Research Plan

Tslil Strauss

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"*… our economic system and our planetary system are now at war. Or, more accurately, our economy is at war with many forms of life on Earth, including human life. What the climate needs to avoid collapse is a contraction in humanity's use of resources; what our economic model demands to avoid collapse is unfettered expansion. Only one of these sets of rules can be changed, and it's not the laws of nature*."

— Naomi Klein in *Critical Care: Architecture and Urbanism for a Broken Planet* (2019, p. 13)

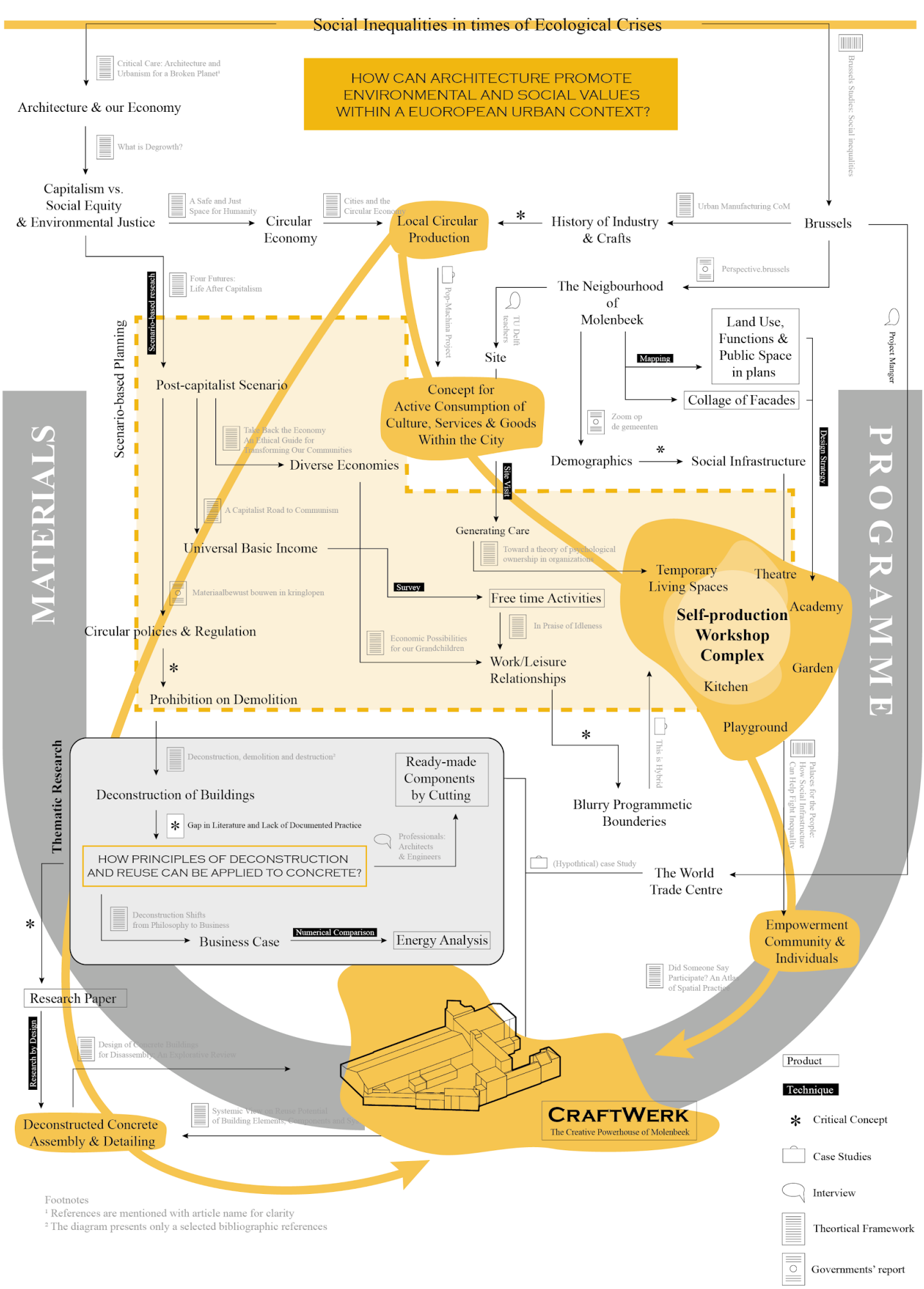

Figure 1: The research structure with the parallel research tracks

Keywords: Circular Economy, Economic System, Architecture, Concrete, Urban community, Self-production, Empowerment

Note: key terms in Italic link to the *glossary*

Problem Statements & Research Questions

In recent years academic literature and scientific research critique the global capitalist system, which thrives on constant growth, to be in conflict with ecological and social considerations (Architektur Zentrum Wien, 2019; Yuan et al., 2011; Gibson-Graham, 2013). It is argued that capitalism is driven by corporate profits, over-production and excess consumption. As a result, it often ignores environmental approaches for a more sustainable use of Earth's resources, as well as social approaches that prioritize *social equity* and well-being. One example is *The Degrowth movement*, a group of activists and researchers that calls for "*a shift in common values towards care, solidarity and autonomy*" (What Is Degrowth?, 2020).

The proposed research aims to position architecture, its role and potential impact, in relation to these economic, environmental and social issues. The overall design question is **how can architecture promote the defined environmental and social values within an urban community?** Due to Covid-19 and travel restrictions, a focus on Europe helps to narrow the question to **how can architecture promote these environmental and social values within a European urban community?**

Operating within the conventions of *circular economy*, as an alternative for the current *linear economy*, this project sets out to promote the responsible use of natural resources, as well as equal distribution of primary social goods (i.e. rights, liberties, income and wealth) and empowerment of urban communities. Integrating these environmental and social values, the architectural brief revolves around **local self-production**. This concept will be developed throughout the project using a specific site as a case study: a former industrial area in the low-income neighbourhood of Molenbeek in Brussels, Belgium. This site was chosen due to the rising inequalities in Brussels over the recent years, expressed among others in large gaps in income and high rates of unemployment next to "well-paid transnational elite" (Kesteloot & Loopmans, 2009).

According to the structure of the Architectural Engineering studio, a technical thematic research pertaining to the overall design question is executed and concluded with a written academic paper. The thematic research focuses on the life cycle of materials in the built environment. The construction sector has a significant role in the transition to a *circular economy*: the integration of *deconstruction* practices, and the *reuse* of deconstructed elements, would allow a circular flow of materials. It is of high importance to expand and develop activities of *deconstruction* to include concrete, as it is the most dominant material in our built environment (Preston & Lehne, 2018), with an annual production of 33 billion tons of concrete (Strategic Business Plan Iso/Tc 071, 2016).

The thematic research concerns the *reuse* of deconstructed buildings as part of a circular approach towards natural resources. Hence, the thematic research question I pose is **what actions will be required to bring about a transition from conventional *demolition* to *deconstruction*?** Developed further via the sub questions; **how does deconstruction relate to our current economic system? What technical and managerial developments could support such a transition?** And **how can principles of deconstruction and *reuse* be applied to concrete?**

Theoretical Framework

The project integrates the principles of *circular economy* together with the theory of *Diverse Economies*, introduced by J.K. Gibson Graham (2013), which offers a more socially-oriented approach. The *diverse economies* theory calls to reframe the economy by recognizing the diversity in economic activities in our world rather than focusing merely on wage labour as the sole activity driving our economy.

The project's conceptual framework, presented in the table below (fig. 2), incorporates environmental and social aspects of the architectural practice throughout its stages: `Construction & End-of-Life` and `Operation`. Two parallel research tracks are formed: **circular building** which explores the ways construction, and deconstruction, can become circular in terms of material use while practicing *care* in terms of labour; and **building circularity** which explores the desired programme to allow for (circular) diverse economic activities and opportunities for weakened social groups. In other words, **circular building** is about practicing architecture in a circular manner, and **building circularity** is the potential of architecture to integrate circular habits into the daily life of its users. The structure of the two research tracks aims to address both ecological and societal considerations simultaneously, in order to create a coherent and comprehensive design proposal (fig. 1).

During MSc3 the technical thematic research focuses on material use. Parallel to the technical research a conceptual-contextual research is executed in order to understand the architectural programme as a means to encourage circularity in day-to-day user activities within the specific context of the selected site. In MSc4 the focus will shift to the implementation of circular principles and *care* to the labour and energy requirements of the building.

	Construction & End-of-Life	Operation
Research track	**Circular building**	**Building circularity**
Environmental	Materials Technical Thematic Research	Energy demand
Societal	Labour	Programme Conceptual-Contextual Research

MSc3 MSc4

Figure 2: Conceptual framework and development of the research plan

Methodological Positioning

The overarching methodology for the project is *scenario-based planning*, used for both of the research tracks. Inspired by the book 'Four Futures: Life After Capitalism' (2016) by Peter Frase, different scenarios are imagined relying on the ideas of *circular economy* and *diverse economies*. In order to construct scenarios that will assist in gaining insight for the research as well as for the design, other theories are studied, such as philosophical ideas regarding work and free time (Russell, 2004) and the concept of *Universal Basic Income* (van der Veen & Van Parijs, 2006) as shown in the research diagram (fig. 1).

The defined scenario for the thematic research is one where *demolition* is prohibited as part of advanced circular regulation. This scenario shifts the emphasis from current economic barriers to the technical, practical and managerial challenges of a transition into a circular economy (appendix 1). Specifically, it allows the exploration of a proposed method: cutting and reusing structural in-situ concrete, discussed in greater details in following sections.

For the conceptual-contextual research, a more detailed scenario: a post-capitalist society, where *diverse economies* and *universal basic income* are the norm, inspires the development of the architectural programme. The aim here is to define an architectural programme that will express the social ideas behind the imagined scenario and at the same time will create the optimal conditions for an alternative self-production space in Brussels.

Research Methods

The two research tracks require different methods, due to their distinct character.

Technical Thematic Research

Literature review: a review of academic literature and scientific articles forms the basis of the research, providing an overview of existing knowledge regarding:

- *Deconstruction*: definition, economic challenges, environmental and social benefits
- *Reuse*: current state, regulations and norms, *design for deconstruction*
- Concrete: material composition, environmental impact, current material flow and end-of-life treatment

Interviews: since cutting in-situ concrete to be reused in construction is not common practice, projects documentation and academic research are lacking. Interviews with professionals provide initial answers to questions regarding, inter alia, technical challenges, available cutting methods and barriers relating to logistics.

A physical experiment: in order to bridge the gap between academic and practical work, a better understanding of the physical challenges of *deconstruction* is needed. A test set up was created, with the aid of colleagues from the Civil Engineering faculty, to test several available cutting methods for concrete and influence on structural strength. Unfortunately, the experiment was not executed due to lack of funding.

Case studies: documentation of projects which incorporated *deconstruction* and *reuse* of materials provide additional insight into some of the consequences on the architecture and the architectural design process (Zaman et al., 2018; Pilloni, 2014; Munroe et al., 2006). Projects where social agendas play a role are studied, such as cases that focus on the opportunity to create jobs or to provide training programmes. These agendas advocate for *deconstruction* as a tool for the empowerment of the local community and the stimulation of the local economy.

Integration with the deconstructed Brussels World Trade Centre (WTC) towers case: at the time of writing, the WTC towers in Brussels are being deconstructed, while the structural concrete is left as is to be reused. In order to further elaborate and test the proposed method of cutting structural concrete, a hypothetical scenario, where the concrete is instead removed, is explored. The Towers are situated along the canal that allows the transportation of materials to the selected site, 4 km further on the canal.

Quantitative analysis: the hypothetical case of the WTC towers is tested further with an analysis of potential saving in energy consumption, in comparison with common practice of concrete *recycling* (appx.5)

Conceptual-Contextual Research

Literature review: as a means to position the project within academic context and formulate the architectural concept, the literature reviewed concerns topics such as *universal basic income*, work and free time, circular production, self-production and *social infrastructure*.

Cultural analysis: studying the city's history and its economic transformation assist in forming a narrative that describes the cultural and spatial characteristics of the place. The narrative can then form a basis for decision making during the design process.

Socio-spatial analysis

Demographic analysis: demographic characteristics assist in identifying social (inequality) issues that could be addressed by the design, e.g. high unemployment rates among youth, high numbers of single mothers, barriers due to spoken language.

Municipality's vision and reports: to operate within a neighbourhood in Brussels in an informed way, the complexity of the specific urban environment must be understood. By reviewing studies commissioned by local authorities, the situation of the project can either conform to the vision and goals set, or to challenge them by offering relevant alternatives.

Urban plan analysis: mapping and analysing urban plans in different scales pinpoints socio-spatial issues (e.g. lack of public space for gathering, absence of recreational/cultural function) in order to formulate a strategic plan that responds to an existing urban situation.

Typology

Data collection: the existing buildings on site are analysed using floor plans and sections with the intention to reveal spatial qualities and weak points. Conclusions from the analysis inform the definition of a desired architectural intervention. Additionally, on a larger scale, the mapping of the various land uses reveals the character of the industrial/residential mix, which is a main topic in the municipality's vision and relates to the future development plan for the canal zone in the city.

Phenomenology

Simulation with VR tool: a virtual visit, due to Covid-19, provides an experience of the city from both a bird's-eye view and eye level, revealing the state of the site, its situation within the urban tissue and its spatial relationships with important elements such as the canal, parks, industrial zones, churches, monuments and others.

Archival research: as a site visit was initially not possible, due to Covid-19, a collage of the street's facades was created in an attempt to explore the unique character of the highly mixed-use district, expressing the hectic nature of the place.

Imagery: during a site visit, that was later possible, the experience of the site, specifically the existing hidden courtyards on the site, with their scale, materiality, entrances and routes are documented to express the enclosed 'urban rooms' created by the 'inner facades'.

Sensory mapping: by creating an imaginary soundscape of the site, the desired atmosphere is tested, allowing to consider the organisation of the functions and the routes throughout the site from a user perspective.

Argument on Relevance

In the most general sense, these ecological, societal, political and economic questions are important in an architectural research, as architecture is always positioned within a given context, with its multiplicity of disciplines and their intersections. For the purpose of this project, an architectural position that incorporates ideas from various disciplines (e.g. economics, political science and environmental studies) is important in order to develop an approach that brings together ethical and sustainable consideration in terms of materials, labour, local community, possible economic model and programme.

Social inequalities exist on different scales, from the Global South and the Global North down to a Municipality, expressed for example in the negative correlation between low income and access to green spaces in Molenbeek. A demographic analysis made by the city of Brussels stresses the urgency in addressing such social issues (Perspective.brussels, 2016). Additionally, with the focus on productive activity, Brussels is a fitting candidate, with its history as an industrial centre; up until the 1960s, approximately 60% of jobs in the city were associated with industrial activities. However, due to economic transformation toward service industries, industrial jobs nowadays represent less than 3% of total employment (Cities of Making, 2018). This results in less diversity of professional skills, which in turn contributed to increasing socio-economic gaps, as some groups are pushed out or left with fewer job opportunities. An architectural design has the capacity to imagine alternative futures and in turn build physical spaces that promote alternative behaviour and desired values according to the ideas of circularity and diversity in local economy as discussed above.

The consumption of non renewable natural resources plays a significant role in the ecological crises we are now experiencing, such as biodiversity loss, freshwater shortage and air pollution, as presented in the *Doughnut Economy* in relation to *social equity* and *environmental justice* (Raworth, 2012). These complex crises require urgent actions to be taken within various different disciplines, including architecture. The discussion about natural resources and energy consumption is highly relevant to architectural practices, since the construction industry in Europe is responsible for approximately 50% of the total natural resources consumed and 37% of the total energy consumption (Durmisevic, 2017). Thanks to its mechanical strength and durability, among other properties, there is twice as much concrete in the built environment compared to all other building materials combined (Gagg, 2014) - 33 billion tons per year globally (Strategic Business Plan Iso/Tc 071, 2016) . Thus, the relevance of rethinking the life cycle of concrete lies in its great potential impact on the environment. Concrete expresses the conflict presented above between economic value and environmental impact, due to its low financial cost of and high environmental cost. The technical research of *reuse* of concrete can demonstrate circular planning with the aim to formulate a replicable building system.

Design Strategies & Preliminary Design

The research informs both the architectural design process and its outcomes. The findings from both the research tracks will inform the final design, as shown in the research diagram (fig. 1). The design proposal suggests a site redevelopment to house CRAFTWERK, a common space with local self-production at its core. The preliminary design is based on the following strategies and guidelines which are in line with the research findings. The next step will be to translate the environmental and social values into architectural principles (appendix 1).

I. Building Circularity: The Programme

The conceptual-contextual research helps to define criteria for the selection of a suitable site for the project. The site-specific research later results in an urban strategic plan (appendix 3) and a site-specific brief. A preliminary organisation is suggested to include the following functions: workshops (metal, wood, textile and electronics), a communal kitchen, an open academy, short-term living spaces, an assembly hall, a garden, a playground and an exposition space. The programme forms an integral part of the concept of CRAFTWERK by defining the complex as a creative powerhouse: a place to enable the shift from passive consumption to active production of goods, services and culture in the neighbourhood of Molenbeek in Brussels. The motivation behind this concept is to promote the establishment of *social infrastructure* focused around productive activity to encourage proactive participation in the local economy. The programme and the floor plans (appendix 4) are developed based on the theoretical background mentioned and on the scenario of a post-capitalist society, as well as on social characteristics and (spatial) needs of the local community as concluded from the research. Special attention is given to the following groups, among others: single mothers, youngsters, unemployed, and unemployed holding a foreign diploma. The intention is to professionally empower these groups - for example, a playground adjacent to the textile workshop could help enable the integration of unemployed single mothers to the local economy.

II. Circular Building: The Materials

The research into the opportunities of *deconstruction* lead to the formulation of an approach that emphasises responsible use of materials.

The technical thematic research resulted in a proposed method for *reuse* of structural concrete by cutting reinforced in-situ concrete into ‘ready-made’ structural components. It was concluded the solution is technically viable and has the potential to reduce energy consumption by approximetly 70% (appendix 5). Based on the hypothetical case study of the World Trade Centre in Brussels, located 4 km from the selected site, a catalog of standard concrete components is defined with standard measurements according to the limitations of the original structure of the towers (appendix 6). The concrete components provide an inventory of structural elements.

The design challenge is thus to demonstrate how the concrete components could be reused, with consideration to assembly methods, joints, labour and aesthetic (appendix 7). The design will play a significant role in the completion of the thematic research, as it will continue to explore and test the possibilities of *reusing* concrete as a proof of concept. This project presents the architect’s dual challenge: on the one hand, a design based on a given inventory of materials and components - namely the ready-made concrete elements, and on the other hand, the development of a suitable design for future *deconstruction*.

Glossary of Key Terms

Care

was defined by the political theorist Joan Tronto in 1991 as follows: "*on the most general level, we suggest that caring be viewed as a species activity that includes everything we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That world includes our bodies, our selves, and our environment, all of which we seek to interweave in a complex, life-sustaining web*." (Architektur Zentrum Wien, 2019, p. 13). In this context, it is referred to as an ethical approach toward the well-being of people and the planet.

Circular Economy

(often referred to as **Circularity**) is based on three main principles: (1) designing out waste and pollution (2) keeping products and materials in use and (3) regenerating natural systems. It provides a framework for "*a new way to design, make, and use things within planetary boundaries*" (Cities and the Circular Economy, 2020). To that end, it calls for "*gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system*" (The Circular Economy In Detail, 2020). Simply put, waste should be considered to be a resource, and to thus "close loops" of material flows by *reusing* materials over and over again. Circular economy is seen as an alternative to the

Linear economy,

which follows the prevalent material flow: extraction of raw materials - product manufacturing - use - and finally disposed of as waste.

Deconstruction

is a widely accepted term for the systematic and careful disassembly of buildings to recover valuable materials. In a sense it can be referred to as 'construction in reverse' (Munroe et al., 2006). By practicing deconstruction we are able to *reuse* the disassembled building materials.

Demolition

is the removal of buildings and often refers to "*the complete elimination of all parts of a building*", which marks its end of life (Thomsen et al., 2011). The term conventional demolition refers to the common practice of removal by heavy machinery. While such removal does not allow the *reuse* of components or materials, it does allow *recycling*, which requires additional energy-intensive processes to transform it again into usable material.

Doughnut Economy

is a visual framework developed by the economist Kate Raworth that aims to bring *planetary boundaries* and social boundaries together in order to define a space where humanity can thrive. Raworth integrates sustainable development with *social equity* in relation to natural resources: "*Humanity's challenge in the 21st century is to eradicate poverty and achieve a prosperity for all within the means of the planet's limited natural resources*." (Raworth, 2012, p.3).

Design for Deconstruction

refers to the design of buildings with consideration for the reuse of recovered material in the end-of-life phase (Durmisevic, 2017).

The Degrowth movement

holds criticism of capitalism as a system that "*pursues growth at all costs, causing human exploitation and environmental destruction*". The term **Degrowth** refers to the transformation of societies to "*ensure environmental justice and a good life for all within planetary boundaries*" (What Is Degrowth?, 2020).

Diverse Economies

is a theory and practice that calls to "*recognize the economic diversity that abounds in this world*" by taking notice of all hidden economic activities, rather than only identifying wage labour as 'the economy' (Gibson-Graham, 2013).

Environmental Equity

is the equal distribution of environmental burdens and amenities - pollution, noise, safety, as well as access to nature, green spaces etc. (Kruize, 2007).

Environmental Justice

is defined as "*fair treatment and meaningful involvement of all people regardless of race, ethnicity, income, national origin or educational level with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies*" (Environmental Justice, 2021).

Recycling

means turning a product into raw materials, through an energy consuming procedure, for the manufacture of a new product.

Reusing

refers to using an object as it is without additional processing or remanufacturing. This reduces energy consumption, pollution and waste, thus making it a more sustainable process than recycling.

Scenario-based Planning

is a tool which fosters "*long-term and complex thinking that allows for an exploration of the dynamics and sustainability of social-ecological systems*", in which a **Scenario** is defined as "*a coherent, internally consistent, and plausible description of a potential future state of the world*" (Oteros-Rozas et al., 2015).

Social Equality

concerns the distribution of social goods and burdens, such as income, wealth, opportunity, education, and health care (Social Equality, 2020)

Social Equity

is the active commitment to fairness, justice, and equality in terms of public policy and management (Wooldridge & Bilharz, 2017). It is worth stressing that while equality means the equal treatment of every citizen, equity is the treatment required to achieve a state of equality.

Social Infrastructure

is defined by Eric Klinenberg as "*the physical places and organizations that shape the way people interact*" (Klinenberg, 2018, p.5). Several examples from his book are libraries, schools, playgrounds and parks.

Universal Basic Income

is an unconditional income, for each citizen, to allow his basic needs. The idea was initially introduced by Bertrand Russel and since then often discussed as well as being the subject for experiments in various forms (van der Veen & Van Parijs, 2006).

Planetary boundaries

are the environmental boundaries defined by a group of renowned Earth-system and environmental scientists in order to quantify the limits of humanity's burden on Earth's system, with consideration to its capacity for self-regulation (Earth's boundaries, 2009).

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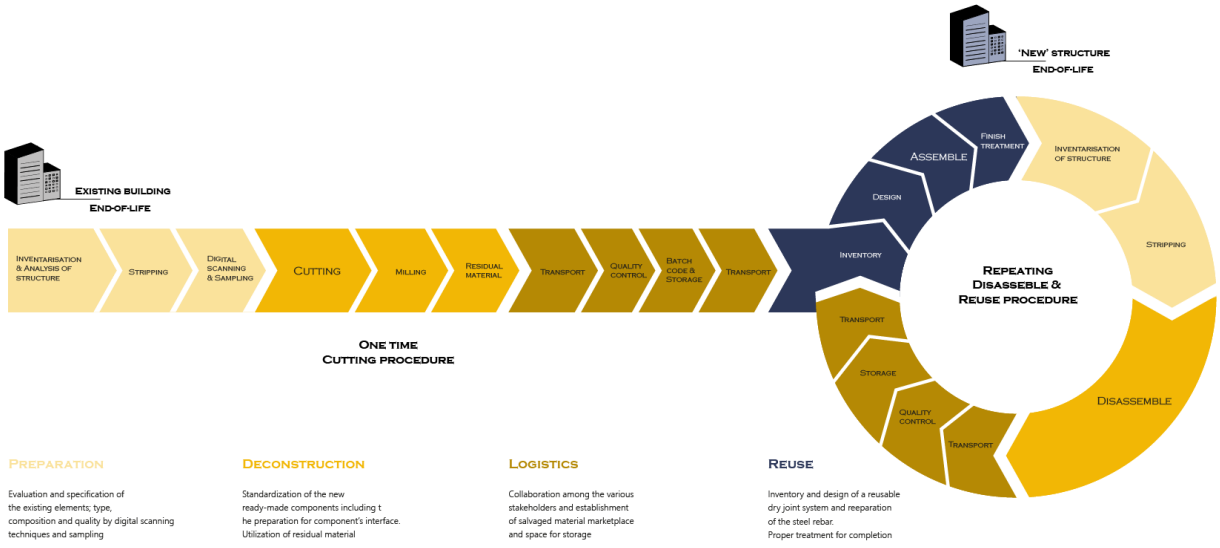
Appendices



Appendix 1. steps diagram from linear to circular material flow of concrete

Beyond economic challenges: technique and logistics

Architectural Principle	programme	urban	complex	facade	structure	details
Flexibility	seperation of similar functions	‘empty’ public square	unfixed funcfions	self-standing facade	over-dimensioned standard	demountable
Informality	informal routes	former industrial typology	informal entrances	active edges	reused materials	easy to make
Openess/ Invitingness	overlapping functions	link with canal and main square	discontinutaion in street facades	accesible facades on ground level	column-beams	visible

Appendix 2. Architectural principles derived from the research tracks

An integration of the environmental and social values to be promoted

(an initial draft to be further developed during MSc4)

Transformation of the complex
from a **passive** part
to an **active** architecture
in its context

Circulation from square

Open Facade

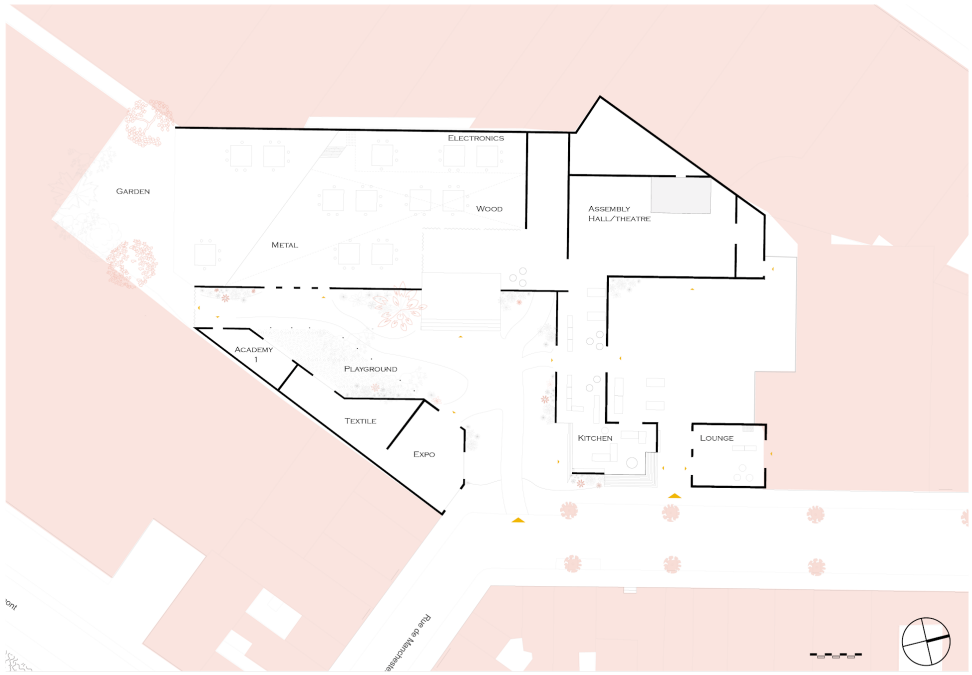
Courtyards as public space

Active edges inwards

Relation with the canal

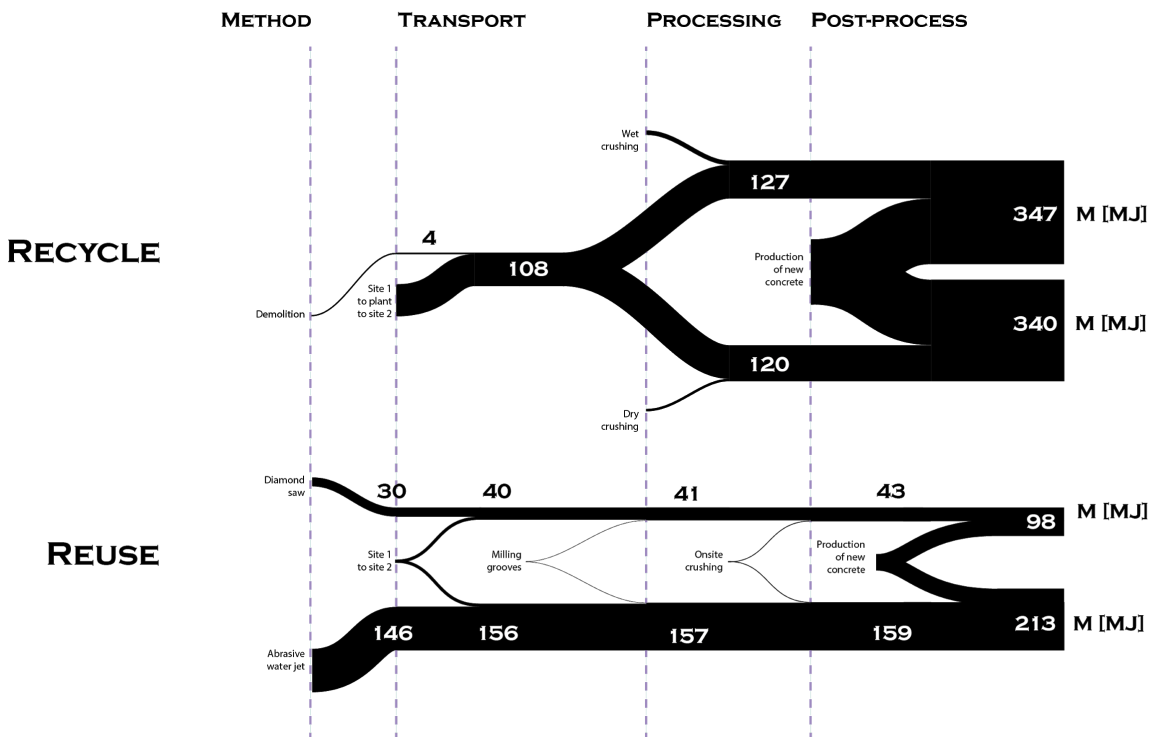
Appendix 3. Urban strategic plan

Responding to socio-spatial characteristic of the context



Appendix 4: Preliminary ground level floor plan

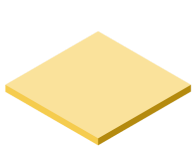
Hybrid complex for *Diverse Economies*



Appendix 5. A quantitative analysis

Potential energy saving: *Reuse* vs. *Recycle*

Inventory of concrete components from the WTC towers



Slabs

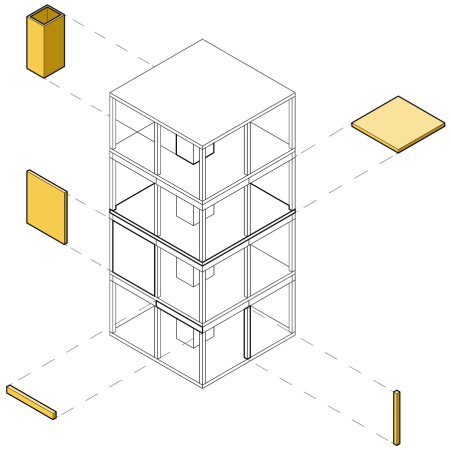
#	Measurements Code *thickness.length.width*
620	15.750.750
620	30.750.750
120	15.375.750
120	30.375.750

Walls

#	Measurements Code *thickness.length.height*
100	26.30.320
80	30.750.320
80	20.750.320
8	30.750.460
8	30.750.410
8	50.750.450

Coulums

#	Measurements Code *cross section.height*
26	40.40.450
26	40.40.420
26	40.40.320
90	50.50.460
50	50.50.420
50	50.50.320
30	115.65.460
30	115.65.410
60	80.75.460
60	80.75.410



Deconstruction of concrete in theory

Appendix 6. A catalog of standard concrete components

The hypothetical case study of the WTC towers

Appendix 7. Preliminary design

CRAFTWERK: view from the street, atmosphere and materiality