Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Personal information	
Name	Vittoria Mirra
Student number	4712579

Studio		
Name / Theme	AR3AE100 - Architectural Engineering Graduation Studio - 1 Million Homes	
Main mentor	Arch. Mauro Parravicini	Architectural Engineering + Technology, Building Product Innovation
Second mentor	Ir. Paddy Tomesen	Architectural Engineering + Technology, Building Product Innovation
Third mentor	Ir. Christien Janssen	Architectural Engineering + Technology, Building Physics
Argumentation of choice of the studio	The Architectural Engineering Graduation Studio is focused on the technical aspects within architecture. This studio gives the opportunity to approach the design process from a technical point of view, which attracted me to this studio. The 1 Million Homes track addresses the current housing shortage in the Netherlands. This track offers the space to find solutions to a current problem within the built environment. The possibility of meaning something for the building industry, intrigued me.	

Graduation project	
Title of the graduation project	Solarpolis - Climate Adaptive Living
Goal	
Location	Merwedeterrein, Arnhem, The Netherlands
The posed problem	Over the last years, the Netherlands has been struggling with a continuously growing housing shortage, because of the decreasing average household. Nowadays, there seems to be a necessity for 1 million homes before 2035. These houses need to be affordable for the lower and middle class, including starters. Furthermore, to lower the CO_2 emissions within the built environment, these new habitations need to be at least Nearly Zero-Energy Buildings (NZEB). This means there is a need for energy neutral habitations, which are affordable for the average Dutch inhabitant. In the life cycle of buildings, there are four kinds of emissions: during the preparation of materials, during the construction of a building, during the use of a building and during the disposal of the building. These emissions can be lowered by using prefab modular systems and by working on the climate systems. Furthermore, a modular strategy helps develop affordable, quick to build habitations that are flexible for future trends.

Research questions	**Overall Design Question** How can a modular and climate strategy help develop an affordable, high quality neighbourhood with varied houses for the lower and middle class in the Merwedeterrein, Arnhem? *Sub-questions* - How can the design of climate systems for modular strategies decrease the purchase price of new energy neutral buildings in the Netherlands? - What properties are important while developing flexible, modular housing? - What classifies as a high quality neighbourhood and what is needed to make the Merwedeterrein high quality? **Thematic Research Question** How can the design of climate systems for modular strategies decrease the purchase price of new energy neutral buildings in the Netherlands? *Sub-questions* - What kind of climate systems are used in the Netherlands? - What elements can compose a climate system for modular architecture? - How can we make currently used climate systems more affordable?
Design assignment in which these result	A high quality, energy neutral neighbourhood, consisting of a modular structure which can compose varied houses (1-person households, 2-person households and family houses)

Process

Method description

This design consists of three research questions. The main thematic research question addresses how the design of climate systems for modular strategies decrease the purchase price of new energy neutral buildings in the Netherlands. This research starts with a study on the average climate in the Netherlands. The climate data, retrieved from an online repository are processed through the program *Climate Consultant.* The outputs help decide which element typologies are needed in a climate system for buildings in the Netherlands. Afterward, to analyze currently used climate systems, two passive and two active case studies are used: M'DAM (NL) and Park Avenue (NL) being the active case studies and Veldhuis (NL) and Agar Grove (England) being the passive case studies. Through documentations, calculation sheets for the energy performance, interviews with some architects and further reflection upon the received information, the climate principle schemes of the four case studies are set up. All the elements of these climate systems and four innovative elements, to get an idea of future trends, are analyzed individually based on purchase and usage price, purpose and effectiveness. Subsequently, the elements are analyzed based on the flexibility of the elements to see which elements would work better for a modular building. Finally, different applications of these climate system elements are analyzed, to see if there are ways to make their application more affordable. All this information is processed into a catalog which helps design an affordable, flexible climate system.

The other research questions address what properties are important while developing flexible, modular housing and what classifies as a high quality neighbourhood and what is needed to make the Merwedeterrein high quality. These questions are approached through references and research by design.

These different researches help develop a modular strategy combined with a climate strategy. This strategy is used to design a high quality neighbourhood in the Merwedeterrein.

Literature and general practical preference

Literature (Theories)

In this project, theories are used to frame certain aspects within the thematic research.

Yanovshtchinsky, V., Huijbers, K. and van den Dobbelsteen, A. (2013). *Architectuur als klimaatmachine.* 2nd ed. Amsterdam: Sun, pp.45, 60–65, 72–79, 232–234.

Etude and Levitt Bernstein People Design (n.d.). *Easi Guide Passivhaus Design.*

Literature (Data)

The thematic research is mainly based on case studies. The data are retrieved from different sources.

Brink (n.d.). *Ventilatiesysteem Multi Air Supply.*

Buro Bouwfysica (2020a). *Rapportage energieprestatie.*

Buro Bouwfysica (2020b). *Thermische schil en equivalente warmteweerstand.*

Camden (2019). *Agar Grove Estate.*

Etude and Levitt Bernstein People Design (n.d.). *Easi Guide Passivhaus Design.*

Hawkins\Brown (n.d.). *Passivhaus Strategies Phase 1a and 1c - Agar Grove.*

Inventum (n.d.). *Modul-AIR Blue warmtepomp met duurzame koeling*. [online] Inventum.com. Available at: https://www.inventum.com/producten/modul-air-blue/ [Accessed 7 Jan. 2022].

Karbonik (n.d.). *Elektrische Vloerverwarming.*

Loohuis Energie & Installatie Advies B.V. (2018a). *Bouwaanvraag - Finch Kohnstammlocatie Monnickendam.*

Loohuis Energie & Installatie Advies B.V. (2018b). *Rapportage EPC Berekening.*

Max Fordham (n.d.). *Agar Grove Phase 1A.*

Troelstra, W. (2021). *Passiefbouw Veldhuis Apeldoorn blijkt Parisproof.*

Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

The master program MSc AUBS is a broad program focused on different parts of the built environment: from building management to building construction. Within the master track "Architecture", the different aspects of these disciplines come together and show how the different studios approach the discipline of architecture. Some studios focus more on the technical aspects, others on the architectural values and others on the socio-cultural aspects. The Architectural Engineering Graduation Studio focuses more on the technical aspects within architecture. However, the track "1 Million Homes" addresses the problem of housing shortage, which adds the social-cultural and economic aspect to the technical aspect. By focusing on the affordability of a modular and energy neutral neighbourhood considering the housing shortage, this graduation project manages to address many elements of different disciplines, but also socio-cultural aspects like the high quality public space and economical aspects like the affordability of a habitation. This shows the importance of the collaboration between the disciplines within the built environment.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

This graduation project addresses many aspects, like climate design, affordability, social cohesion, modularity, flexibility. The research on the climate systems addresses the current topic of the elevated emissions of buildings. The results of this research and design can be used in the Netherlands and other countries with similar climates, however the developed methodology, based on the integration of the climate system on every scale and focussed on the extensive use of passive design, can be used on a larger scale. Furthermore, a design (strategy) for an affordable, energy neutral, high quality neighbourhood (which is flexible and quick to build thanks to the modular strategy) can reduce the housing shortage and the need for sustainable habitations in the Netherlands, as well as in other countries.