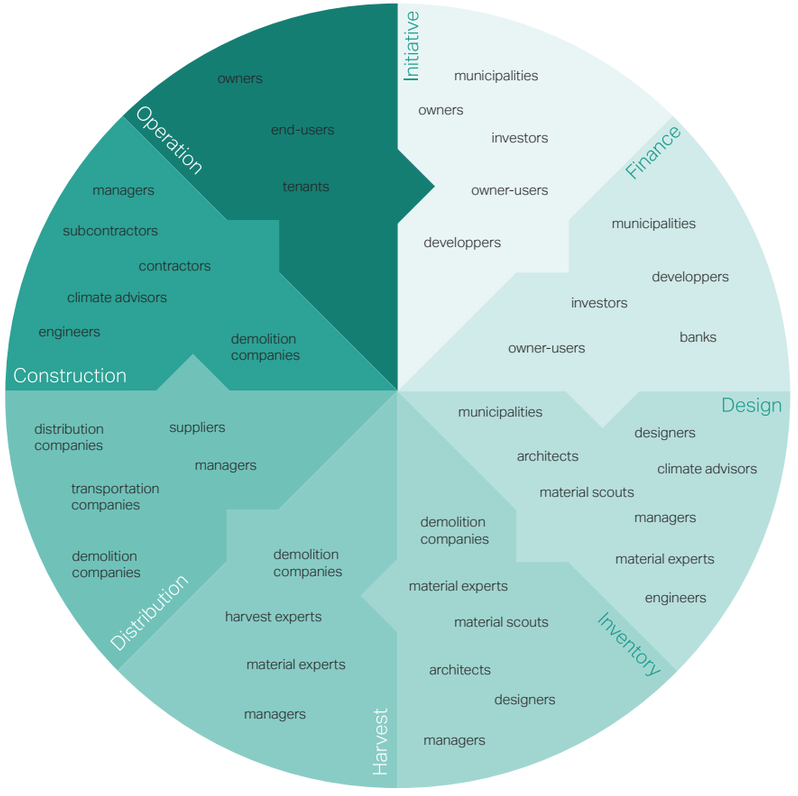
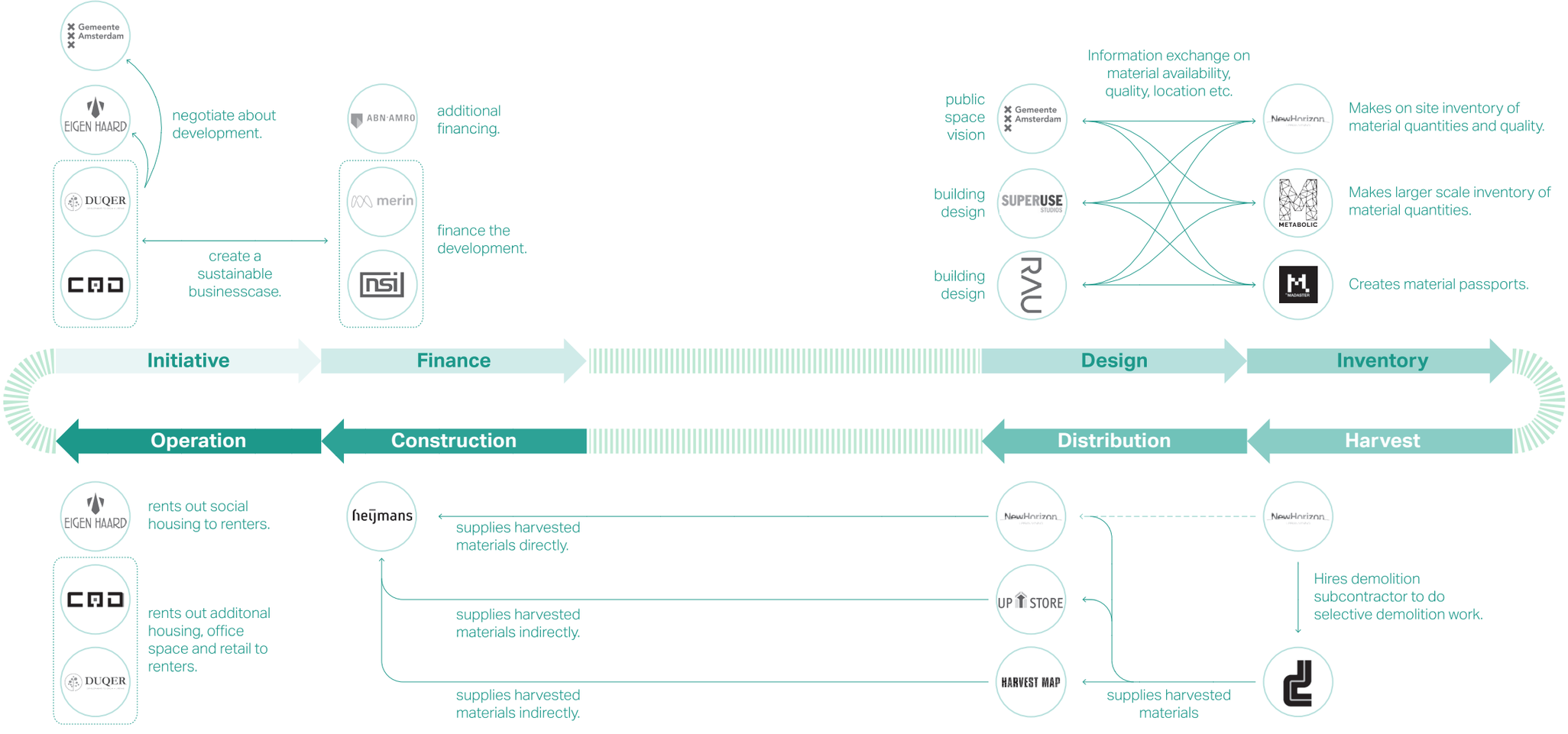


Image The different types of stakeholders and how they form an ecosystem together.

Connecting the Dots

Scenario for stakeholder engagement

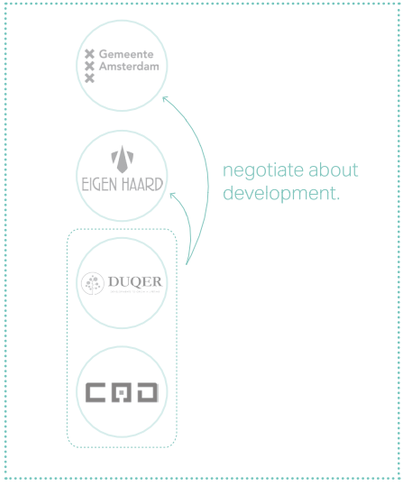
When the stakeholders have been mapped out, we can connect them. This scheme shows a fictional scenario, where stakeholders engage with each other during the different phases.



Stakeholder engagement

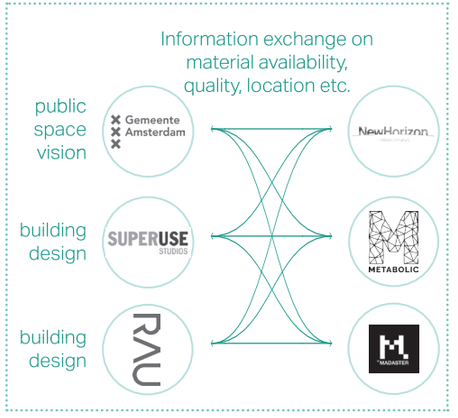
Phased engagement plan

Initiative
Developers, the municipality and a housing corporation negotiate on the segmentation of the developing project. The municipality wants a minimum of 40% of social housing in the area. However, this is not financially interesting for developers. They want density and high quality apartments to gain high revenues. However, the zoning plan allows for a low density. The outcome of the negotiation might be that 20% of the developed dwellings will be social housing, but the municipality will allow a higher density. Also, the developers must invest in the public space around the project.



Finance
Institutional funds will finance the development entirely or partly. If needed, a bank can supply additional funding. These institutional funds have already invested in office buildings within the area. A new, high quality development can create value for the entire area, which is interesting for investors.

Design
Architecture firms come up with designs for the development within the vision of the municipality and the wishes of the developers. Ideally, they incorporate information on locally harvestable materials acquired from partner stakeholders within their designs, as to lower the need for new building materials.



Inventory
The partner stakeholders that are responsible for acquiring this information do this on three levels: they make inventories on large scale and on site, and they create material passports. All this information is allowing the used materials to be reused in the future and to make sure no value is lost over time.

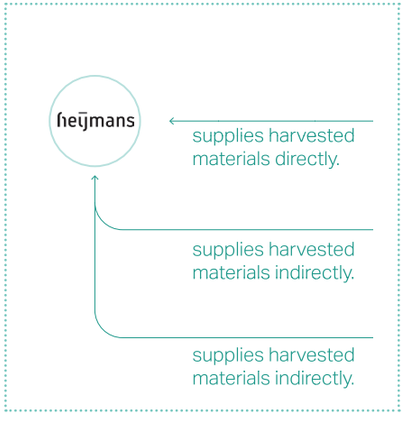
Stakeholder engagement

Phased engagement plan

Harvest
In case the development requires an old building to be demolished, a harvest process should be started. With the information on the inventory a plan can be made. One party takes on this job and hires demolition crews to disassemble specific parts of the building. One crew is responsible for all the concrete, while another is responsible for all the bitumen roofing.

Distribution
Once all materials are harvested, they can be distributed to their destination. Ideally, all materials are reused on site for the construction of the new development. They can be stored on site until needed. However, not every material might be needed. In that case, the materials are distributed to the marketplaces or manufacturers.

Construction
In the best case, the materials are reused on site. The contractor receives the materials at the right time in the construction process, to lower the need (and time) for storing materials. Logistically this is challenging, because some materials are needed at a later stage than others. Planning is key here.



Operation
When construction is done, the building can start to be used. The housing corporation finds renters to rent out the apartments. The developers also find, or already have renters.

Sources

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In 2015, the City of Amsterdam prepared a Vison and Action Agenda for the circular economy. Today, the City is finding new ways of integrating circular economy into urban planning as the Netherlands aim to become fully circular by 2050.

The City of Amsterdam is recognised as a first mover in the transition to the circular economy, with the CONTEXT and cases presented in this book, the municipality can further prepare to seize the opportunities this paradigm presents.

To secure focus and recommendations for a Circular Amsterdam, the City has commissioned Kasper Guldager Jensen, Founder of GXN, as Circularity Expert and GXN as special advisors. Lead by Kåre Stokholm Poulsgaard, the GXN team deliveres circular economy analysis and action plan for the Amstel-Stad development area.

This book outlines a methodology and case study for how to work with urban upcycling in the Amstel-Stad.

The methodology integrate insights from expert interviews to develop an actionable framework for urban upcycling, focusing specifically on changes to the construction value chain.

The case study provided in the book analyses material quantities and qualities on a representative building in Amstel-Stad slated for demolition. Insights from the case study are then applied to an analysis of the wider area to discuss material and energy potentials of integrating upcycling strategies in its development. An additional stakeholder analysis outline potential partners that can help realise urban upcycling in the area.

A big thank you to the team from the City of Amsterdam team for a great collaboration. And massive respect and thanks to the students at the GXN led Big Upcycle Studio at TU Delft for putting in a tremendous effort in preparing the mappings, interviews, analysis and cases of the books.