RESEARCH PLAN

Personal Information

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Studio

Architectural Engineering: Open Buildings
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Title: **Flexibility in the face of environmental crisis. How to design smarter buildings?**

Graduation Project

Key words:

Adaptivity

Flexibility of function

Parametric module spacing

Multiscenario building

Kit of parts

Timber based structure

Argumentation of choice of the studio:

The master studies of architecture would most likely be the last stop on my high-educational journey. Therefore I wanted to use my time here to the fullest and learn as much as possible. I appreciate the freedom of research and design of Architectural Engineering which was essential for my choice. Since the building industry is slowly shifting towards its sustainable future therefore it is crucial for me to learn about a relatively new branch of architecture which is large-scale timber-based structures. Until now I have designed only one building that was based on CLT structure and ever since I wished to be able to pursue that direction of research and design.

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GENERAL PROBLEM STATEMENT

1. Increasing demand for student housing in the Netherlands

According to the National Student Housing Monitor there is a shortage in the 20 largest student cities of 27,000 student homes. In Delft alone, the estimate shows a shortage around 6,000 student homes by the year 2030. The problem goes deeper as most student homes are in the city of Delft and not in the TU Delft Campus which affects its residents and their comfort of living, to say the least. Unfortunately, the Campus currently has only 1,000 student homes altogether, the rest of the students live either in Delft or in other towns where rents are significantly lower. According to (DeltaX,2021) there is a plan for the future development for the campus - Zuid Campus which would consist of new educational buildings but also 7,000 new student homes. Yet, it would mean that only 20% students would live at the Campus out of 40,000 planned that would be studying here. In comparison, the Oxford Campus can currently accommodate around 10,000 students which is roughly 50% of all students admitted to Oxford University.

2. TU Delft Campus is lacking a student community center where they can develop their own initiatives, share ideas and work on interdisciplinary projects.

Although, every faculty has its own coworking area, small library and cafeteria what is lacking is the space for the integration for students from all different faculties where they could not only work together and exchange ideas but also spend their free time and create their own diverse community. The need for more integration facilities has been recently vocalized by students which lead to creation of the Free Zones which are designed to host any small scale outdoor activity. This is indeed a good initiative but it hardly covers the needs for the entire Campus. The X, or Building 37 is on the other hand focusing more on sport-related activities with all sorts of indoor and outdoor pitches, courts and sports halls. What is clearly missing is a student community center that could serve as a hub for all interfaculty scientific activity and cooperation, a free space for students to work, innovate and develop their own initiatives.

3. There is a high demand for sustainable building materials.

According to the UN (GSR,2021) report the construction industry in 2020 was responsible for 36% of global energy consumption and 37% of energy-related CO2 emissions which leaves a lot of room for improvement. Since the most common building materials like steel and concrete are great polluters, there is a high demand for the new versatile constructing material that could level with the endurance and strength of standardised ones. In the last 30 years, timber-based construction has seen its renaissance due to the new advancements in timber technology like compositing, innovative joinery, advanced adhesives and digital tectonics that elevates timber to be as strong as steel or concrete structure. Only recently there has been a rapid popularization of the idea of timber based high-rise like, the Treet in Bergen completed in 2015 or Brock Commons in Vancouver which used CLT-based 2D modules and Glulam columns, completed in 2017 both of which were the world's tallest timber-based buildings respectively. The timber-based structure allows for a greater degree of prefabrication which makes the construction process not only shorter but also way quieter and cost-efficient. Moreover, due to the lightness of wood, the foundations are also relatively more shallow which improves the cost efficiency. On the other hand, the ability to store CO2 is a very appealing property that can potentially reverse the CO2 emissive trend in the building industry.

4. The predominant spatial and functional rigidness of most newly built buildings in face of land scarcity and high land prices.

With the technological progress of the building industry, the approach to a building as an entity has changed significantly. The rapid socio-economical changes have often led to various stages of redundancy no matter if it were for the residential neighborhoods, industrial buildings or entertainment facilities. However, most of the built environment is still a rigid building designed for a specific purpose without any valid plan for change or dismantling process in the future. Even the contemporary multifunctional buildings often have functions rigidly imbedded into the tissue of the building without any room for further adaptation. Such a situation is also reinforced by the nature of the structural materials like steel and concrete, which are difficult to adapt to the new needs. As a result, many buildings deteriorate due to lack of a plan for adaptation or are being left due to the ineffectiveness of their properties and being allocated for reconstruction or worse, demolition which generates a significant amount of waste and pollution. Clearly, the adaptivity of a building is not only a functionality aspect but also plays a major role in emission reduction policy to fight the enviromental degradation that is caused by the building industry.

Adaptivity/Flexibility - “capable of adapting or of being adapted” also to adapt is “to make suitable to or fit for a specific use or situation” (Mifflin, 2011) However, in terms of architecture according to Harbaken: “Words like ‘adaptability’, ‘flexibility’, and ‘polyvalence’ have multiple and often overlapping meanings that make it virtually impossible to come up with a vocabulary acceptable to everybody“.

The term adaptability refers to the building’s ability to accommodate a change of its properties in order to fit in the current needs. There are many definitions of what that ability entails however, in my research I would focus mostly on the adaptation of function and spatial flexibility. In that research, the key feature will be utilizing the properties of easily mountable and demountable timber-based prefabricated modules which can be moved around the building in order to adapt to the needs of the current moment.

The table below showcases the analysis of the terminology of adaptability through different contexts. It comes from the scientific article - Adaptability of Buildings: A Critical Review on the Concept Evolution (Askar, Bragança, Gervásio, 2021)

Building Typology	Definition	Type of Change	Motives
Housing	Adaptable housing is the one that can adapt to users’ changing physical needs, in particular as they get older or lose their mobility	Accessibility, furniture (spatial)	Users’ physical restrictions
Office building	Adaptability is a mean of increasing usability and extending buildings functional lifespan	Change of use	Long-term vacant office buildings
Office building	Adaptability describes a building of 1. multifunctional use (generality); 2. built-in possibilities to rearrange, take away, or add elements (flexibility); 3. possibility of division into different functional units or extendibility (elasticity)	Change of use or function, spatial arrangements, change of size	Rapid change in private and public organizations, building redundancy
General	Adaptability features a system’s ability to adapt itself towards changing environments	Interior changes	Varying operating conditions
General	Adaptable architecture is “an architecture from which specific components can be changed in response to external stimuli, for example the users or environment”	Spatial flexibility and constructional openness	Changes both in the social, economic, and physical surroundings, and in the needs and expectations of occupants
General	“The capacity of a building to accommodate effectively the evolving demands of its context, thus maximizing value through life”	Spatial, structural, and service strategies	Changing operational parameters over time
General	“A building that has been designed with thought of how it might be easily altered to prolong its life”	-	Building obsolescence
General	Building adaptation as the ability of a building to fit within new conditions or needs by means of reuse or upgrading	Change in performance for existing buildings	-
General	Structural adaptability is “The capacity of the building structure to be able to undergo changes to the structure itself, with or without only small consequences for the remaining building storeys”	Structural	Structural obsolescence and inflexibility leading to economic unviability
General	“The ease with which buildings can be physically modified, deconstructed, refurbished, reconfigured, repurposed, and/or expanded”	Changes in space, size, layout, components, use, and function	Building obsolescence leading to premature demolition
General	Ability to be changed or modified to make suitable for a particular purpose”	-	Building obsolescence leading to premature demolition
General	The adaptive capacity of a building includes all characteristics that enable the building to keep its functionality through changing requirements and circumstances, during its entire technical lifecycle and in a sustainable and economically profitable way		Obsolescence and economic unviability

(Askar, Bragança, Gervásio, 2021)

RELEVANCE

The final design project can potentially become a pilot project for other Campus related buildings regarding timber-based structures and their incremented spatial flexibility. The emphasis on adaptability can be a vital point of discussion about the Campus’s future and its limited land available for new construction. The use of a timber-based structure can influence the future strategies for the sustainable future of TU Delft.

PROJECT OBJECTIVE

The objective of this project is to design a multifunctional building that accommodates mainly student housing and the community center. The goal is to create an architectural framework that would accommodate multiple functions through spatial flexibility that would use the wood's unique properties like lightness, durability, greater capacity for prefabrication, easy mountability and dismountability. The project should showcase the possibilities of adaptive timber-based architecture and present different scenarios for the building and show how it could be transformed throughout the years. The spatial scenarios will be optimised through parametric design tools to ensure the optimal layout for the building. Moreover, the ability to adapt will be enhanced by modular timber-based prefabricated elements that can be configured in numerous variants to adapt for the spatial needs of its users. The exact parameters will be determined throughout the research phase.

The spatial configuration in this project could potentially have two different timeline options:
1. It would provide a configuration of functions throughout the lifespan of the building, where space can be adapted to various functions in accordance with the needs of the TU Delft Campus. e.g. office and coworking areas can be turned into housing units.
2. It would provide a cycle of space adaptations in course of the day based on the user activity in the building. e.g. conference rooms in the morning can be turned into a lecture hall in the evening.

Both strategies will be researched and determined which one will be applied in the Design Phase of the graduation project. The program of the building will cover student housing, a coworking area, conference rooms, offices, laboratorium, an auditorium, a cafeteria and a grocery shop. The final choice will be conducted through the case study of student community centers and analysis of facilities in the area of the chosen site. The program might change throughout the design process although the main principles of a communi-

OVERALL DESIGN QUESTION

How can we design a mix-used community center integrated with affordable student housing that would utilize prefabricated timber-based modules to ensure the spatial flexibility and a long-term adaptivity in face of the land scarcity of the TU Delft Campus?

THEMATIC RESEARCH QUESTION

What combination of timber-based prefabricated modules would improve the spatial flexibility of multipurpose mid-rise building?

SUBQUESTIONS:

1. What design strategies are currently in use for designing a long-term adaptivity of the building?

2. What kind of modular timber-based solutions are most suitable for interior spatial flexibility and adaptive architecture? (Case study of timber joinery and timber-based 1d,2d and 3d modules)

3. Which parameters would improve the parametric floor plan design that would influence the spatial flexibility of the building interior? (assessing info and implementing it in experimentation for optimal solution)

PRELIMINARY SITE ANALYSIS

The North side of the Campus is quite packed with faculty buildings and it is rather difficult to find a free site for a new structure. The south side, however, offers a lot of free land to accommodate new university's buildings. Moreover, there is a new plan for TU Delft Zuid that would accommodate new faculty buildings and dwellings for the students. Having that said, it feels more resourceful to focus on the central part of the Campus where is a big concentration of student housing already in close vicinity to the existing faculties. To find a new site in a densely built area I suggest repurposing one of the parking places which would encourage people to use bikes and the public transportation instead of cars. The site that I have chosen is particularly interesting due to the high trees that are present on that parking spot. It presents an opportunity to create a blend between the Community Center and a park which would have added value to the project. Moreover, on that particular spot there used to be a modular housing structure for students a.k.a the Space Box, which could serve as a great inspiration for the project.

THEMATIC RESEARCH METHODOLOGY

The research will be conducted basing on three main steps that would take place during the research phase and the design phase. For each step there have been chosen various methodologies to anwser the research questions and subquestions. The steps will intertwine on the experimentation phase since it will be most time demanding step and it would need more fine-tuning. The research planning schematics can be found on the next page.

The research will consist of elements such as:

- Literature research
- A case study of spatial flexibility strategies
- A case study of timber based modules and joinery
- Reference analysis of multifunctional university buildings and community centers
- Site analysis
- Visit on site
- Design research through experimentation (scripting, packig problem, optimization tools)

Investigation:

- a case studies research
- analysis of the site
- case study on the scripting techniques and strategies

Experimentation:

- digital modeling research
- experimental research
- iteration case study

Integration:

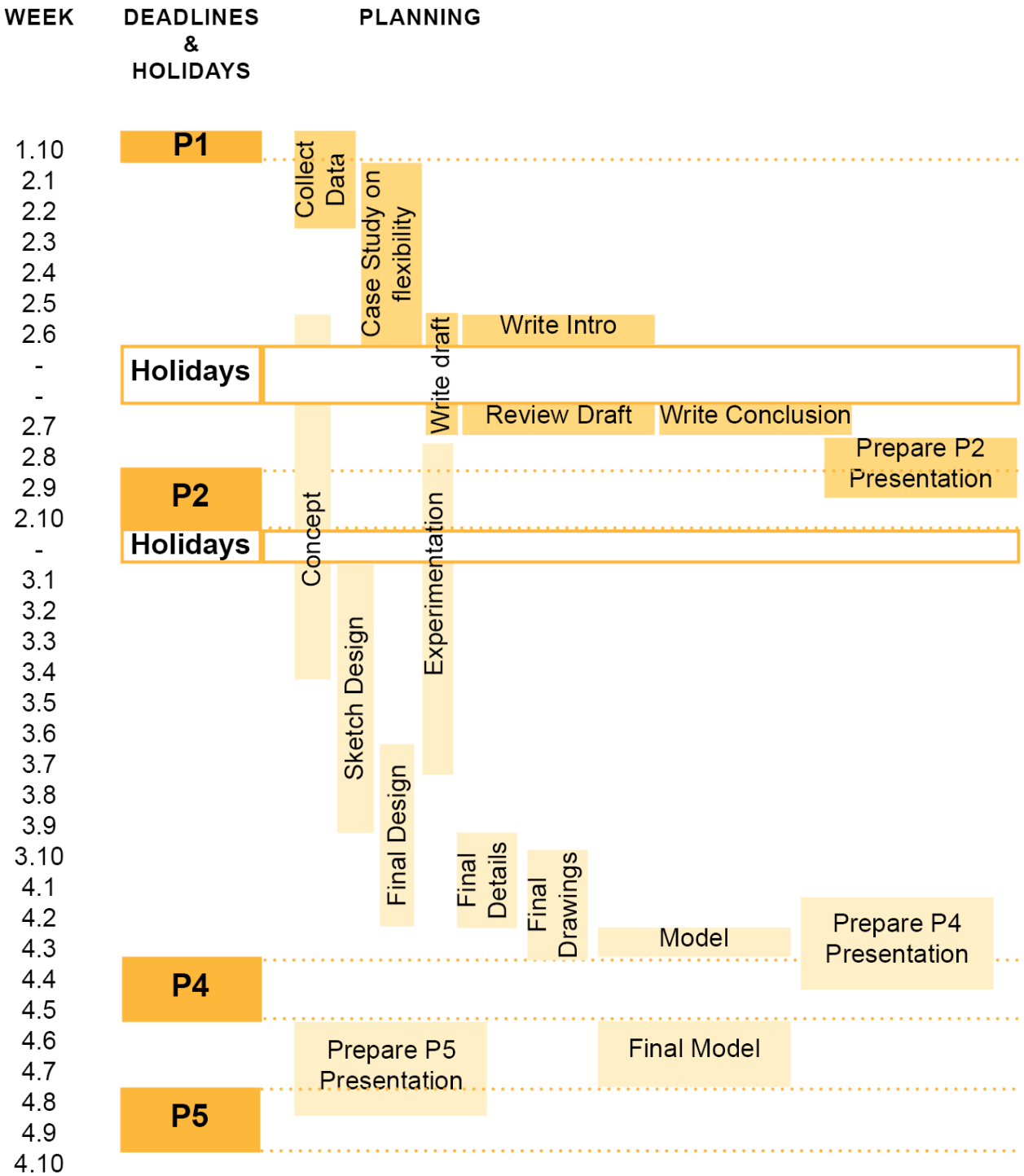
- Application of the findings
- optimization scripting for the floor plan

Research Phase

Design Phase

To find out which modular strategy will fit best in my project it is nessecery to conduct a case study of the buildings with similar design or function. Through compare and contrast, I will be able to decide which particular strategy should be used here. The analysis of the timber-based modular architecture will provide insight into the possible joinery and modules that could potentially influence and even enhance the building's ability to adapt to the changing needs. The findings will be then applied in the digital model to ensure its spatial optimization and flexibility for many functions that would intertwine with each other. If there will be enough time I will also use software for structural analysis - Karamba 3D in order to showcase the possible future adaptations for the building.

PLANNING


WEEK
DEADLINES & HOLIDAYS
PLANNING
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P1
Holidays
P2
Holidays
P4
P5
Collect Data
Case Study on flexibility
Write draft
Write Intro
Review Draft
Write Conclusion
Prepare P2 Presentation
Concept
Sketch Design
Final Design
Experimentation
Final Details
Final Drawings
Model
Prepare P4 Presentation
Prepare P5 Presentation
Final Model

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