Building a Circular Economy

Buildings, a Dynamic Environment

LE BATI BRUXELLOIS SOURCE DE NOUVEAUX MATERIAUX

VUB

ARCHITECTURAL ENGINEERING

Buildings are all around us and, somehow, they seem to have become our natural environment. However, little is natural about them. Most buildings are designed deliberately, the materials they are composed of are engineered carefully and their indoor climate is constantly adjusted. As buildings are not adapting themselves, we must do so. This way they form a dynamic environment in which – and through which – we interact. The dynamism of the built environment has significant consequences on resource consumption and, therefore, the environment we inhabit. These consequences – unsustainable by nature – challenge conventional design and construction practice. In this publication we try to grasp that untenable situation and offer an alternative.

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Situated on the imposing Kunstberg with a vista over Brussels, the contemporary convention centre Square dialogues with the historical heart of the city. Arch. A2RC (photo: Philippe Debroe)

Introduction

Buildings are all around us and, somehow, they seem to have become our natural environment. However, little is natural about them. Most buildings are designed deliberately, the materials they are composed of are engineered carefully and their indoor climate is constantly adjusted. As buildings are not adapting themselves, we must do so. This way they form a dynamic environment in which – and through which – we interact. The dynamism of the built environment has significant consequences on resource consumption and, therefore, the environment we inhabit. These consequences – unsustainable by nature – challenge conventional design and construction practice. In this publication we try to grasp that untenable situation and offer an alternative.

To create awareness and empower the construction sector in its transition towards an economy of closed material loops, this publication proposes a holistic framework. It is the result of a series of observations, interviews and co-creation sessions with different construction actors, including architects and contractors, researchers and policy makers as well as building users and managers. Introducing buildings as a dynamic environment, this publication points out the challenges and opportunities for a circular built environment in Brussels and beyond.

The Atlas brewery illustrates Anderlecht's rich industrial past, and is now awaiting its transformation into residences and workshops. (photo: Waldo Galle)

1. Questioning an Unsustainable Model

How is it possible we build buildings that could last for centuries, while we waste them within a few decades?

In cities we meet up with family and friends, in our favourite stores we find what we need, and in our houses, we feel at home. These places are treasured and the buildings that shape them are loved. Nevertheless, we see that some buildings are cherished forever, while others do not last long. Following this observation, making buildings last longer seems obvious.

Each of us can contribute to a lasting built environment. Although city dynamics are complex and beyond the power of individual designers, contractors and users, our contributions range from constructing buildings more durably, to using them more wisely. Yet there are plenty of challenges ahead and our durability ideal might even have an unsustainable outcome.

1.1. The Durability Ideal

A building's durability, its quality to stand wear and tear, depends on its principal structural materials, the environment in which it is placed, and its socio-economic context. Together, they determine how long the building can last.

Standards, like the Eurocode on structural design, state that the design service life of a project must be defined together with the client and proposes a service life of 50 years for conventional and 100 years for monumental building structures. The British standard defines the 'normal' life of a building as 60 years. By setting these figures, such standards allow to determine the reliance of structures. They do, however, not consider the legal and contractual responsibilities that might apply, neither do they reflect the actual period during which a building has social, functional and economic relevance and impact.

Different building materials, the environment in which they are used, and the economic reality they are situated in give rise to different rates of deterioration. For example, steel and reinforced concrete will tend to deteriorate faster than masonry does in outdoor environments. Moreover, Priyan Dias[1] discusses how a worldwide change in cement manufacturing lowered the durability of concrete around 1975, and how a worldwide scarcity of timber resulted in the use of less durable wood. We now understand that these sector-wide changes had their impact on many buildings' service life. Similarly, we might identify for example the increased use of plastic coatings and sealants as a future risk for the transition towards more sustainable material management.

A sound selection of materials, their appropriate assembly with attention to detailing that considers the interaction between materials and their environment, is studied by various construction research institutes and is taught as best practice to designers and contractors. Today, we know how to build in a durable way, and history has proven that buildings can last for decades or even centuries.

1.2. Brussels' Oldest Buildings

A closer look at the Brussels building stock reveals that load bearing masonry walls and timber floors of terraced houses have performed outstandingly in terms of durability. These elements have lasted well beyond an anticipated design service life of 50, 60 or 100 years.

In Brussels, 65 percent of the 158,965 buildings and 489,187 dwellings studied in the Brussels Retrofit XL research project are dated pre-1945. For this period, the *maison bourgeoise* outnumbers all other types. Their construction system is mainly governed by protection against fire[2]. The wooden floors span perpendicularly to the facades between 28 to 48 cm thick brick walls as defined by building regulations. Non-structural party walls are made of brick too. These elements, applied in a protected environment, can be expected to last a century or longer.

Buildings that received a special status over time, because of their historical or cultural importance, survive even longer. For example, the iconic art nouveau building Old England, housing the Musical Instrument Museum since 2000, opened in 1899 as a department store. The metal market hall of Schaarbeek, erected in 1901, now hosts all kinds of cultural events. Or the Royal Warehouse of Tour & Taxis, dating back to 1906, has become a new productive hub. Even older are the stone remnants of the first city wall, such as the Black Tower on Sint-Katelijne and the Anneessens tower on the Keizerslaan, both dating back to the thirteenth century.

Although we know how to build in a durable way, surprisingly young buildings are threatened by demolition in Brussels. The bank complex at the

Havenlaan, the Paul-Henri Spaak building housing the European Parliament, or the Boudewijn building of the Flemish Government are ready to be demolished after a service life of only 18, 23 and 25 years respectively. Apart from durability, other parameters must play a decisive role.

1.3. The Reality of Change

Unceasing ageing and urbanisation, limitless mobility, increasing waste production, unprecedented global warming and decreasing biodiversity put the ecology, economy and well-being of present and future generations at risk[3].

Although continuously improving construction practices increase the durability of buildings, many building elements do not reach their technical service life but are wasted earlier. Typically, dwellings start to be adapted within three years after their completion and some are entirely refurbished at the age of 25[4]. Most changes are driven by functional, technological, economic or cultural evolutions (p. 11) such as changing comfort standards or new housing forms like co-housing[5]. Moreover, it is expected that the evolutions initiating these alterations will continue to accelerate. This increasing dynamism could consequently further shorten the functional service life of buildings and their elements[6].

Dias identified two consequences of the confrontation between durability and change[1]. One consequence of society's fondness for change is that investors and developers may not want to invest in more expensive, yet durable buildings. Simultaneously, owners sometimes try to use a building longer and beyond its design service life, because demolition and reconstruction would force them to comply with new planning regulations. The result is an increasingly less durable or outdated building stock, no longer in accordance with its users' wishes and needs. While it was the intention to maximise the durability and social, functional and economic value of our beloved buildings over time, we end up with an unwanted and unsustainable model for our built environment.

Because society and the resulting user requirements and standards are constantly subject to change, our buildings reach the end of their useful service life when they are not yet outdated. Our wishes and needs render otherwise durable buildings obsolete. This dynamism requires buildings to change; to use them differently or adapt them to the new, temporary needs and requirements of a neighbourhood and its inhabitants.

1.4. Brussels, a Dynamic Environment

The research report *Metabolisme urbain de la Région Bruxelles-Capitale* states that for office buildings, following the technical and organisational changes in recent years, obsolescence has increased significantly. It is calculated that their useful service life is currently no longer than 15 years.

Such statistics together with some remarkable building alterations in

Brussels illustrate the consequences of society's changing needs. From all residential refurbishment permits awarded in the Brussels-Capital Region, the majority concerned the demolition and reconstruction of houses, and a significant 15 to 30 percent concerned the repurposing of hotels, offices, retail spaces and workshops.

One remarkable example is the conversion of the hospital Deux Alice in Ukkel into housing. During this reconversion, the building structure erected in 1971 was maintained. Some annexes were dismantled, and extra shafts pierced, stated Philippe Weidner, coordinator of the project[7]. The possibility to preserve the hospital's durable structure suggests the quality of some buildings to be transformed effectively to fulfil the city's evolved societal needs.

Another example is Brussels having become a hub of multifunctional spaces for entrepreneurs. A myriad of co-working spaces can be found in coffee bars in the city centre as well as in luxurious townhouses in the European quarter. These functional transformations illustrate how changes in the way we work result in new demands for the existing building stock. The diversity of building types the co-working initiatives are situated in, hints to the quality of some buildings to house more than one function, even without significant building alterations.

Drivers for change

Drivers for change can be categorised into the four dimensions proposed by Donald Iselin and Andrew Lemer[5]. Their categorisation is adopted for its comprehensiveness and relation with the building's performance. Per dimension some examples are ordered from more building- to more context-related drivers.

Functional drivers, related to the purpose of the building, its elements or amenities.

- Natural wear and tear, maintenance and possible (ab)use of the building.
- User and owner needs, such as spatial capacity and organisation.

Technological drivers, related to the efficiency of the installed technology compared to that of alternative ones.

- Building components' inherent quality, safety and effect on the environment and health.
- Technological innovations, such as the emergence of 'smart' energy management.
- Standards on energy efficiency, accessibility or indoor comfort.

Economic drivers, related to the cost of the existing building, compared to the expense for an alternative one.

- Operational expenses, such as management and maintenance costs.
- Property valuation, related to the location and possible urban developments.
- Development of real-estate markets, including opportunities to sell and let the building.

Social, legal, political and cultural drivers, related to the broad influence of social values, political agendas or lifestyles.

- Household and dwelling forms, such as co-parenthood, house sharing, etc.
- Cultural changes, for example in heritage valuation or environmental impact valuation.
- Policy and legislation, reflected in building and spatial planning regulations.

Obsolescence and service lives

Time, often referred to as the fourth dimension, implies changes in user requirements and standards. Because of that change our durable buildings become obsolete. André Thomsen and Kees van der Flier explain: "Obsolescence presents a serious threat to built property as it rarely accounts for the immobile, long-lasting and capital-intensive characteristics of property, nor for its societal and cultural significance"[8].

Obsolescence of the building stock is partly a physical phenomenon. Technical factors such as deterioration and everyday wear and tear play an important role in the aging of a building and its components. Moreover, obsolescence is a result of human action and disregard as functional and economic factors also enter the picture. Think of changed expectations regarding comfort or profitability, or changing business objectives, political agendas, and lifestyles. All can result in the fact that a building is no longer used. Consequently, a distinction can be made between the potential and actual performance of a building, and between the corresponding technical, functional and economic service life. That distinction helps to understand the way we can manage buildings and their components more responsibly.

Technical service life (or physical service life) can be defined as the period during which a system, component or material can perform its intended function under anticipated conditions.

It is described as the time it takes for a building, or component to wear out or fail, or the period after which a facility can no longer perform its function because physical deterioration has rendered it useless. It is claimed that the technical service life of products gets longer due to growing knowledge and better technologies, but simultaneously this is challenged by those studying the idea of 'planned obsolescence'.

Functional service life (or social service life) can be defined as the period during which a system, component or material meets its users' expectations.

It is described as the time it takes for a building to fail meeting the requirements evolving with social goals or political agendas, set in new legislation about, for example, accessibility, or reflected in changing lifestyles, work habits, household compositions etc. It is claimed that buildings' functional service life is becoming shorter and shorter due to the increasing dynamism of society.

Economic service life (or financial service life) can be defined as the period during which a system, component or material is economically feasible and competitive to be used.

It is described as the time it takes before an alternative building or system is less costly or more profitable to operate and maintain; for example, the period after which a building cannot compete effectively with its neighbour for tenants and rental income. In some cases, the economic service life is therefore understood as a balance between costs and revenues, and its end is seen as a trigger for investments in refurbishments or replacements.

Often, a contradiction between these technical, functional and economic periods, spurs obsolescence and triggers major reconversions or demolitions. Thomsen and van der Flier, however, nuance: “Clearly, it is not true for monuments and other structures with heritage or other intrinsic values that may not be demolished, nor it is true for empty out-of-service structures on valueless land that no one will demolish, and even not for obsolete worn-down property as long as the owners and users continue to desire it and it does not harm its environment.” These definitions are thus strongly context-dependent and their interpretation relative to time and place.

To meet changing needs, there is sometimes no other option than to demolish a building. For this building on the Kunstlaan, like many others, that generates a lot of waste. (photo: Waldo Galle)

2. Identifying the Consequences

Our planet cannot bear the impact of our buildings.

In contrast to society's dynamism, conventional buildings are inherently static. Their rigid load bearing structure, tailor-made façade openings and concealed services and fixtures require invasive refurbishments to keep them fit-for-purpose. When they no longer fulfil the users' needs, they remain vacant or are demolished. Such demolitions or vacancies cause the energy, material and budget that were once invested in these buildings to be entirely unutilised or simply lost. The static character of conventional buildings and the material flows that their refurbishments entail become even more problematic when they are linked to specific consequences. With functional refurbishments or building demolition and replacement, a vast amount of waste is created, new materials are mined, and energy is consumed. Construction therefore has an important share in the 2.6 earths that would approximately be necessary to support our demands on nature if everyone on the planet had the same ecological footprint as an average western European[9].

2.1. Waste Production

The first detrimental effect of our mining and construction activities are the waste flows they initiate. The total estimate of construction and demolition waste generated annually in the Brussels-Capital Region (including brick, plaster, flat glass and asphalt) adds up to 650,000 metric tonnes or one third of the total mass of all non-domestic waste[10]. In Europe even 60 percent of the 2,652,000,000 metric tonnes of waste is related to the built environment[11]. Not only new constructions but also building maintenance and refurbishment contribute to that amount. Although official statistics state that more than half of the construction and demolition waste is – and much more could be – recycled, observations demonstrate that the quality and value of those materials are not preserved. For example, old plasterboards that could be reused during the production of new boards are rarely recovered. Because boards that have been used in conventional buildings are polluted with non-removable finishing layers, they end up in mixed debris[12]. That makes the recycling of plasterboards and other building materials ineffective and unfeasible and shows that the way materials are applied today is decisive for the course of their entire service life.

2.2. Resource Consumption

The second consequence of our static way of building is its material intensity. Already in 1992, a report of the World Resources Institute pointed out that the continuous depletion of the earth's mineral and fossil resources will ultimately restrict their availability[13]. In Europe, around 36 kg of raw materials such as sand, clay and ore are extracted per person per day[14]. On average, at least 45 percent of that consumption is attributed to activities of the construction industry and the built environment[15]. Moreover, the extraction and processing of raw materials is very intensive in the use of energy, water and land. The resulting social and environmental burdens such as the destruction of fertile grounds, toxic pollution and in some cases human rights violations are undeniable and cannot be ignored. In sum, the irreversible effects of today's material consumption put enormous pressure on future generations.

This is also true for the Brussels-Capital Region. According to the 2015 report on the metabolism of the region its material flows are lower than the European average but still significant: 46 percent of the imported materials and 30 percent of the exported waste are minerals and other construction materials.

	Export			Import		
Transport mode	**Road**	**Rail**	**Boat**	**Road**	**Rail**	**Boat**
Mass of all goods	15,202	302	298	19,863	914	4,161
Mass of minerals and construction materials	4,538	0	13	7,366	14	1,691
Share of minerals and construction materials	30 %	0 %	4 %	37 %	2 %	41 %
Total share			30 %			46 %

Transport of goods arriving at (import) and coming from (export) the Brussels-Capital Region in metric kilotonnes[16].

2.3. Energy Use

As a third effect, the embodied energy of buildings, i.e. the energy necessary to manufacture the building components and construct the building, is gaining in relative importance as buildings' operational energy performance is optimised. The energy that is required for the construction of a nearly zero-energy dwelling equals 40 to 60 percent of its energy use over a period of 60 years[17-18]. Moreover, although all resources are used increasingly efficiently, their depletion will continue as long as the relation between resource use and economic growth is maintained and a linear take, make and dispose attitude continues to characterise our economy[19]. To counteract this, key sectors such as housing must be radically transformed. As the European Environment Agency points out, "living well within ecological limits will require fundamental transitions in the systems of production and consumption that are the root cause of environmental and climate pressures"[9]. "Such transitions will entail profound changes in institutions, technologies, policies, lifestyles and thinking," its report continues.

The last decades, a policy of waste awareness has consequently emerged[20]. For example, landfill costs in the European Union have grown due to rising taxes and gate fees. Other directives such as compulsory sorting and recycling of smaller waste fractions have also had a positive effect by forcing construction practice towards new demolition processes and raising investors' awareness of the long-term environmental, social and financial burdens of construction[21-22]. Accordingly, architects and engineers are now challenged to develop and apply design strategies that anticipate society's dynamism[23]. After all, when all these consequences of conventional building are considered, one thing is certain: all resources must be used more responsibly.

With her installation 'Muted Scenery' Petra Blaisse redefines the utility and experience of the former Brussels Citroën garage. (photo: Waldo Galle)

3. Discovering the Alternatives

Two approaches could align the way we create and use buildings.

Conventionally we design our buildings as a durable solution for temporary problems. But because user requirements and standards change increasingly faster, many buildings reach the end of their functional and economic service life at a moment when they are not yet outdated. Two alternative approaches towards our built environment are presented in this chapter, within the framework of Design for Change: service life extension and closing material loops, both strongly resonating with the idea of a 'circular economy'.

3.1. Service Life Extension

Knowing that in many situations changing needs and demands are the actual reason that buildings and building components are wasted, a first strategy to use our resources more responsibly is to extend their economic and functional service life until they reach their technical one. This way the utility and value of the product or building is maximised over time.

One of the main keys for the service life extension of buildings, is Design for Longevity as it was defined by Paola Sassi: "to ensure a long-life building it is […] essential to design in sympathy with the environment, but also to provide a building that can accommodate changes of use and has a durable building fabric that is easily maintained and upgraded". This strategy of anticipating future use strongly resonates with the idea of 'prevention' and 'reduction' in the Ladder of Lansink (p. 26-27).

The two related design principles are therefore generality and adaptability. Both principles contribute to a 'circular' construction economy because they facilitate the reuse of the existing built environment. When a building is generic, it can be reused over and again without alterations. Brussels' old warehouses or workshops illustrate this very well. Alternatively, when a building is adaptable, its functional and economic service life can be extended by efficient renovations to house new functions. As a result, when the building's service life is extended, the utility of the invested resources increases, reducing resource consumption, waste production and thus lowering the building's overall environmental impact.

A building or any other system can be considered **multi-purpose** if it suits the requirements and needs of several users and activities succeeding one another, whether they are known or unknown during conception. A building that has a high degree of generality has the potential to accommodate evolving demands within its existing form. High generality is facilitated by an open lay-out with well-connected and generous spaces.

Adaptability of buildings is their capacity to efficiently accommodate, through building alterations, the evolving demands of its users and context. This adaptation can be almost instantaneous, using for example moveable components, or can require a thorough refurbishment. Accordingly, 'Design for Adaptability' is a design strategy developed to anticipate future rehabilitations of a building and allowing easy reconfigurations for another use.

3.2. Closing Material Loops

To maintain the value of all components a building is made of at all times, it is not enough to extend the service life of whole buildings. Components should circulate according to endless loops too. If at the end of a building's technical, functional or economic service life its components are recovered, they can be reused for the same or another use. This recovery requires different design choices and is facilitated by for example alternative business models. Both are part of the emerging concept Buildings as Material Banks'.

According to the H2020 project studying this concept[24], considering buildings as 'material banks' is seeing them as repositories or stockpiles of valuable, high quality materials that can easily be taken apart and recovered because they are designed for disassembly. "By harvesting materials and parts during deconstruction and renovation of buildings, these materials can be reused in the construction, operation or refurbishment of other buildings, thus reducing the need for primary resource mining"[24]. "Moreover, the term Buildings as Material Banks also refers to a materialised investment. Seeing material resources as a temporary way of materialising investments opens the door to a wide range of circular business models"[24].

Design for Disassembly is the design principle of creating building elements that can be disassembled and from which components can be easily removed without damage.

In the Circular Retrofit Lab at the VUB university campus in Elsene, new and recovered building components are used in a reversible way. Arch. KADERSTUDIO (photo: VUB Architectural Engineering)

Design for Disassembly, often referred to as Reversible Building Design, enables resource efficient repair, maintenance, replacements and the reuse of building materials, products and components. Therefore, it relies on design qualities such as reversibility, independence and simplicity of connections and components. Reversible Building Design has been developed and tested by multiple players the last years on an experimental basis, but is far from mainstream.

Circular business models are economic systems in which value is created and conserved through reuse of products, while performance rather than ownership is made accessible to users.

Moving away from ownership by the end-user, in order to extend the responsibility of product manufacturers, circular business models are closely related to and inherit the advantages of the sharing economy. The BAMB project reports: “down-cycling and recycling at raw material level date back a long time; product-service systems for shorter lifecycle items are growing; supplier buy-back agreements for structural components are currently being explored”.

Design for Disassembly and Circular Business Models foster circular material loops as they allow to valorise components before they reach the end of their technical service life, through maintenance and remanufacturing, resell and reuse. These principles to overcome the discrepancy between our conventionally static building stock and continuously changing demands, strongly relate to the ideas of ‘reuse’ and ‘recycling’ in the Ladder of Lansink (p. 26-27).

3.3. Design for Change

Design for Change is a design and construction practice that acknowledges the continuously changing requirements and aspirations of individual users and society. It builds on the idea that by anticipating future alterations from a building’s design onwards, is it possible to fulfil changes in user needs and demands with non-invasive and responsible construction. Accordingly, it aims to play a key role in reducing the environmental impact of the construction sector and in achieving a genuine sustainable and circular building economy[23].

Today more than ever before, circularity is on the agenda. This material management strategy is embedded in the European, Flemish, Walloon and Brussels policy and is increasingly addressed in the architectural assignments issued by regional and local authorities. With the launch of the Brussels Regional Program for a Circular Economy (BRPCE), Brussels has even become part of a leading group of regions aiming to stimulate an economy of closed material loops in construction and other sectors.

A circular economy is defined as a continuous positive development system, that is restorative and regenerative by design and keeps components and materials at their highest utility and value at all times. The Ellen MacArthur Foundation explains: “as envisioned by the originators, a circular economy is a […] development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows”. While seeking short and long-term value for all actors involved by decoupling economic growth from resource consumption, a circular economy questions conventional values and procedures.

Circularity and the Climate

As mentioned above, the material flows and waste production initiated by construction, have undeniable consequences, locally and globally, today and in the future. Think of the destruction of fertile land and toxic pollution. However, one impact that gets the most attention today is the climate change human activities cause. And yes, construction contributes to global warming too. Not only the consumption of fossil fuels to heat our buildings is responsible for the exhaust of greenhouse gasses, also the production of construction materials and the incineration of demolition waste plays an important role.

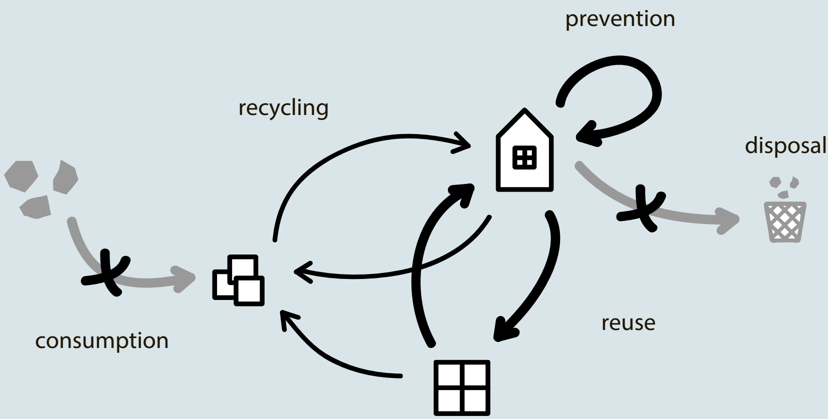
With their policy paper An Van Pelt, John Wante and Luk Umans show that the transition to a circular economy is a transversal shift with the potential to reduce energy consumption itself, supporting the climate objectives[25]. In addition, they identify circularity as a strategy for climate adaptation. “An economy that uses fewer materials, less water, land, energy and food is more robust and can adapt better to the effects of climate change,” the authors state[25]. For the European countries researched in the OECD study Greenhouse Gas Emissions and the Potential for Mitigation from Materials Management all material-related processes, including the production of goods and fuels, transport of goods, food production and storage and waste processing, account for about 55 percent of total greenhouse gas emissions. From this observation, it follows that the circular economy could be an effective mitigation strategy for climate change. Concretely, the direct and indirect savings the authors identified are:

First, a longer service life or the shared use of products ensures that fewer products are necessary to meet the same demand. This means that CO_2 savings can be achieved in production, transport and waste processing.

Second, in the choice of raw materials for products, various circular strategies are possible for generating climate gains. For example, products made from recycled materials could yield CO_2 savings since they prevent the extraction and transport of primary materials.

Third, the use of rapidly renewable raw materials rather than fossil-based resources in industrial processes, including for example the production of bio-based goods, can lower those processes’ and goods’ carbon footprint. Moreover, bio-based products can temporarily store CO_2.

“Focusing on the circular economy and therefore on using materials sparingly and trying to keep them in loops for as long as possible, is an obvious strategy for climate mitigation," conclude Van Pelt, Wante and Umans. "Through a circular economy we achieve a double profit: we limit the pressure on the (scarce) resources of the earth and we simultaneously save on the emission of greenhouse gas".



To maintain the value of buildings' components over time, one can use them in closed loops.

The Ladder of Lansink

The Ladder of Lansink, also known as waste hierarchy, is a standard to discuss and deal with waste. Also called the waste hierarchy, Lansink's Ladder distinguishes five forms of waste management: prevention, reuse, recycling, recovery and disposal. The Ladder was filed as a Dutch policy directive in 1979 and left a permanent mark on the Dutch and European waste and material management sector.

Lansink's Ladder not only distinguishes five forms of waste management, it also orders them. Article 4 of the 2008 Directive of the European Parliament and Council on Waste states that this "waste hierarchy shall apply as a priority order in waste prevention and management legislation and policy".

Waste prevention is all about avoiding waste from arising. Equivalent to 'bring your own shopping bag to the supermarket' would be to 'use an existing building, rather than to build a new one' and to question 'do we need a building at all?'

Product reuse is using a product again for the same or another purpose for which it was made. Like a beer bottle that is refilled, or clothing and toys that go to a next user, we can also refurbish an existing building and use second-hand construction products.

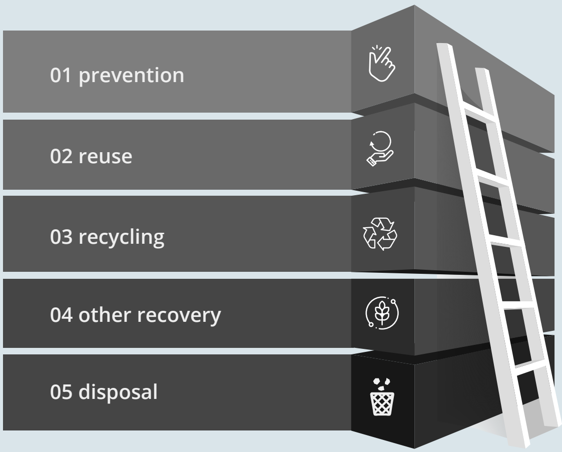
Material recycling is all about retrieving 'raw' materials from old products and using them in the manufacturing of 'new' products. Like glass in the bottle bank, of which new jars are made, also insulation materials and building boards are made of waste flows such as clothing or wasted wood.

Other recovery includes any operation during which waste serves a useful purpose by replacing other materials which would have been used to fulfil another function, including the reclamation or regeneration of chemical substances by for example composting or energy recovery.

Disposal on garbage dumps is the least desirable option, and no longer permitted in some, but not all European countries. Commercial waste, such as (contaminated) soil, residues from waste incineration plants and asbestos-containing debris, are still deposited in a controlled way.

Several scientific studies adopting environmental life cycle assessment methods have confirmed this order, but often warn for unintended and unanticipated consequences or rebound effects, such as increased transport distances, unhealthy processing conditions or contamination of products[26].

Since 2008, the Lansink Ladder is included in the European Directive on waste (Waste Framework Directive) as the guiding principle which subsequently has been implemented in the Brussels waste ordinance of 2012. This means that all governments and private actors in Europe and Brussels must be guided by the ladder when generating and processing waste. The first measures in Brussels' waste policy pursued the collection and elimination of waste through incineration or landfilling. This was followed by the evolution towards energy or material valorisation. Today, the challenge is to climb higher on the Lansink ladder by focusing more on prevention by design, reuse by remanufacturing and recovery by for example composting and industrial synergies.



Lansink's Ladder, submitted in 1979 as a Dutch policy guideline, ranks five forms of material management.

The H-Bench, developed by Studio Segers for ECO-oh!, is a robust and modular piece of furniture made from recycled plastics. Following their nomination for the Herny van de Velde award, the bench was exhibited in Bozar. (photo: Waldo Galle)

4. Understanding Who Might Profit

To foster the transition towards an alternative model, gains and losses of all must be balanced.

In conventional construction, many actors are involved. Architects and engineers conceive the building according to the requirements of the users and property managers and, simultaneously, financiers and real estate agents are collecting the financial resources. Later, the building is constructed by various contractors. The products they use are produced and delivered by a plethora of material suppliers and manufacturers. The whole process is supervised by governments and their trustees representing the interests of the larger society.

To succeed in the transition towards a more adaptable and circular building stock, each of those actors will have to change some expectations and habits. After all, systemic shifts do not take place if not all parties are involved. Therefore, each of them must see advantage, in one or the other way, in the transition and give a renewed meaning to its role. The following Brussels testimonials illustrate the interest in a circular built environment by various actors in construction.

4.1. The Owner-Developer-User

The case of BEFIMMO

As one of the actors in the value network of the built environment, professional portfolio managers and real estate operators such as Befimmo maintain a long-term engagement with their buildings. “It is exactly that engagement that motivates the company to act in the most sustainable way as possible,” explains Emilie Delacroix, Head of Corporate Social Responsibility and Innovation at Befimmo. “The idea to consider the reuse of buildings and their components is one of the strategies for sustainability we recently identified during a stakeholder consultancy," she continues.

That sense of responsibility is not given by the government, requiring to build and manage buildings in accordance with closed material loops, nor by financers demanding for solely sustainable investments. In contrast, Befimmo's motivation to align a conventional business such as portfolio management with the UN Sustainable Development Goals is twofold.

First, it is about anticipation. "We see how tools for the quantitative assessment of the environmental impact of buildings are proposed to the construction sector in all Belgian regions and it would not surprise us if it gets a normative character soon or later," says Frédéric Tourné Head Environmental Management at Befimmo. "The same happened with energy performance assessments which we anticipated successfully". By testing emerging assessments and innovative construction strategies today, Befimmo wants to be a step ahead.

Second, motivation is found in the resulting risk management. Today, the company feels no urge to build with reclaimed materials, to refurbish rather than replace buildings, or to try reaching a zero-vacancy rate. Nevertheless, unsustainable buildings are valued less than average. The tipping point from which sustainable buildings become more valuable is considered just a matter of time. Not anticipating this mental shift by creating more adaptable buildings, holds a considerable risk according to Befimmo.

Moreover, the company is rethinking its value proposition. With a symbiosis of the technical, commercial and environmental expertise present in the company, Befimmo explores if it could offer additional services to its clients, improving how spaces are used, and thus how its portfolio is valorised by its users.

4.2. Designers

The case of CONIX RDBM Architects

Because a building does not reach its final state when it is built and handed over to the client, the architectural office CONIX RDBM Architects has an interest in a long-term involvement of the designer with the building project. "That is why M, standing for Maintenance, is part of our company's name", says Managing Partner Jorden Goossenaerts. "RDBM or Research, Design, Build and Maintenance, reflects the life cycle and user-centred perspective we aspire," he explains.

One motivation for their approach is the wish to make buildings last. A conviction that buildings should be really sustainable, be able to sustain and offer added value. That ambition goes further than optimising the operational energy performance, and tackles the building's contribution to the urban environment, its generality and versatility, and the complementary manageability. This resonates with Steward Brand's adage that a design is not the end but only the start of a building's life.

Today, clients also become more aware of the sense of long-term responsibility. Local and regional government agencies, real estate developers and investment funds ask increasingly often to demonstrate the long-term consequences of a design proposal: the total cost of ownership, but also the possibility to close material loops and foster reuse. Certainly, in DBFM contract projects, that life cycle approach is taken because responsibilities are centralised resulting in more thoroughly considered initial choices.

Moreover, a long-term engagement in building projects and a building's operation, would be an opportunity to restructure architectural practice. Spreading out the involvement of the designer over the life cycle of a building could generate continuous revenue streams, allowing to accumulate knowledge, optimise the design process and increase the resulting design quality. A far going shift in the designer's involvement, material management and contracts are therefore necessary.

"Building Information Modelling and Management might be the key to the long-term responsibility of architects for the buildings they designed. The insights such a model offers in combination with skills and expertise of building designers can initiate new ways of operating buildings and managing their components," concludes Goossenaerts.

4.3. Manufacturers

The case of Saint-Gobain

Today, many material producers question their role in the value chain of structures and construction materials. Saint-Gobain, a world-wide manufacturer of a varied series of building products, including glass wool sheets and gypsum boards, understands it might be vulnerable if it would be unprepared to the shift towards an economy of closed material loops, and recognises the leading role it could play in a sector-wide transition.

"Push-factors emerge quickly and have an unmistakable effect on the market," says Pieter Van Laere, Sustainable Development Manager of Isover, part of the Saint-Gobain group. Illustrative are the Danish directives tolerating only circular building products in public tendering, and the Dutch policy program for becoming a completely circular region in 2050. "In reaction, Saint-Gobain wants to give a supply-driven answer wherein materials are recycled and recyclable, reused and reusable".

For Saint-Gobain, circular economy is a driver for innovation. New recycling and remanufacturing techniques and processes, but also advances in supply chain management can yield crucial advantages. The competition for resources such as sand and gypsum is a key theme in that innovation. In that respect the company studies for example which 'urban' material flows can replace those of which the certainty of supply is discussed, and consequently

Like buildings, public spaces change regularly. During summer, the Poelaert square is transformed into a bar with deck chairs. (photo: Waldo Galle) how its activities and investments must be adapted to those replacements.

Altogether, anticipating trends is Saint-Gobain’s strategy to manage the risks that are related to society-wide transitions. “After a history of over 350 years, being a sustainable material producer not only implies we reduce the environmental impact of our activities,” says Van Laere. “As important is offering enduring value to clients and shareholders,” he continues.

Lacking concrete political directives, Saint-Gobain set its own course with the Sustainable Resource Management Policy it published in January 2016, entitled Toward a Circular Economy. That course is chief explains Van Laere: “Like a big ship, Saint-Gobain is not easily manoeuvrable, but it does have the robustness to be a forerunner in the transition towards a circular construction sector”.

4.4. Investors

The case of Triodos

In Belgium, about 70 percent of all households own the house they call their home. Private ownership is strongly encouraged by regional governments, although the price of houses and apartments has more than doubled since 2000. As a result, the affordability of housing becomes a challenge for more and more families. 13 percent of those who enter a loan, pay more than 40 percent of their income to a mortgage, and the past year 8 percent had difficulties paying fixed or additional housing costs. Moreover, in the Brussels Region, 43,000 families are registered on the waiting list for social housing.

A long-term loan, large amounts and a high percentage of the income that goes to the mortgage: these factors mean a risk, both for borrowers and banks. “This situation is unsustainable, neither in financial, nor in social terms,” says Didier Léon, Senior Relationship Manager Real Estate & Infrastructure at Triodos Bank Belgium.

In the frequently discussed transition towards an economy of closed material loops, opportunities are identified to make housing affordable again. When closing material loops by designing out waste, the value of a building is maximised over time. That could turn housing from a capital-intensive commodity into a sustainable investment. “In that case, the conventional mortgage, that must be repaid as soon as possible, is no longer the only option,” according to Léon.

Being part of the transition, it is necessary to find the right opportunities. Léon explains: “In real estate today, we focus on historical buildings and reconversions. We are convinced that the concept of sustainability reaches well beyond the energetic performance of a building. It covers a much broader scope including the neighbourhood, mobility, available space, and comfort of users. Exactly those qualities characterise historical buildings.”

Further, when companies, private persons and governments start investing in sustainable, circular estate together, that will be disruptive for the whole value chain in construction. Perhaps the resident will own only a part of his home and maybe he is no longer responsible for maintenance and insurance. Léon thinks of community land trusses and co-operative ownership. “They might seem unusual for us, but in Switzerland they are the new normal”.

“However, without reliable agreements, that change is not possible”, he emphasises. “Cooperative housing, even more than a mortgage, must be able to provide housing certainty. Transparent and simple contracts between all players are therefore required”. Léon concludes: “The return is not only financial. Buildings also generate social, cultural and ecological profit”.

4.5. Society

The case of Homegrade

Homegrade is the advice and guidance centre for housing in the Brussels-Capital Region. It is open for all citizens, both tenants and owners, who wish to improve the quality of their home. “Homegrade accompanies Brussels’ inhabitants for free in improving their homes and reducing the ecological impact,” explains Homegrade Advisor Sophie Holemans. “Our team of experts answers questions and, if required, guides families step-by-step, both technically, administratively and financially”.

“Because we see that many works are done by owners, and sometimes even by tenants, the purpose of Homegrade is to show citizens how they can apply the circular economy principles at their own level,” Advisor Guillaume Amand says. “By creating awareness and sharing information, we can change some habits; an effort which will eventually lead to savings in embedded energy of the materials consumed and in waste treatment”.

Already in 2016, Homegrade published the leaflet Renovate: Repair, Reuse and Recycle. A step towards a circular economy, and more information is accessible on their webpage dedicated to sustainability. “Transformation and reuse cannot be improvised but require correct information on how people can organise a project from A to Z,” emphasises Holemans, “and for that reason, the support of the Brussels-Capital Region is crucial”.

Recently, many items were added to the Homegrade toolkit, for example a poster on reuse opportunities, an inventory notebook for reuse audits, and an online video. These hand-on items are only 3 of the 30 tools that have been developed by the international consortium of the Citizens-4-Energytransition project. Their website also offers a carbon footprint calculator and educational games.

The advice and information that Homegrade provides coincide fluently with Regional Programme for the Circular Economy in Brussels, the facilitation programme Sustainable Building by Brussels Environment and, for example, their open calls for Be.Exemplary projects. “Each at our own level we can shape the transition towards a circular economy in the built environment driven by Brussels citizens,” concludes Amand.

During two panel debates architects and engineers were invited to take position against several hypotheses about Design for Change and circularity. (photo: Charlotte Cambier)

After being the master planner, the architect could become the master connector, linking together flows of people, experiences and materials.

The Architect in a Change-Oriented Construction Sector

A Brussels Perspective

The Brussels-Capital Region depends largely on other regions for the import of building materials and the processing of construction waste. In recent years the awareness of this dependence and the environmental impact of the building industry has increased rapidly and regional policy has initiated waste and material management programs as well as sustainability assessment methods[1]. These initiatives introduced to the architectural debate, among others, the *long-term value* of buildings, or the search for buildings and building components that remain relevant after the initial requirements that shaped them have changed.

Opportunity, or yet Another Constraint?

In the context of a growing interest in the long-term value of buildings and building components, concurring with the transition towards an economy of closed material loops, new policy guidelines and client requirements are gradually changing the architect's range of responsibilities. For example, demolitions must be preceded by reuse-audits without project delays, during refurbishments as many components as possible must be preserved while fulfilling new standards, or, new buildings must integrate materials in a reversible way. On some occasions, such demands are perceived as an opportunity to reduce the project's (environmental) cost and increase the building's long-term value. On other occasions, the same demands are perceived as yet another constraint, for example during very competitive design calls[2].

The position of the architectural designer towards these demands is not unimportant. After all their implementation depends primarily on their adoption by designers and contractors. But furthermore, the survival of the built environment professions, including architects, might depend on their response to the challenge of sustainability[3]. It is thus important to understand and overcome the apparent duality between architects' acceptance and rejection of circularity and the related Design for Change principles. To do so, we reviewed the added value of architectural designers in and beyond this ongoing transition.

This review is based on the observation of two panel debates organised in 2018 during the research project *Le Bâti Bruxellois : Source de nouveaux Matériaux* (BBSM – Brussels' Buildings : Source of new Materials)[4-5]. During these debates, the participating architects and engineers were invited to take position against several hypotheses, illustrated by their own projects (p. 40-43). Here, we present the outcome of these debates as three reflections. They respectively touch upon the architectural designer's responsibilities, skills and new role.

While these reflections do not cover all possible needs of the architectural designer in a change-oriented construction practice, they serve as a starting point to understand the aforementioned duality: a state-of-affairs collecting insights of forerunners, allowing more architects to get inspired to rethink their role and practice.

An Architect's Responsibility

Since architects provide a wide set of services, their work involves a high degree of responsibility towards their clients and society[6]. Because of that responsibility, the profession of the architect is regulated in its own specific way, in Belgium by the Architects Act of 1939. The Act introduces a protected title that formally distinguishes the architect's design task from the contractor's commercial activities, to guarantee that architects advise their clients independently[A/6]. The Act also specifies that an architect's involvement is mandatory for "the design of the plans" and – exceptional in Europe – the "supervision of the execution of the works"[7], effectively establishing a monopoly for architects for such tasks. Today however, the responsibility of the architect is challenged by a further broadening task and new forms of collaboration in construction.

The architect's monopoly does not cover all their regular tasks, which also include construction planning, estimation and expertise[6]. Moreover, regulations require architects to implement knowledge on specific themes such as energy and water use or building safety and health. While some architects flourish in these and others have found ways to delegate expertise, their broadening task often results in economically unviable working conditions and is perceived by architects as the most serious threat to their profession[B/8-9].

Additionally, the legal responsibility of the architect is challenged by DBFM (Design, Build, Finance, Maintain) and IPD (Integrated Project Delivery) projects. Such collaborations are becoming increasingly popular and have proven to be useful and efficient abroad[10]. Yet, because of the Architects Act, there is no legal ground for such collaborations in Belgium[C]. In these collaborations the client enters into a contract with a team of construction professionals through one leading party[9]. The Architects Act strongly disadvantages architects in such agreements, as they cannot legally establish contracts with contractors. Financially and in terms of content, the architect is therefore in a weaker position compared to other construction partners[D/9].

These challenges require us to review the added value of architects. To do so, let us start with a broadening perspective on design. According to Nikolaas John Habraken, being an actor of the built environment means to have “the ability to transform some part of that environment”[11]. The search for the architect’s responsibility, legally defined as “the design of the plans”, or more generally making design choices, is then turned into a reassessment of his or her ability to transform the built environment[E]. Moreover, studying the architect’s role in a change-oriented construction sector, our interest extends to his or her ability to enable transformations. Confirmed by the projects that participating architects presented during the panel debates, that ability relates to design choices at two levels.

The first level of design choices relates to the way buildings are shaped. This shape determines how they can and cannot be used, how easily they can be adapted, and thus how fast they will become obsolete[12-13]. That is illustrated in the work of BAST architects & engineers[5]. Their study for the refurbishment of the youth care centre Ten Dries in Sint-Denijs shows that the choice for spatial generality facilitates transformations but is no guarantee that a building’s enduring value is positive. That is aptly demonstrated by the old building currently in place: spatially generous but detested by the local community because of the centre’s troubled history. This emphasises that in addition to functional changes, also the meaning and expression of a building should be designed to evolve over time.

At the second level design choices define how buildings are materialised. They determine the initial performance and durability of the building, as well as how easily its components can be recovered and reconfigured[14-16]. That is illustrated by the collaboration between KPW architecten[4] and academic researchers[17-18]. The life cycle analyses the latter made for the redevelopment of the Gandhi neighbourhood in Mechelen and the refurbishment

Johan Anrys (51N4E) - Art centre Buda in Kortrijk (refurbishment, extension)

Johan Anrys (51N4E) - Care homes Grootkapel in Beersel (new-build)

Johan Anrys (51N4E) - Social housing Peterbos in Anderlecht (refurbishment)

Olivier Breda (Dzerostudio Architectes) - Greenhouses Tomato Chili in Brussels (reclaimed components)

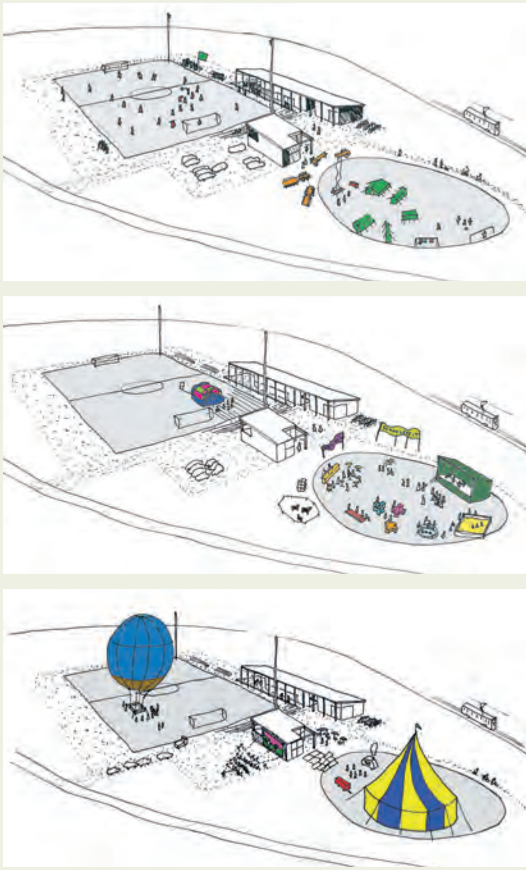
Olivier Breda (Dzerostudio Architectes) - Plug-in offices City Gate in Anderlecht (reclaimed components)

Pieter Walraet (KPW architecten) - Social housing Gandhi neighbourhood in Mechelen (new-build)

Pieter Walraet (KPW architecten) - Social housing Hoogbouwplein in Zelzate (new-build)

Pieter Walraet (KPW architecten) - Youth centre Oude God in Mortsel (new-build, reclaimed components)

Jorden Goossenaerts (CONIX RDBM Architects) - Mixed-use Multi (former Philips tower) in Brussels (refurbishment, reclaimed c.)



Pieter Walraet (KPW architecten) - Youth centre Berg ter Munt in Tervuren (new-build)

Jorden Goossenaerts (CONIX RDBM Architects) -
Care homes Keyhof in Huldenberg (new-build)

Geert Verachtert (Van Roey) - Sports centre
Sportoase in multiple locations (new-build)

Maarten Vanderlinden (BAST architects & engineers) -
Child care centre Wiegelied in Ostend (new-build)

Maarten Vanderlinden (BAST architects & engineers) -
Youth care centre Ten Dries in Sint-Denijs (refurbishment)

Simone Valerio (KADERSTUDIO) - Single dwelling
Asper in Gavere (new-build)

Simone Valerio (KADERSTUDIO) - Mixed use Learning from Tubize in Tubize (urban redevelopment)

Kathleen Van de Werf (BUUR) - Living Lab Potterij in Mechelen (refurbishment)

Kathleen Van de Werf (BUUR) - Hospital campus Circular Care Campus in Antwerp (urban redevelopment)

Jan Laute (AAC Architecture) - Urban intervention Au ReTour in Brussels (reclaimed components)

Jan Laute (AAC Architecture) - Office interior AAC Architecture's own offices in Brussels (reclaimed components) of a social housing block in Zelzate show that alternative design solutions adopting Design for Change principles can reduce the (environmental) cost of future transformations. Nevertheless, the outcome strongly depends on the solutions' technical characteristics including reversibility and durability, and their implementation strategy which can be idealistic or more reserved.

Making responsible design choices at both levels is nevertheless in the architect's realm. Three tasks, illustrating that, were highlighted during the panel debates. First, like every architectural project, change-oriented design requires rigorous research. Conventional design analyses remain chief or gain even more importance in the light of new demands. Such analyses assess, for example the accessibility of spaces and technical services, or the net-to-gross floor area ratios[CONIX RDBM Architects in 4]. Second, the implementation of Design for Change principles requires creativity and conception. Because the spatial, technical and financial context of every project is different, a one-size-fits-all solution does not exist but requires good designers[KPW architecten in 4]. And third, transmitting project knowledge and insight into the design's long-term value to the future user is considered an indispensable task too[F/Van Roey in 4].

An Architect's Skill

René Heijne and Jacques Vink state that conventionally, "designers have been trained along functionalist lines […] with a clearly described brief", but that the need to address change introduces a challenging design task because "both the future use and its users are largely unknown"[19]. Accordingly, in a change-oriented construction sector, a designer's skills, including methods and tools, need to be much broader than the mere articulation of function and space. Some of these competences have been identified by Stephen Kendall when educating architects in the United States; they include the ability to grasp underlying principles, design with constraints, conceive without program and implement research[G/20].

The need for new or altered skills was also discussed during the BBSM debates. Some were identified as an opportunity for architects, such as the need for insight into the complexity of both society and construction (cf. research task), the ability to imagine and depict present and future values, needs and solutions (cf. conception task), or the skill of discussing and negotiating the solutions at the table (cf. transmission task). Aside from opportunities, the panel discussion also highlighted risks. Both are illustrated by the following four conclusions of the debates.

- Designing according to Design for Change principles challenges architects to answer current and future needs by using existing spaces and components. In Belgium's refurbishment-oriented practice, architects are already skilled to manage that constraint[Dzerostudio Architectes in 4].

- Design for Change requires designers to think in systems of building components. Today, they already design with products and elements, not with raw materials. Using systems creatively must therefore be capitalised as an architect's asset[KPW architecten in 4].

- When seeking long-term value, life cycle thinking is crucial. It is exactly the architect that has the skills of supporting and encouraging a well-considered management of the building: they can depict future needs, enable dialogue, and build alliances[CONIX RDBM Architects in 4].

- Currently, architects rely increasingly often on contractors for material choices and technical solutions. However, in order to be able to conceive innovative circular design, architects will have to renew their knowledge about construction[51N4E in 4].

Furthermore, in the early history of change-oriented building design, architects showed great interest in specific methods and tools enabling relevant skills. Referring to the work of SAR (Stichting Architecten Research), Kendall explains: "to handle the complexity of levels of intervention, distributed control and change, Open Building practitioners applied particular design methods. These include capacity analysis in the design of 'supports' or 'base buildings'; the use of zones and margins as a means of describing the limits of variation in spatial terms; and dimensional and positioning grids to facilitate communication between different parties each responsible for different building elements"[21]. During the two panel debates, we also observed the interest in emerging methods and tools of participating architects, illustrated by the following two aspects.

- Projecting divergent scenarios, plausible as well as surprising, allows evaluating the resilience and robustness of the design proposal at the table[22]. Designers must therefore imagine divergent user-paths and adopt a scenario planning method[KPW architecten in 4 - KADERSTUDIO in 5].

- Data-driven methods are indispensable to handle the complexity of circularity principles[CONIX RDBM Architects in 4] and vital to scout second-hand materials or assess their reusability[23]. Construction professionals could look at methods such as Building Information Management systems and Blockchain to ensure data transparency and quality in the construction process and building life cycle; managing data could even become a business[Van Roey in 4].

An Architect's Role

After analysing the responsibility and skills of the architect, this section reflects on the discipline's operational model, identifying options to make a renewed engagement for architects economically viable and valuable. In literature and during the panel debates, limited viability and reduced competitiveness were identified as issues slowing down sustainability forerunners[24-25]. However, if the whole economy transforms towards a circular one, it is conceivable that the architect's position in the value network of construction must change too[4].

In 2014 Rotor DC recovered from the modernist 'Institut de Génie Civil' in Liège more than 1 000 m² of floor tiles produced back in the 1930s. (photo: Olivier Beart)

Today, architectural designers are using increasingly diverse knowledge and different design methods (cf. first and second reflection). However, in the already saturated market of architectural professionals, that work is not rewarded financially[9]. Looking at the value network of construction, that might be explained by the fact that the architect's engagement represents only a short period relative to the long-term impact of their choices. During the panel debates, several initiatives in other construction disciplines were identified as opportunities to also change the architect's position. We identified two dimensions along which new business models are emerging: shifts in short and long-term engagements, and shifts in direct versus indirect (design) services.

First, as implied by the Belgian Architects Act, architects deliver a design and support only the construction process. Rather than handing over all knowledge at the end of construction, a designer could profit from the developed insights throughout the building's service life[CONIX RDBM Architects in 4]. In Belgium and elsewhere in Europe, long-term engagements are being established. For example, contractors participate in DBFM projects and service providers offer performance-based refurbishment contracts[26-27]. Moreover, consultancy firms propose to offer guidance "through the entire real estate life cycle"[28]. They seem to fulfil a need that was identified by René Heijne and Jacques Vink: "Flex-buildings require active management. Besides the day-to-day business of upkeep and repair, there needs to be a policy for the building's fit-out. This includes deciding which users and uses are desirable and in which proportions"[19]. They seem to imply that a part of the design responsibility – including research, conception and transmission tasks – is shifting from the design phase towards the operational phase of a building's service life.

Second, a conventional Belgian client is usually both the investor and the future user. In a circular and service-based economy this is no longer evident. If infrastructure is shared, components rented, or materials leased, the owner will not necessarily be the user, let alone the facility manager. Each of these positions can be taken by different entities, each with their own objectives and needs. One future role for architects might be to align those objectives and needs. After being the master planner, the architect could become the "master connector", linking together flows of people, experiences and materials, offered as a service to the investor[BUUR in 5]. Alternatively, the architect might take the position of developer and manager of general infrastructures and adaptable infill systems according to Design for Change principles; this would be an indirect design service – though direct design consultancy will still be necessary to implement such systems. Today, some Brussels practices already demonstrate this shift. They have led to the development of specific skills, such as consultancy on reclamation and reuse, or as disassembly and resell of construction components[29] or expertise about specific construction techniques, for example the design and construction of rammed earth elements[30]. Considering

Situated along the canal in Sint-Jans-Molenbeek, the site of the former Belle-Vue brewery could be redeveloped while conserving the old malt-house. Arch. L'Escaut architectures (photo: François Lichtlé)

the boundary conditions set by the Architects Act, such alternative engagements are, however, not obvious for architects.

Towards a Change-Oriented Construction Practice

A growing interest in Design for Change and circularity principles has changed the design requirements of policymakers and clients. Reviewing the role of architectural designers, in and beyond this ongoing transition, rendered interesting points for discussion. First, enabling future transformations of the built environment was identified as a key responsibility of architects. Therefore, research, conception and transmission were identified as complementary design tasks for the architect. Second, the added value of architectural designers is not limited to “the design of the plans”. Their insight into the complexity of both society and construction, their ability to imagine and depict present and future needs, and their skill to discuss and negotiate solutions are of great value during the implementation of circularity. Third, a shift in short and long-term engagements, and in direct versus indirect design services, sets the solution space of a renewed, more viable position of the architect in the value network of construction. All together, these findings demonstrate the potentially significant role architects can play in a construction sector shifting towards a circular practice[H].

These findings are also a starting point for a more exhaustive discussion about the renewed role of architectural designers, not only involving architects, but also academics, sector organisations and policymakers. Changes in legislation, business models, professional skills and attitude must be reviewed too. Moreover, for the architect of today, designing with and for reuse is based on experimentation and learning. During the BBSM debates, finding the right project setting – exploiting opportunities and mitigating risks – was identified as a crucial attitude towards that experimentation. Accordingly, if architects will need to experiment more, they need to be taught the skills and insights necessary to shape change-oriented buildings. So far, many of the existing examples relied on the individual experience and interests of the involved designers and their clients. For that reason, the transfer of insight and experience, through education or sectoral networks, will be crucial to profit from the identified potential. Simultaneously, policymakers could work with and learn from forerunning architects, understanding and acting upon the necessary legal adaptations in relation to a changing architectural profession, especially to safeguard economic feasibility and fair competition.

Notes

A Both architect and contractor can nevertheless be held liable for defaults in the building for a period of ten years after completion of the work.

B After noting the same already in 1998, Nikolaas John Habraken reflected on the possibility that this is exactly the result of many architects' ideology: "clearly many decisions [...] are simply beyond the scope of the designer. Nonetheless, architectural design ideology steadfastly favours fully vertically integrated design. With ongoing industrialisation and systematisation, building design is increasingly a matter of selecting and combining"[11].

C Variations of DBFM and IPD projects have already been used on a large scale in Belgium, e.g. in school projects. In these variations the architect does, however, not profit from the shared risks and efficiency gains, but is involved into summons against the initiating government agency issued by the Architects' Order[9,31].

D Lorenzo Van Tornhaut concludes that "the architect has been forced by the evolution of the building process to cooperate with multiple parties and to give up parts of his sovereignty. Nevertheless, the architect remains the one who (obligatorily) plays a central, coordinating role"[9] that while "the exact role of the architect has become unclear"[6]. As a result, the idea to abolish the Architects Act is being raised again[32]. Simultaneously, the number of turn-key projects rises increasingly faster[33]. In addition to the competition amongst peers, these projects are identified as a major economic threat for architects[8 in 6].

E Transformation as the basis of the designer's role, is framed further by Asko Sarja's observation. He states that design and architecture are culture-related parts of a larger mechanism: "the objectives and targets of construction are defined by the general politic of each society in relation to the environmental, sociological and economic objectives. Underlying this development and specific to each region and society is a heritage of culture, arts and architecture. The advancement of knowledge is served by natural sciences, engineering sciences and general technology and is transferred to building technology through building design, production and product development. The entire evolution is strongly governed by market forces and company operations"[34].

F Or as Bernard Leupen illustrates: "durability is not only a question of applying sustainable materials and sturdy constructions but of treating these with great care. If the frame commands respect, the user will look after it better. At the same time, the frame can become its own set of instructions"[35].

G Also in Belgium, the skills, insights, methods and tools an architectural designer should master, are discussed recurrently. For example, in education it remains undecided if training in accounting and project management should be part of the architectural curriculum[36-37, 8].

H This conclusion reminds us of Nikolaas John Habraken's critique: "the masters of the avant-garde such as Le Corbusier, Mies van der Rohe and also Frank Lloyd Wright taught us by example that full vertical control, including even the design of furniture, was necessary to achieve good architecture. [...] We have been educated in a tradition that was ignorant of the used of levels in urban form. [...] Our present interest in time-based building seeks a remedy to the rigidity and uniformity that comes from excessive vertical control"[38].

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Old mill building Moulart along the Canal in Anderlecht was transformed reservedly into an economic and cultural attractor where people work and learn. Arch. Bogdan & Van Broeck (photo: Waldo Galle).

5. Linking Needs and Ambitions

Altogether, needs and ambitions seem strongly related.

Can they be tackled by a single shift?

What are the limitations and obstacles for a built environment that is designed for change, and where do different construction actors find common ambitions? Identifying those threats and opportunities was the goal of three co-creation sessions with representatives of the construction value network. The outcome is structured per discussion and topic and offers some starting points for circularity forerunners.

5.1. Practice and Innovation

For decades the Brussels' construction sector has been investing in knowledge and innovation. After the transition towards refurbishments and passive energy standards, it now invests in selective demolition, recovery, reuse and other activities to extend service lives and close material loops. "The sector is ready to take up the idea of a circular economy", state the participating representatives of the Belgian Building Research Institute (Ambroise Romnée, Project Manager) and the Brussels Construction Confederation (Lara Pérez Duenas, Circular Economy Advisor and Hugues Kempeneers, Sustainable Construction Manager). However, forerunners rarely receive the space and time to bring their ideas into practice. "This is the result of the saturated and competitive market contractors act in," they explain. Only a few examples, many of them are laureate of the Be.Circular call, could demonstrate what is already possible. For example, some contractors are training a 'valoriser' to harvest reusable components before demolition. Characterised by a mix of only a few large, many small and a lot of self-employed entrepreneurs, the construction sector is concerned about the accessibility to innovation by all actors. "The last decades, innovation has led to increased differences between and specialisation amongst smaller and larger contractors," the Brussels Construction Federation knows. Some larger ones can specialise in for example prefabrication, a market-wide practice, while smaller ones had to become experts in for example renewable materials, a niche. Proposing Building Information Management and Material Passports as a necessity for the circular economy is therefore considered a risk for the sector, states the federation. Rather, smaller and accessible tools such as Werflink, an online sharing platform on which construction companies can share equipment, materials, freight space and facilities, are considered useful. "It can be used on a project-by-project basis, limiting the administrative burdens that might be related to circular material management", the participants explain.

Similarly, the increasing interest in evaluating and labelling the 'level of circularity' of products and projects, must be judged case-by-case. Whether such a label is quantitative or qualitative, it could offer designers and contractors the opportunity to valorise the added value they create. In a competitive market this is important to distinguish best practices from business-as-usual. However, "such labelling should not become mandatory or be integrated in tendering documents and biddings", the participating representatives of the construction sector say. After all, though labels and evaluations might allow better-informed choices, it is in the collaboration and creativity of the designers and contractors that innovation can take place.

5.2. Material Banks and Research

Rather than finding feasible ways to valorise debris, anticipating waste and activating so-called dormant material stocks already present in the built environment is considered more effective and efficient by the participating researchers and experts including Michael Ghyoot (Rotor), Émilie Gobbo (UCL), Aristide Athanassiadis (ULB) and Camille Vandervaeren (VUB). Considering buildings as material banks represents a window of opportunity, a buffer for matching material supply and demand. While proving their value, materials are waiting for their next life cycle stage: waste will be food. However, to exploit this potential, better insight in the materials present in the building stock and their active management are indispensable.

Proceeding from industrial ecology, i.e. a discourse that seeks to understand complex integrated human-natural systems, the idea of Urban Metabolism should be seen as a lens to study the built environment and the materials it holds, "not as an instrument to manage them," expert Aristide Athanassiadis states. Urban Metabolism is an urban environmental assessment technique that provides a synthetic view of flows entering, being used and leaving the urban system.[27] Though challenging, by mapping material flows, processes and powers, identifying contextual relations and maintaining a multi-disciplinary approach, the lens of Urban Metabolism facilitates sustainable decision making, including closing material loops.

Identifying challenges and opportunities, failures and successes in the many smaller initiatives in the Brussels-Capital Region, allows creating awareness, and further supports the development and implementation of alternative, more sustainable design and construction choices. Therefore, adequate and reliable product assessments and experiment evaluations, by for example Life Cycle Assessments, Urban Metabolism studies or Disassembly Network Analyses, are indispensable, claim the researchers: "To make the circular construction economy happen, also the loop of knowledge must be closed". Engaging science with all individuals and society, has the potential to upscale the many sustainable experiments and accelerate the transition.

5.3. User Needs and Policy Opportunities

"In new business approaches such as DBFM projects, cooperative ownership, or service contracts, lays an opportunity to increase the utility of building components; simply by formulating our needs differently," put forward the participants of the third co-creation workshop, Lara Pérez Duenas (Construction Federation Brussels), Yannick d'Otreppe (Brussels Environment) and Lionel Devlieger (Rotor). Is it for example possible to tender for reuse, write performance-based briefs or share buildings and materials. "Unfortunately, the complexity of current legislation hampers innovation in the habitual roles the different construction actors play," state the participants. "In private construction, confidence between construction actors is the key to successful sustainability innovation in many best practices," they agree. The participants emphasise further that the collaboration of policy makers with architects and their associations is historically limited but could strengthen that trust considerably.

Further, innovative contracts and procedures must be as reliable as conventional ones to avoid risks for the client, designer and contractor. This requires research and development, and thus time and money. In every-day practice, those resources are scarce. Accessible knowledge and assistance are therefore an important leverage for the implementation of material reuse. As an example, Rotor's vade-mecum about off-site reuse of construction components or the assistance of over 100 construction projects and companies in the context of the region's plan for the circular economy, have led to hundreds of best practices since 2016, among which Tomato Chili. If this results in a circular economy and a market of projects that are designed for change, remains, however, an open question, according to the participants.

Creating trust through open communication and supported by a network of professionals is therefore one of the main tasks the Brussels' Construction Federation and Brussels

Decade after decade, with new needs new elements are added to the city such as the baths of Brussels. This heritage of tomorrow presents us with many choices. (photo: Waldo Galle)

Environment take on. To foster reuse and innovation in practice, initiatives such as CityDepot, Recy-K and Greenbizz bring construction actors together, resulting in symbiosis and eventually in the reuse and remanufacturing of materials and products. “Enabling and supporting these initiatives is the real power of local and regional governments to foster innovation further,” the participants state.

From its platform, neutral and open to all stakeholders, **CityDepot** offers the ‘carpooling of goods’ to and from the city; and proves that it can be much more environmentally friendly and economical to collaborate than to transport one’s own goods.

The **Recy-K** project presents itself as an experimental platform; an open ecosystem that integrates a multitude of actors from the institutional world, researchers, artists, low-skilled collaborators, etc., accelerating together a social and circular economy through training and socio-professional reintegration.

Greenbizz provides companies and start-ups with an area of 8,000 m^2 of facilities and services to create and develop their sustainable projects. The goals include boosting sustainable economic sectors and supporting sustainable business initiatives by offering start-ups an optimal environment.

In addition, “eco-innovation and research in construction are promoted by regional agencies,” emphasise the participants. For example, EcoBuild. Brussels, the cluster for sustainable construction and renovation in Brussels, focuses particularly on energy efficient retrofitting and the circular economy. It brings together all construction actors from companies and craftsmen, to universities and professional associations, across areas including architecture, engineering, manufacturing and real estate development. The participants confirm that “the main missions of EcoBuild include the organisation of networking events, fostering relations among its members, dissemination of good practices, as well as training and advice.”

After shedding light on circular alternatives, many questions remain. Which do you want to be answered, or could you answer yourself?

Isa Genzken's 'Camera' is installed on top of a five-story Art Nouveau building in Brussels that houses the art gallery Greta Meert. Arch. Louis Bral, Robbrecht & Daem (photo: Waldo Galle)

6. Broadening perspectives

What allows 'controlling' building life cycles?
Intensive collaboration between companies or a single manufacturer?

What should accelerate the circular economy?
Policy measures, binding (eco)directives, or free market power?

What is the legal, economic and ecological space of a circular construction sector?
A local, regional or (inter)national market?

What is society's relationship with materials?
Continued right of property, or a lease-based society?

What is the involvement of construction in other sectors and vice versa?
Closed loop reuse, or a web of complex interdependencies?

What is the new durability ideal?
Will buildings be more generic or more adaptable? Components reusable or renewable?

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Buildings, a Dynamic Environment

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This document could be further developed and updated as new insights become available. The authors do not warrant that the content of this booklet is accurate, complete or up-to-date. Instead, readers are invited to share their suggestions and insights on www.vub.be/arch/circulardesign.

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To create awareness and empower the construction sector in its transition towards an economy of closed material loops, this publication proposes a holistic framework. It is the result of a series of observations, interviews and co-creation sessions with different construction actors, including architects and contractors, researchers and policy makers as well as building users and managers. Introducing buildings as a dynamic environment, this publication points out the challenges and opportunities for a circular built environment in Brussels and beyond.

Grasp buildings as a dynamic environment and discover the challenges and opportunities of a circular construction sector.

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