29-OKT-2021

RESEARCH PLAN | STUDIO

PIM BRUEREN
4658752

PREPARING FOR A MODULAR RETROFIT FUTURE OF WALK-UP APARTMENTS WITH THE USE OF COMPUTATIONAL DESIGN

ANNE SNIJDERS
SERDAR ASUT
MARCEL BILLOW

FIGURE 1

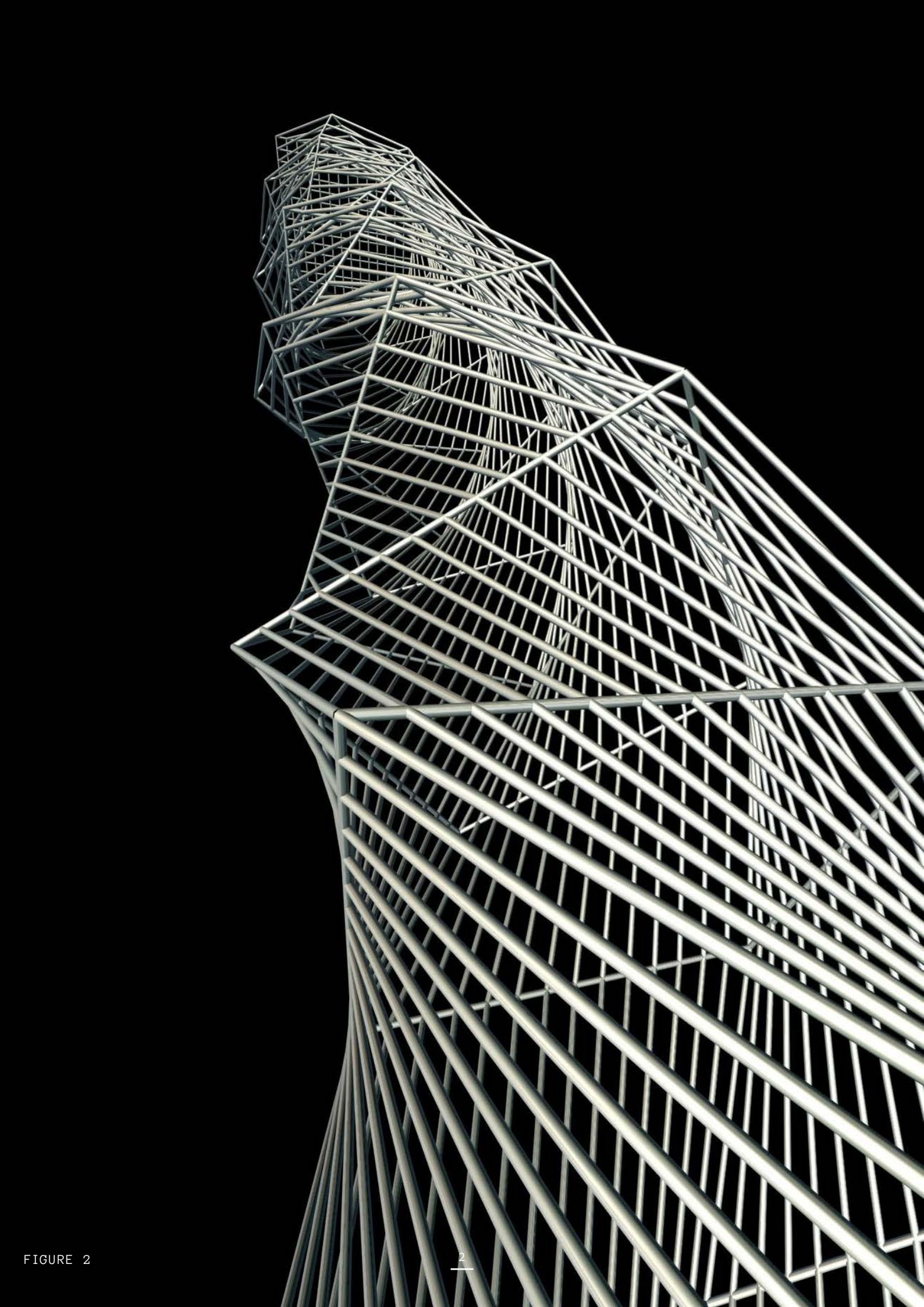


FIGURE 2

ABOUT

Pim Brueren
46587652

Title:
Preparing for a modular retrofit future of walk-up apartments with the use of computational design

Keywords:
Modular, renovation, computational design, adaptability, retrofit walk-up apartments

Studio:
Architectural engineering - Second life

Interest:
For me, architecture has always been about bringing the image through the different scales. I believe that the amount of time spent on the details is often just as important as the overall design. Doing something with an existing envelope challenges me even more. Combining architecture and digital tools is something I am very excited about.

MENTORS

ANNE SNIJDERS
DESIGN MENTOR

SERDAR ASUT
RESEARCH MENTOR - COMPUTATIONAL

MARCEL BILLOW
RESEARCH MENTOR - FACADE CONSTRUCTION

RENOVATING OLD HOMES IS NOT ABOUT MAKING THEM LOOK NEW...

IT IS ABOUT MAKING NEW UNNECESSARY

TY MCBRIDE

PROBLEM STATEMENT

Preparing for a modular retrofit future of walk-up apartments with the use of computational design

Figure 3. Four subtypes. Top left: subtype 1 interwar traditional construction methods Amsterdam. Top right: subtype 2 interwar traditional construction methods Den Haag. Bottom left: subtype 3 postwar mixed construction methods. Bottom right: subtype 4 postwar construction systems. Pictures are from the municipal picture data banks of Den Haag Amsterdam and Utrecht.

Over the last decades the western world has shown rapid urban densification.[1] In this western world several cities have to cope with Poor living conditions and gentrification due to deferred maintenance and a hasty need for more housing. The scope of this research will mainly focus on Dutch cities. Additional housing is needed to meet the housing demand and improvements to existing ones are required to comply with the Paris Agreement, or the National Energy and Climate Plan (NECP), which proposes a reduction of greenhouse gas emissions by at least 80% by 2050 and a reduction of approximately 90% in buildings.[2] The latter is especially important for this research, because to cope with the NECP the existing housing stock has to be transformed, which includes the stock owned by housing corporations. The social housing stock, largely owned by housing associations, shows two solutions for this problem: demolition or renovation. Thereby, demolition will result in more raw materials leading to higher emission values. But to further agree with the NECP, destruction will yield more raw materials and thus higher emissions values. These social housing also has to cope with the climate plan, which embraces the ambition to achieve CO2 neutrality of its housing by 2050. Most solutions that currently exist focus on the relatively easy part of the housing stock: row houses. This can partly be explained by the large share of terraced houses in the Netherlands and the fact that these houses are relatively easy to renovate one after the other.[3] But that leaves a huge gap in the rest of the existing building stock. For example, the enormous number of walk-up inner/ post war apartments. The walk-up building type is divided into four main typologies. The variations within these four typologies are small, but within each transformation a new approach and configuration is chosen, even within its own typology.[3]

Elaboration of the four different typologies;

- The interwar brickwork walk-up apartments, with vertical lines, and a closed staircase. Mostly situated around Amsterdam
- The interwar brickwork walk-up apartments where the front door is situated directly on the street in open air.
- The postwar mixed construction methods mostly produced by small and middle contractors, traditional brickwork loadbearing walls and facades combined with prefabricated construction components for foundation piles and beams, floors, and stairs.
- The postwar dry assemblage of prefabricated construction components walk-up apartments, which many people recognize as real postwar architecture with a rational or industrial character.

However, there is much demolition of post-war homes, change is needed to revive existing buildings, as demolition contradicts with the government's ambition to be energy neutral for the entire social housing stock by 2050. Because in terms of construction, they offer decent - good basic values for apartments. Renovation of walk-up apartments is different from terraced houses because it is not always possible with occupied living in the existing flats.
The main goal with renovation projects is to achieve better energy emissions, living conditions and solve the housing problem. These buildings being renovated slowly, one by one, for the demand of today. Future improvements and demands are not incorporated. The skin of the building needs a replacement every 30-50 years, and this building part even has a 'longer lifespan' than, for example, installations or floor plans.[4] This revitalization and reconfiguration now cost a lot of material, time and money, because a new transformation is needed every 50years where a new renovation approach is chosen. A modular approach could prove to be more (cost)effective if the old walk-up apartments were transformed to meet contemporary requirements, but already prepared for easy, modular future transformations. With the aim to achieve immediate and more reasonable transformations in the future with lower cost, more customization and lower emissions.

1.Erik Koomen, The attraction of urban cores: Densification in Dutch city centres, Urban studies, vrijeUniversitei-tAmsterdam the Netherlands, 2020

2. World Green Buidling council, Delivering the Paris Agreement - The Role of the Built Environment, 2021

3. Leo Oorschot, Lidwine Spoormans, Sabira El Messlaki, Thaleia Konstantinou, Tim de Jonge, Clarine van Oel, Thijs Asselbergs, Vincent Gruis and Wessel de Jonge, Flagships of the Dutch Welfare State in Transformation: A Transformation Framework for Balacing Sustainability and Cultural Values in Energy-Efficient Renovation of Postwar Walk-Up Apartment Buildings, department of Architectural Engineering, 29 may 2018

4. Steward Brand, how buildings learn: What happens after they're build, 1994, 978-0-670-83515-7

OBJECTIVE

Preparing for a modular retrofit future of walk-up apartments with the use of computational design

The goal of this research is to design a modular façade system that not only ensures the renovation of tomorrow, but also the renovation of the future, by adopting a more modular approach, using computational design and prefabrication. The entire renovation process could be simplified and accelerated, while improving the customization of the different building blocks. A digital tool that takes into account; materials, customization and easily interchangeable parts would ultimately make renovation easier and more affordable. Primarily, by making it more affordable, a market is created to incorporate in the social housing stock. A general approach for all four different typologies included in a digital application would be considered. This provides a generative solution for all different typologies and locations. The aim is to collect multiple lists of existing renovation techniques and differentiate which typologies of walkable apartments are most suitable for this modular retrofit approach. Presumably, one typology of a walk-up apartment is chosen for the final design. Because the customization via the software can be used for all different typologies, one typology is selected for the final design. The final proposal will mainly focus on prefabrication and modularity. Modularity would add more options for customization, adaptability and extensions.

This research generates a tool for the explanation and evaluation of design problems. This tool will help to provide insight into the different aspects of the project and the different struggles with the existing building stock. This tool is not yet as determined as the rest of the project, but will be collected through the project. Grasshopper is currently under consideration, which is a digital plug-in within Rhinoceros 3d that can handle parametric solutions. BIM (building information model) can also be considered as inside of these applications is strictly kept how much materials there are used. Possibly a combination of parametric and BIM will be provided as final tool. This tool is necessary to arrive at the final design, as there are variations within the building stock of walkable apartment buildings.

OVERALL DESIGN QUESTION THEMATIC RESEARCH QUESTION

Preparing for a modular retrofit future of walk-up apartments with the use of computational design

Overall design question

How can the renovation process of walk-up apartment buildings be improved by means of modular facades generated by computational design?

Thematic Research Question

To clarify the design question, the question is divided into 3 different topics. Where the topics will be divided into different sub-questions which will be answered through existing projects and literature. First of all, a literature study is conducted into the different typologies and renovation techniques that already exist in the building industry. Second, a literature study within modular parts and how they connect to the existing walk-up apartments is conducted. Finally, research in the more generic building block is explored through computational design, where this will be mainly studied through literature and case studies.

The 3 different topics of the thematic research question consist of 2 questions, the combined answers should form a final answer to the overall design question.

Typologies and renovation of walk-up apartments

- Which different typologies for walk-up apartments from inter/post-war are constructed and usable for this type of retrofit?
- What renovation techniques are there for walkable apartments?

Modularity and modular façade systems in the building environment

- Which modular systems can be used for renovation of walk-up apartments?
- How are modular façade systems connected to existing buildings?

Computational design implementations in the building environment

- Are there existing computational projects with retrofitting of existing buildings?
- How can computational design help by a generative renovation design for walk-up apartments?

After answering, a digital tool and a final design for renovated walk-up apartment will be presented through these thematic research questions. Using this digital tool, multiple generative solutions are created. The digital design of the walk-up apartments is more generative and the modular facade parts are more specific for different buildings and locations. This gives the potential to tackle other building typologies in the same manner, as the approach would aim to be more circular and efficient.

METHODOLOGIES

Preparing for a modular retrofit future of walk-up apartments with the use of computational design

The general approach of the research is desk research, looking into existing projects and literature. This would end up in several topics about renovation, modularity, walk-up apartments, computational design and building systems.
The main research about walk-up apartments will be done by means of a literature study, where mainly quantitative data is obtained. To find out which walk-up apartments are suitable for this type of renovation. Several characteristics must be taken into account. The usability will mainly focus on: construction method, current use, possibility of extending/reinforcing the facade, adaptability, similarities and the possibility of mass production of facade elements.
The modular study will have a list of possible solutions and the most suitable one for this problem. The research will consist solely of literature search. The modular approach would be done using the Modular Facade retrofit with Renewable energy (MFRRn) technologies. The MFRRn refers to the retrofit process where thermal insulation, solar and wind harvesting technologies are integrated with the building exterior finish using a modular approach.[5] The MFRRn must meet four basic aspects: work that needs to be done on existing buildings, work to be done on the facade, use of a modular approach and integration of renewable energy technologies during renovation. The modular approach is cited for its shorter production time and its adaptability and customization.[6] This mass customization can accommodate the different retrofit needs of professional landlords and private owners, increase affordability, and synergizes with circular design principles such as improving product quality, product and (sub)component standardization, and offering (update) choices to users.[7] This choice of users is problematic because the housing association determines which apartments are adapted and how this is done. Making more modular parts could help both parties due to financial income or better living conditions. Modularity makes it possible to spread the retrofit investment over multiple retrofit cycles.
This approach would be applied through computationally modulated buildings implementing the four different typologies and minor differentiation between the buildings. Therefore, the different MFRRn would be matched through the ease of computational calculations. In the future, this would help to implement this system on a large variety of buildings and speed up the renovation process of walk-up apartments.
For the computational part, knowledge is gained about existing initiatives and solutions. Possibly evolve on these existing structures. The question ‘How can computational design help by a generative renovation design for walk-up apartments?’ mainly focuses on various advantages and losses of the computational design approach.
Finally, design research is carried out to combine the different elements into a final design project. This research will combine the literature with the design of various modular components for a general approach for walk-up apartments. A design approach is presented that forms the basis for the modular renovation of walkable apartments.

5. Hu Du, Puxi Huang & Phillip Jones, Modular facade retrofit with renewable energy technologies: the definition and current status in Europe, Cardiff University, 2019

6. Mark Lawson, Ray Ogden, Chris Goodier, Design in Modular Construction, CRC Press, 2014

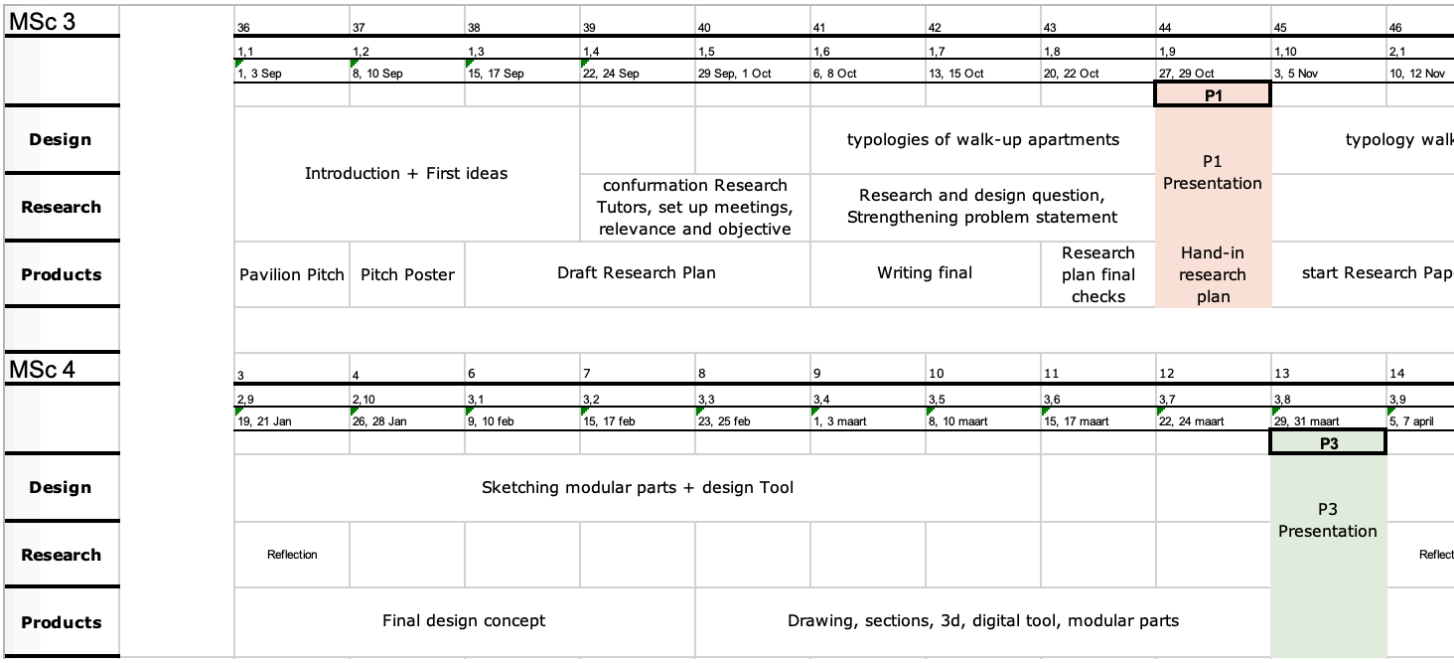
7. A. van Stijn and V.H. Gruis, Circular housing retrofit strategies and solutions: Towards modular, mass-customized and ‘Cyclable’ retrofit products, Central Europe towards Sustainable Building 2019 (CESB19), 2019

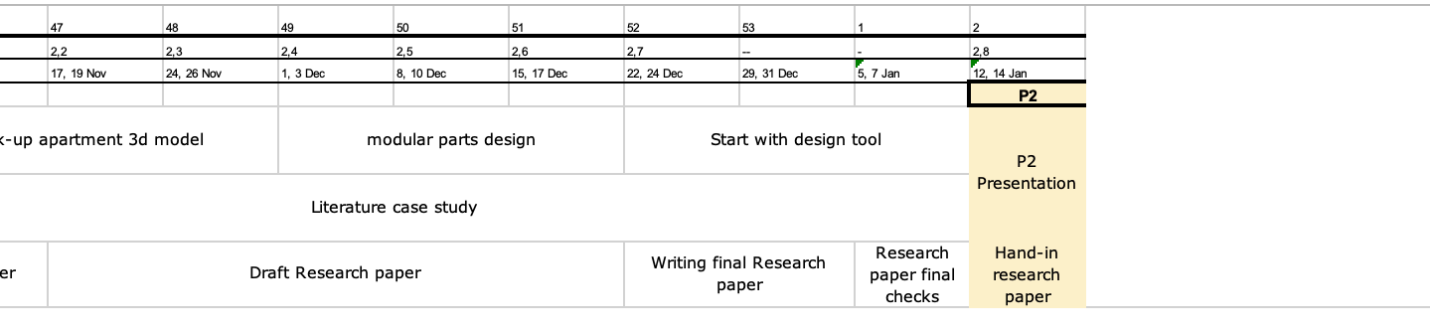
RELEVANCE

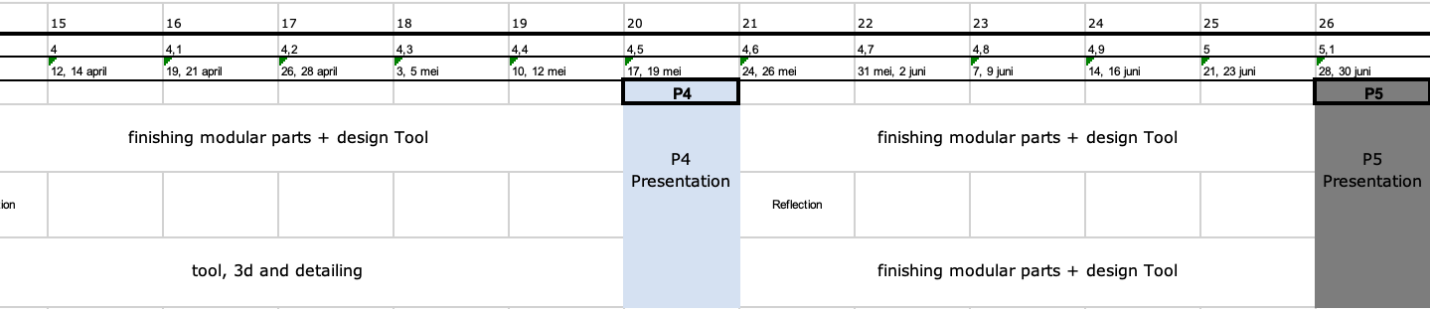
Preparing for a modular retrofit future of walk-up apartments with the use of computational design

Rapid urban densification and poor living conditions and gentrification occur in more than 15 Dutch cities. The housing shortage and the objectives for the National Energy and Climate Plan (NECP) are a current problem. Therefore, different solutions can be implemented. With the aim of being CO2 neutral by 2050, solutions for renovation of the existing housing stock are provisional. Housing associations are mainly focused on contracts and money and not on housing conditions or renovation costs. A system that reimburses the initial costs is therefore an initiative that may allow housing associations to invest in a modular renovation. The current industry is still focused on demolishing the existing post-war buildings, but they offer great potential. It would be a waste of all the emissions and potential already present in the carcass and compartments of the existing homes.
The solution would be a generic problem statement if you could implement the outcome on different buildings, but the design aspects within the modularity side could be more specific.

PLANNING


MSc 3
36 37 38 39 40 41 42 43 44 45 46
1,1 1,2 1,3 1,4 1,5 1,6 1,7 1,8 1,9 1,10 2,1
1, 3 Sep 8, 10 Sep 15, 17 Sep 22, 24 Sep 29 Sep, 1 Oct 6, 8 Oct 13, 15 Oct 20, 22 Oct 27, 29 Oct 3, 5 Nov 10, 12 Nov
P1
Design
Introduction + First ideas
typologies of walk-up apartments
P1 Presentation
typology walk
Research
confurmation Research Tutors, set up meetings, relevance and objective
Research and design question, Strengthening problem statement
Products
Pavilion Pitch
Pitch Poster
Draft Research Plan
Writing final
Research plan final checks
Hand-in research plan
start Research Pap
MSc 4
3 4 6 7 8 9 10 11 12 13 14
2,9 2,10 3,1 3,2 3,3 3,4 3,5 3,6 3,7 3,8 3,9
19, 21 Jan 26, 28 Jan 9, 10 feb 15, 17 feb 23, 25 feb 1, 3 maart 8, 10 maart 15, 17 maart 22, 24 maart 29, 31 maart 5, 7 april
P3
Design
Sketching modular parts + design Tool
P3 Presentation
Research
Reflection
Reflect
Products
Final design concept
Drawing, sections, 3d, digital tool, modular parts


47
48
49
50
51
52
53
1
2
2,2
2,3
2,4
2,5
2,6
2,7
--
-
2,8
17, 19 Nov
24, 26 Nov
1, 3 Dec
8, 10 Dec
15, 17 Dec
22, 24 Dec
29, 31 Dec
5, 7 Jan
12, 14 Jan
P2
k-up apartment 3d model
modular parts design
Start with design tool
P2 Presentation
Literature case study
er
Draft Research paper
Writing final Research paper
Research paper final checks
Hand-in research paper


15
16
17
18
19
20
21
22
23
24
25
26
4
4,1
4,2
4,3
4,4
4,5
4,6
4,7
4,8
4,9
5
5,1
12, 14 april
19, 21 april
26, 28 april
3, 5 mei
10, 12 mei
17, 19 mei
24, 26 mei
31 mei, 2 juni
7, 9 juni
14, 16 juni
21, 23 juni
28, 30 juni
P4
P5
finishing modular parts + design Tool
finishing modular parts + design Tool
P4 Presentation
P5 Presentation
ion
Reflection
tool, 3d and detailing
finishing modular parts + design Tool

LITERATURE

A van Stijn and V.H. Gruis, Circular housing retrofit strategies and solutions: Towards modular, mass-customized and 'Cyclable' retrofit products, Central Europe towards Sustainable Building 2019 (CESB19), 2019

BAM Woningbouw NV, ENECO installatiebedrijven Zuidwest BV, Hogeschool Rotterdam, Technische Universiteit Delft, 2016, 2ndSKIN, zero energy apartment renovation via an integrated façade approach, Project within the subsidy program Energy & Innovation, TKI/ENERGO Reference Number TEGB 113029

Erik Koomen, The attraction of urban cores: Densification in Dutch city centres, Urban studies, VrijeUniversiteitAmsterdam the Netherlands, 2020

Fabrizio M. Amoruso, Udo Dietrich and Thorsten Schuetze, 2019, Integrated BIM-Parametric Workflow-Based Analysis of Daylight Improvement for Sustainable Renovation of an Exemplary Apartment in Seoul, Korea, Department of Architecture, College of Engineering, Sungkyunkwan University

F. Salvador et al., 2002, Modularity, product variety, production volume, and component sourcing: theorizing beyond generic prescriptions

Hu Du, Puxi Huang & Phillip Jones, 2019, Modular facade retrofit with renewable energy technologies: the definition and current status in Europe
Issa J. Ramaji & Ali M. Memari, 2017, Extending the current model view definition standards to support multi-storey modular building projects

Knaack, Ulrich, et al. Façades : Principles of Construction, Walter de Gruyter GmbH, 2014.

Lisanne Havinga, Bernard Colenbrander, Henk Schellen, 2019, Heritage attributes of post-war housing in Amsterdam, Department of the Built Environment, Eindhoven University of Technology, Eindhoven, the Netherlands
M.T. Andeweg, 2013, Niet-traditionele bouwmethoden uit de periode 1945-1965

Joep Hövels, 2007, The Open Modular Façade Concept

Josef Hargrave, 2013, it's alive; can u imagine the urban building of the future?
Leo Oorschot, Lidwine Spoormans, Sabira El Messlaki, Thaleia Konstantinou, Tim de Jonge, Clarine van Oel, Thijs Asselbergs, Vincent Gruis and Wessel de Jonge, 2018, Flagships of the Dutch Welfare State in Transformation: A Transformation Framework for Balancing Sustainability and Cultural Values in Energy-Efficient Renovation of Postwar Walk-Up Apartment Building

Mark Lawson, Ray Ogden & Chris Goodier, 2014, Design in Modular Construction

Steward Brand, how buildings learn: What happens after they're build, 1994, 978-0-670-83515-7
World Green Buidling council, Delivering the Paris Agreement – The Role of the Built Environment, 2021

Figure 1: https://images.adsttc.com/media/images/5e39/5d90/3312/fda8/5e00/0015/slideshow/02-RecodingPostWarSyria_REP-DA2020_TUMB.jpg?1580817802

Figure 2: https://www.coroflot.com/rrami/digital-architecture

PREPARING FOR A MODULAR RETROFIT FUTURE OF WALK-UP APARTMENTS WITH THE USE OF COMPUTATIONAL DESIGN

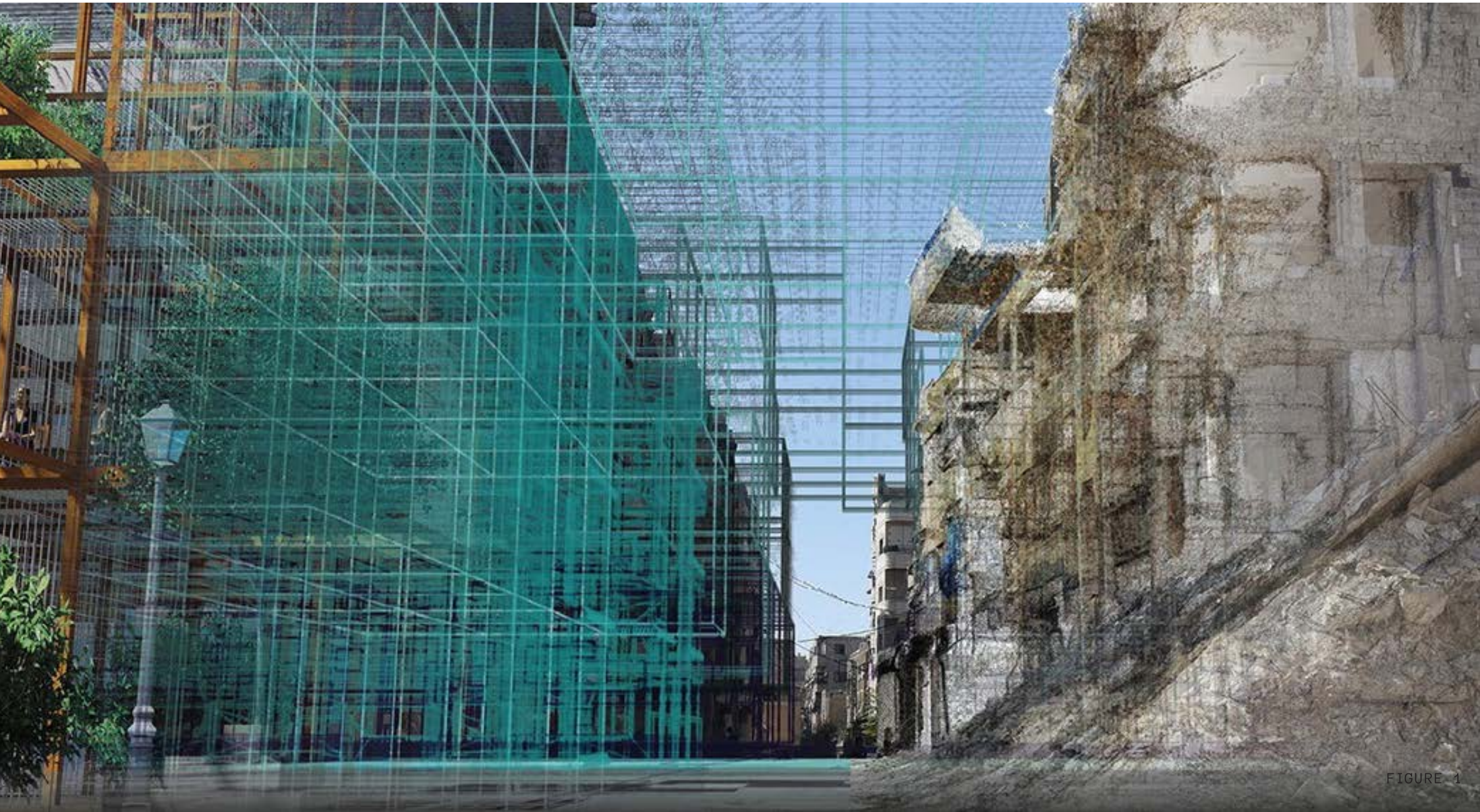


FIGURE 1