HYBRID CAMPUS

Transforming single use parking lots into hybrid buildings

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Context: TU Delft Campus
Technology: Make
Design Program: Open Building

CONTENTS

KEY TERM DEFINITIONS

HYBRID BUILDING

A high density of different individual programs that relate to one another and begin to overlap in their functions, formulating new programmatic typologies. The same applies to the combination and integration of building systems to generate a new system.

MIXED-USE

The incorporation of multiple programmatic functions that act individually from one another.

IN-BETWEEN SPACE

The informal space that links different programmatic functions throughout the building. It is a kind of buffer that mediates between different spaces.

LIVING LAB

Facilitates a place where people and ideas can come together in an environment where there are easily accessible opportunities to learn, create and participate.

TEMPORARY

Components of a building to be easily reconfigured every 20 years to continuously adapt to changing social, environmental and economic contexts.

GENERAL PROBLEM STATEMENT

Lack of Innovation in the Construction Industry

The world is rapidly changing more than ever, with increasing and decreasing populations and issues of land scarcity. There is growing demand from a construction industry that has been considerably slow to technological innovation in comparison to other industries. According to *Imagining construction's digital future*, "adoption has been slow due to a lack of awareness and familiarity within the design and engineering community, a limited supply chain and a lack of availability at scale" (Agarwal et al., 2016). Moreover, within the construction industry the annual productivity growth over the past 20 years was only a third of total economy averages. As a result of thin profit margins and high probability of construction delays. Risk aversion and fragmentation as well as difficulties in attracting digital talent slow down innovation within the industry. Therefore, digitalization in the construction industry is considerably lower than in nearly any other industry (Agarwal et al., 2016) which can be clearly seen in figure 1.

Dependency on Rennovations and Demolitions

The lack of innovation results in the Traditionality of construction methods continuing to produce a building that once complete, is isolated to its time of realization. Inevitably becoming dependent on future renovations and retrofits that are often environmentally and economically costly. In fact, according to the US EPA [Environmental Protection Agency] "92% of all construction related waste produced annually in the US is the result of renovations & demolitions, with only 8% produced from new construction" (Guy & Ciarimboli, 2008). This is largely due to the use of traditional materials such as concrete, which has one of the longest useful lives among building materials, refer to figure 2. However, concrete structures account for the most demolition projects by far and it also has the biggest environmental impacts in the Dutch construction industry (CE Delft, 2013).

Increased Demand

Along with the construction industry severely lagging behind in comparison to other industries, the overall demand for construction continues to increase, "Over the next 10 years, the demand for global construction is expected to increase by 70%" (PricewaterhouseCoopers [PWC], 2015). The cause for this increase in demand is largely due to residential construction services projected to grow at a rate of 6% every year from 2020 to 2030 (Raymond, 2021). Due to increased need for affordable housing, and changing lifestyles resulting in more people living alone or with fewer family members than ever before. The United Nations Department of Economic and Social Affairs has also stated that "55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050" (UN Department of Economic and Social Affairs, 2018) leaving the construction industry to generate greater high density typologies. It is essential that the increase in demand is met with innovative solutions in order to sustain ourselves throughout changing social, environmental and economic contexts.

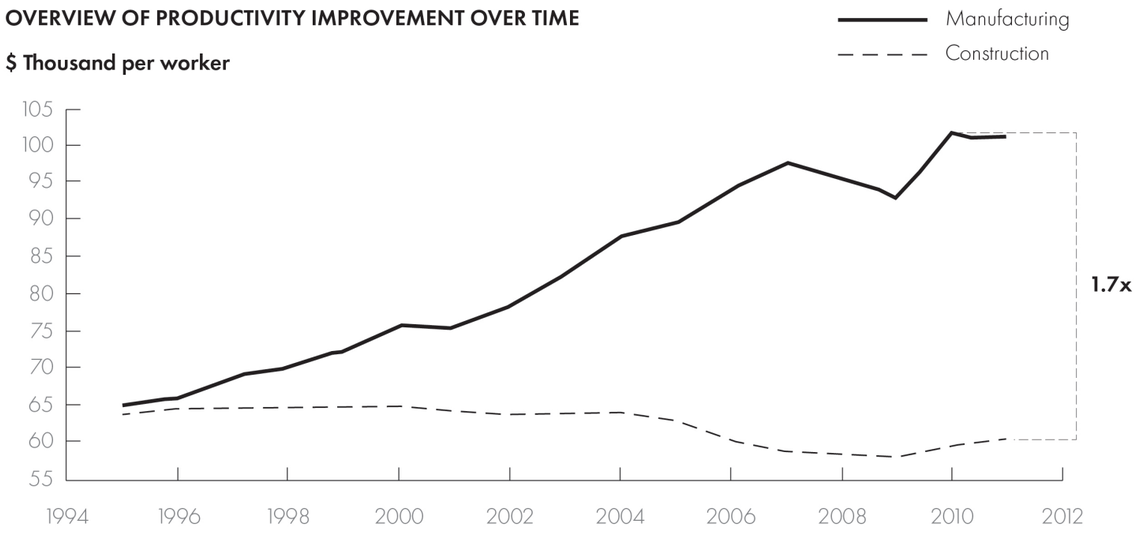


Figure 1

Source: https://www.mckinsey.com/capabilities/operations/our-insights/the-construction-productivity-imperative

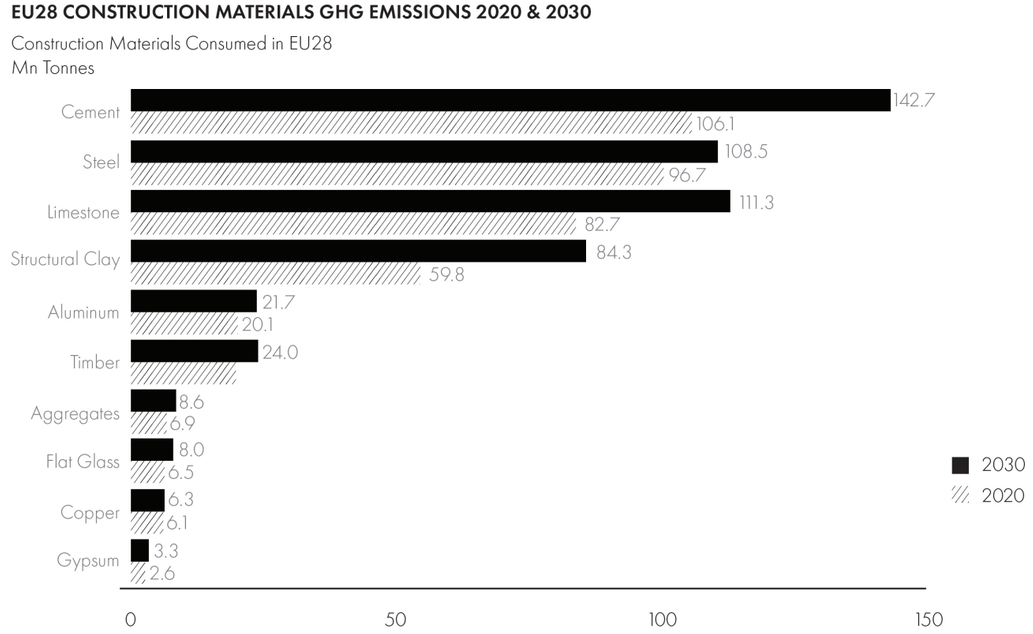


Figure 2

Source: Pinsent Masons, Strabag, European International Contractors and Oxford Economics

General Problem Statement:

As a result of current practices, the built environment is unable to easily adapt to future social, environmental and economic contexts. Producing a significant amount of waste in order to try and upgrade the past, rather than trying to design for the future. With the world changing more than ever, there is a major problem with how we conceive our built environment.

Lack of Innovation

Dependency on Rennovations and Demolitions

Increased Demand

CAMPUS PROBLEM STATEMENT

Does not facilitate the 'living lab' ambition

TU Delft is one of the world's top universities, known for ground breaking research, high level of education and innovative cooperation between external partners. According to the university, it is "a top tech ecosystem that accelerates innovation for a better society. We are home to over 43,500 researchers, entrepreneurs and students" ("About TU Delft Campus", n.d). In order to facilitate this growing tech ecosystem, TU Delft has a long list of ambitions to create a 'living lab' to promote experimentation, innovation and collaboration throughout the campus. In the same light, it is statated that "the campus is intended to become a living lab wherever possible, a place where innovations can be tested." ("TU Delft Development areas", n.d). However, only 6 isolated 'free zones' are available throughout campus which are essentially open plots with no starting framework to easily facilitate students and faculty to come together and collaborate. Moreover, throughout campus current buildings are either faculty specific or only offer places to study and lecture, acting in isolation from one another. With the need for the campus to maximize use of space, there is currently a lack of mixed use and hybrid building typologies that could provide oppourtunities for more activity and cross faculty collaberation. Making it imperative for TU Delft to rethink the role of buildings on campus and vice versa.

Lack of on Campus accomodation

With the number of students increasing, so does the need for accommodation and academic facilities. The living lab is also impacted by the increase in student population and needs to facilitate opportunities for more students and faculty. In response to this, TU Delft states that there is a strong need to maximize the use of space within Delft Campus, primarily in the Stevin Area [Existing campus]. The aim for TU Delft is to turn Stevin into a lively area that links together all the primary functions of the campus; Research, teaching and living. Moreover, there are also plans to develop further south with all new construction for new faculty buildings. However in both existing and new plans, there is little focus being put on housing and mixed use public spaces to promote cross-faculty interaction. According to Monitor Student Housing, Delft currently has 11,800 Dutch students living away from home, 4,600 international students and 100 short-stay students. The forecast is that these 16,500 students presently seeking accommodation will rise to 22,830 in the 2028-29 academic year (Persbureau, 2021). Through an analysis of existing student housing on campus, there are approximately 2144 Housing units which evidently contributes to a lack of activity throughout campus.

TU Delft Campus

2144 Housing Units

A-F: Offered 'Free zones'

CAMPUS PROBLEM STATEMENT

Existing Parking Lots

As a result of the need to maximize use of space on campus and the current lack of high density programming. An initial exploration of TU Delfts existing parking lots was done to establish the proposed site(s) for the project. Six were selected as they are located in undesirable, 'back of house' conditions with little to no activity taking place. Although there are more parking lots throughout Campus, it was these six that provide the greatest surface area and least amount of obstructions to be transformed into hybrid zones to facilitate a series of living labs throughout campus. In total, these selected parking lots make up an area of ±28738m². A significant amount of space for a single use typology when TU Delft has stated its need to maximize the use of space on campus. According to ASVA student union, the average room sizes can range from 14m², 18m², 21m² and 28m² for larger rooms (ASVA Student Union, 2021). Through a basic calculation, it can be assumed that the average student room is about 20.25m².

Excluding any areas of corridors, building systems, etc. If there is a total base area of 28738m² and the average dwelling is 20.25m², then roughly ±1419 units can be added on one level alone. In order to meet the future accommodation of about 23000 students by the year 2029. There would need to be ±16 floors over each selected parking lot throughout TU Delft Campus. However, although this is a very preliminary calculation, it does provide some insight that even meeting accommodation for half of the students (11500) then ±8 floors would be needed. Which is far more than the 2205 student accommodation units that have been realized from 2017 until now as seen in figure 3 (Persbureau, 2021).

Location	Units	Year of completion	Developer
Prof. Schermerhornstraat	332	2017	Duwo
Kanaalweg 3a	47	2017	Duwo
Deltares/Stieltjesweg	665	2017	Duwo
Prof. Schoemakerstraat 97	289	2017	Camelot
Van Bleyswijkstraat	25	2017	Villex
A. Veerstraat 1-15	118	2017	Xior
Abtswoude (tijdelijk)	110	2018	SHS
Phoenixstraat	100	2018	Xior
The Student Hotel	240	2020	The Student Hotel
Campus 015 Pauwmolen	143	2021	Camelot
Balthasar van der Polweg	136	2023	Duwo
Totaal	2205		

Figure 3: Realized Student accomodation from 2017- now

Source: https://www.delta.tudelft.nl/article/shortfall-1500-student-rooms-delft

Parking Lot Areas

1: 6410m² **3:** 4013m² **5:** 3865m²
2: 3810m² **4:** 3451m² **6:** 3324m²

Total Area: 28738m²

TU Delft Campus Problem Statement:

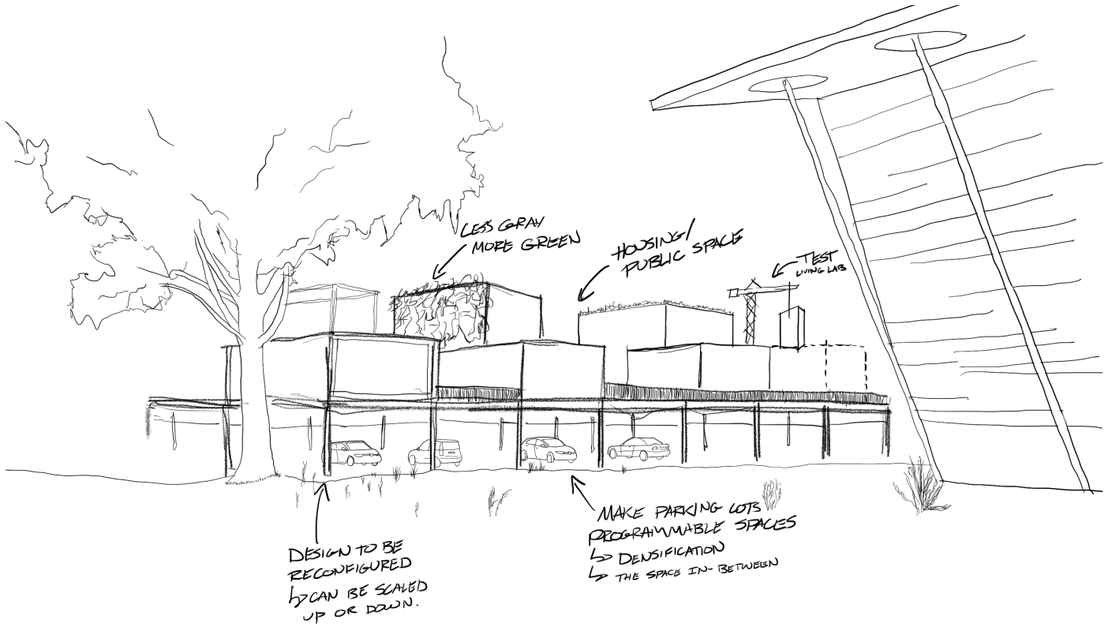
Throughout TU Delft, there is a lack of high density, adaptable mixed-use programming to truly facilitate a living-lab for experimentation, collaboration and innovation. Moreover, this need to maximize space throughout campus provides the opportunity to bring activity to the spaces in-between.

PROJECT OBJECTIVE

The objective for the graduation project is to transform the underused locations of existing parking lots into an active hybrid environment by integrating high density residential, educational, commercial and public uses. Exceeding TU Delft's need to accommodate 23,000 students by 2029, through an optimized temporary kit of parts configuration. The project will explore different spatial qualities within this high density, hybridized environment, rethinking the role of the building on campus.

In order to attain the project objective, architectural typologies and morphologies will act as a primary thematic focus. Within this overall view, sub-themes are introduced to generate a holistic project that will be able to successfully address the previously stated problem statements. These sub-themes include exploring the tectonics of timber, temporary kit of parts, hybrid programme, and hybrid building systems. From the thematic focus and sub-themes, the project will develop a design tool to effectively hybridize existing parking lots with engineered timber systems.

The resulting tool will be utilized to meet a set of spatial quality principles that address three layers of the building, which can be seen on page 22. In turn, the tool is developed to help designers attain the project vision and generate a successful hybridized design.



Source: Authors own Sketch

THEME

Architectural Typologies & Morphologies

SUB-THEMES

Tectonics of Timber
- CNC miling and its implementation to generate a kit of parts
- Quality implications of CNC milling
- Reusability (Lifecycle)
- Social, spacial/ experiential qualities
- Dimensionality of timber elements
- Optimized use of engineered timber

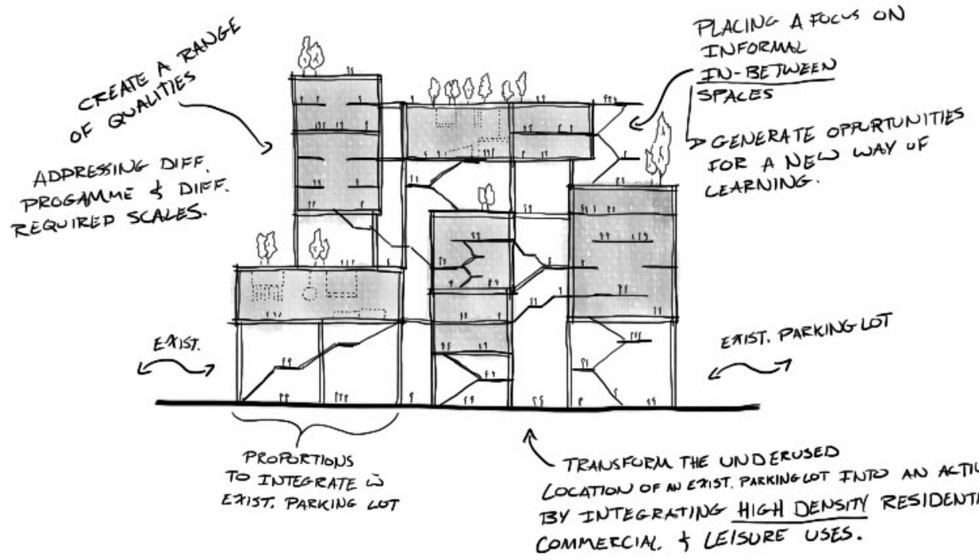
Temporary kit of parts
- Plug and play components
- Joinery of components
- Component tolerances
- 1D, 2D, 3D systems

Hybrid Programme
- Spacial requirements
- Combinations of building systems
-Combinations of Programme
- Generative typologies
- Engagement with surround context

Hybrid Building Systems
- Impacts on rennovation/ demolition memethods
- Environmental impacts
- Material tracking

Design Question:

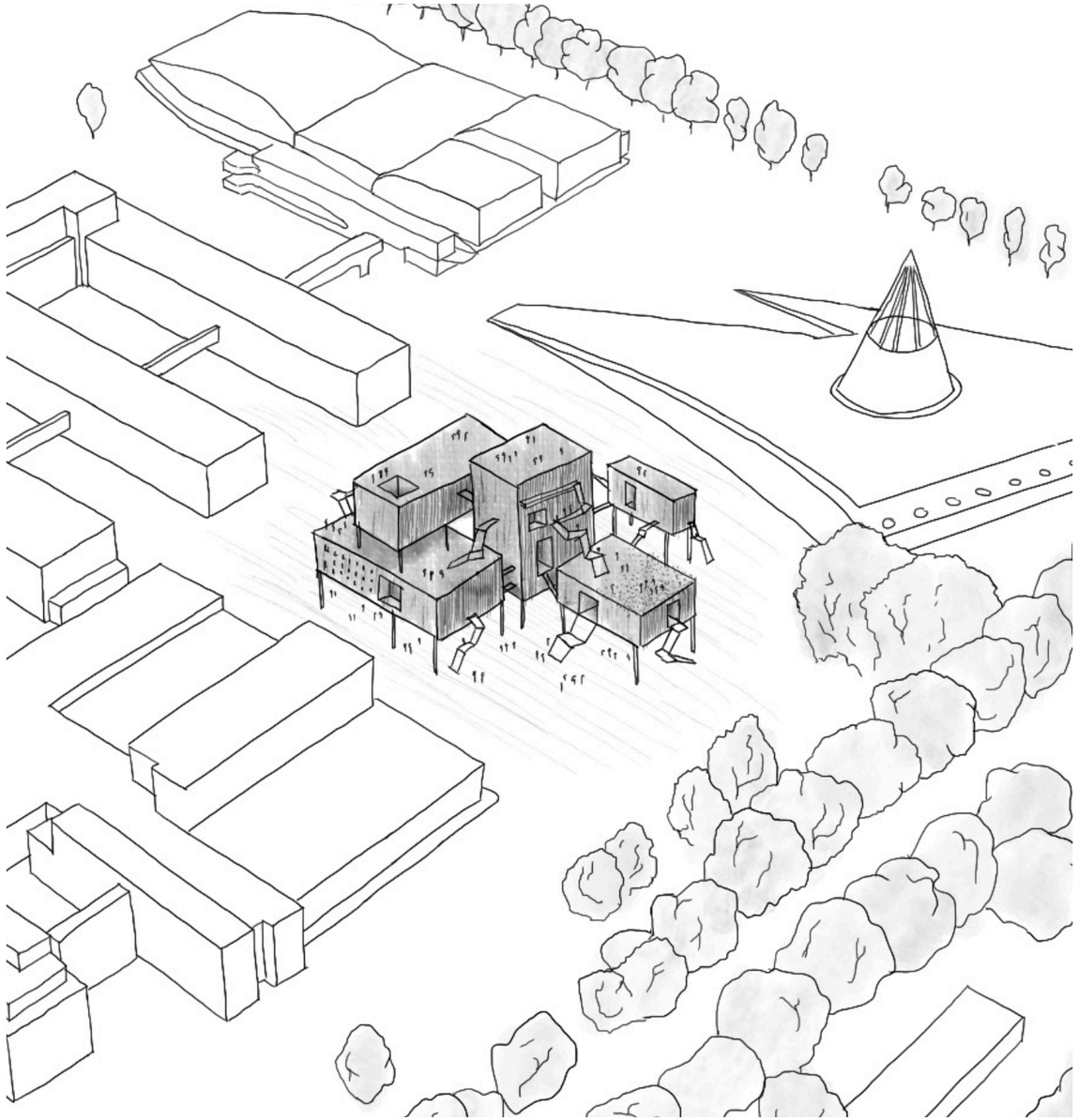
How can a temporary kit of parts generate hybrid building typologies that quickly transform single use parking lots into high density living labs throughout Delft Campus to meet the housing demand?



Source: Authors own Sketch

Design Sub-Questions:

- How does the introduction of hybrid typologies engage with the surrounding context?
- What combination of different programmatic scales generate a temporary hybrid building that best facilitates the ambition of a 'living lab'?
- What methods can be developed to measure programmatic compatibility?
- What are the design implications of programmatic hybridization within a building?



Source: Authors own Sketch

SPATIAL DESIGN PRINCIPLES

LAYER 1: *The approach to the building | Engagement with the surrounding context*

Porous/ Permeable:

- Opening up the building from multiple approaches, allowing people to pass through different aspects. An open, well-organized environment will also improve security

Inviting:

- Large spacious entries to encourage people to come here to meet up and relax.

Green Space:

- Inviting biodiversity into the site, helping to convert the asphalt covered parking lot into places where students can study outside, come together and work on research

LAYER 2: *The in-between space | Horizontal & vertical circulation*

Large Open Collective Space:

- Provide opportunities for cross-faculty collaboration throughout the building. Act as a junction where different programmatic functions overlap. Utilize communal stairs and double height spaces to establish different connection types throughout the building.

Natural Lighting:

- Allow for the in-between space to be naturally lit throughout the building to make the in-between space feel greater than a means of getting from point A to point B

LAYER 3: *The programmatic functions*

Flexible:

- Initial functions should anticipate change, designed with a free plan wherever possible.

Engage with the In-between spaces & surrounding context:

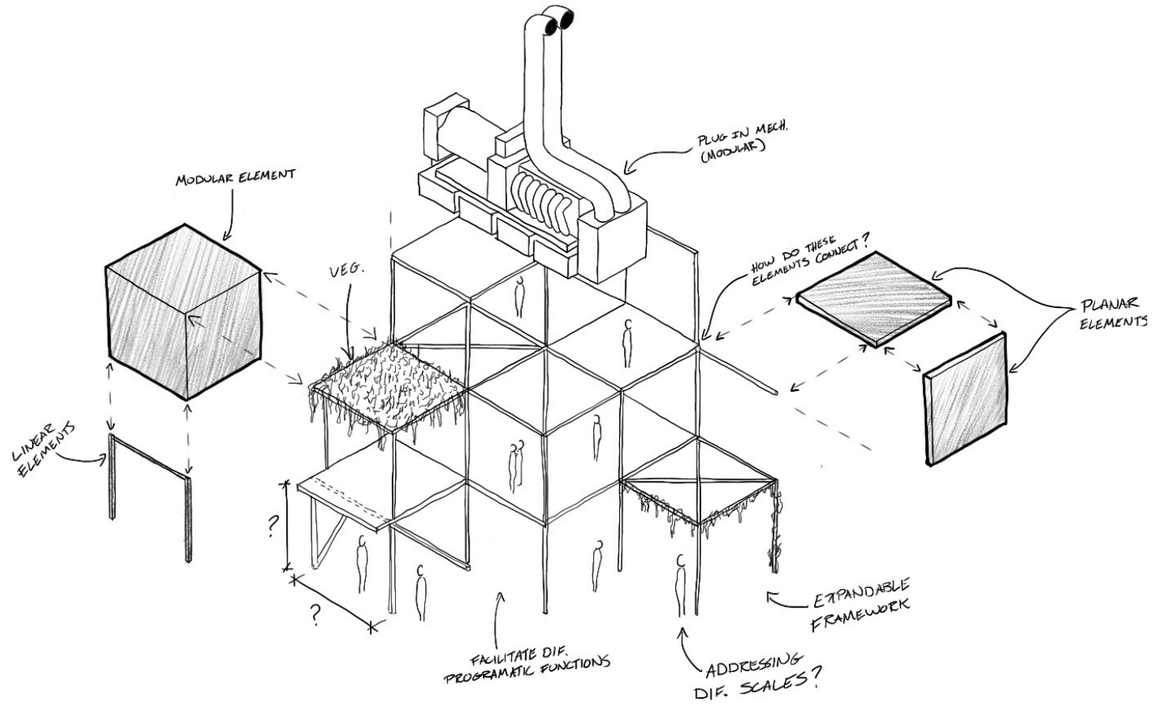
- Taking principles from layers 1 and 2 to generate hybrid typologies.

Each layer of spatial design principles acts as a sequence of experience throughout the project. Starting from the approach to the building and how it engages with the existing context, to the in-between space that takes you throughout the building. Finally ending at the third layer which address the spatial qualities of the programmatic functions. With each principle, the project is aligned with many of TU Delft's ambitions stated on the universities website. As a result, the spatial design principles essentially integrates the campus into the building.

These principles will guide the design of the project, developing architectural typologies and morphologies that are specific for TU Delft campus. Resulting in the techincal research working to attain the design.

Source: Authors own Diagram

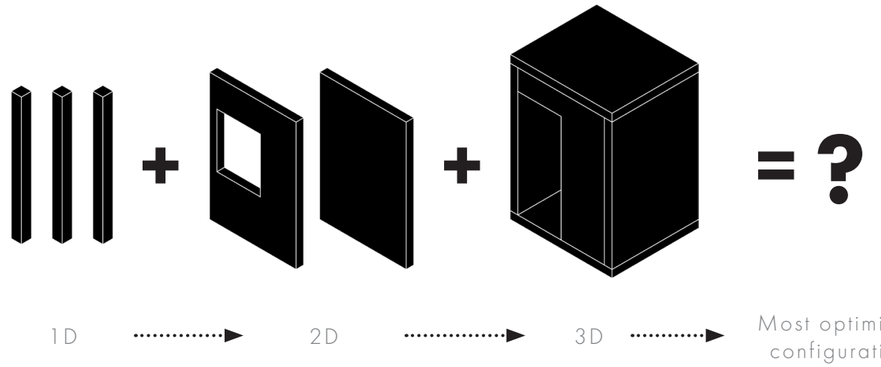
Research Question:
What configuration of prefabricated systems generates the most optimized use of engineered timber for a hybrid building?



Source: Authors own Sketch

Research Sub-Questions:

- What is the relation between 1d/2d/3d engineered timber dimensioning and structural / acoustical/ fire requirements of different programmatic functions?
- What are other aspects / boundary conditions influencing the dimension of 1d/2d/3d engineered timber elements? (Like transport, machine sizes, lifting capacity of cranes etc)
- How to combine this input in a tool for designers, advising in early stages of design about optimized use of engineered timber in relation to designer input such as overall building shape and sizing of compartimentation



Source: Authors own Diagram

THEMATIC RESEARCH METHODOLOGY

The primary research methodologies to be utilized are literature and case study analysis which will generate a collection of information to develop a designer tool. Leading to research by design, where the project will be further developed.

Selected literature and case studies have been selected for both the design and technical research. By doing so, the design focuses on the spatial qualities of architectural typologies and morphologies. The research focuses on the technical aspect of the optimized combination of different engineered timber systems in order to attain the hybrid design ambition. Which will then lead into a building systems analysis, resulting in generating a tool for designers to effectively hybridize existing parking lots with engineered timber systems. As a result, the project becomes a fully hybrid proposal, with the combination of programmatic types and building system types to generate a new type of campus building.

For the design aspect, three Case Studies have been selected with the intention of exploring each of the proposed spatial design principle layers. Essentially, layer 1 will be explored through Steven Holl's Linked Hybrid for its engagement with the surrounding context and layer 2 is then explored through Diller Scofido + Renfro's Vagelos Education Center for its use of hybrid vertical circulation. Finally, layer 3 will be examined through the Downtown Athletic club due to its wide range of different programmatic functions encapsulated in a traditional building envelope.

The research aspect will look at how to attain the project objective with the most optimized use of timber through the hybridization of building systems. Case Studies will be used to examine the use of timber for different program typologies; education, residential, commercial, and public. Developing and understanding of 1d/2d/3d systems that are utilized for each typology and what the most optimized combinations and configurations could be. Creating a tool that ensures the most optimized use of engineered timber within a hybrid building.

As a result of the literature and case studies, a design tool will be developed to effectively hybridize existing parking lots with engineered timber systems and be utilized to attain the proposed project objective through research by design. The tool itself will act as a type of 'master spreadsheet', exploring how the collected information can be used to attain a final design.

It is important to note that due to the ambitious nature of the project. Typologies related to residential and education will be examined first and then the other typologies are to follow. This will ensure that even if there is not enough time to attain all four, then there will still be a successful project that addresses the hybridization of education and residential typologies. However, the ambition is to attain all four.

DESIGN METHODOLOGIES
(Typologies/ Morphologies)

Casestudy Analysis:
- Linked Hybrid - Steven Holl
- Vagelos Education Center - Diller Scofido + Renfro
- Downtown Athletic Club

Literature Analysis:
- This is Hybrid - Steven Holl
- Delirious New York - Rem Koolhaas
- 50 Hybrid Buildings - Catalogue On the Art of Mixing Uses
- Pamphlet architecture 11: hybrid buildings

RESEARCH METHODOLOGIES
(Optimized Timber Systems)

Casestudy Analysis:
- Timber Education Building system
- Timber Public Building system
- Timber Residential Building system
- Timber Commercial Building system

Literature Analysis:
- 100 UK CLT Projects
- Offsite Architecture
- Prefab Architecture
- Manual of Multi-Storey Timber Construction

A TOOL FOR DESIGNERS TO EFFECTIVELY HYBRIDIZE EXISTING PARKING LOTS WITH ENGINEERED TIMBER SYSTEMS

PRELIMINARY DESIGN EXPLORATION
(RESEARCH BY DESIGN)

KIT OF PARTS DEVELOPMENT

SITE SPECIFIC PROGRAM CONFIGURATION

FINAL SCHEMATIC DESIGN

DESIGN DEVELOPMENT

FINAL PRODUCT

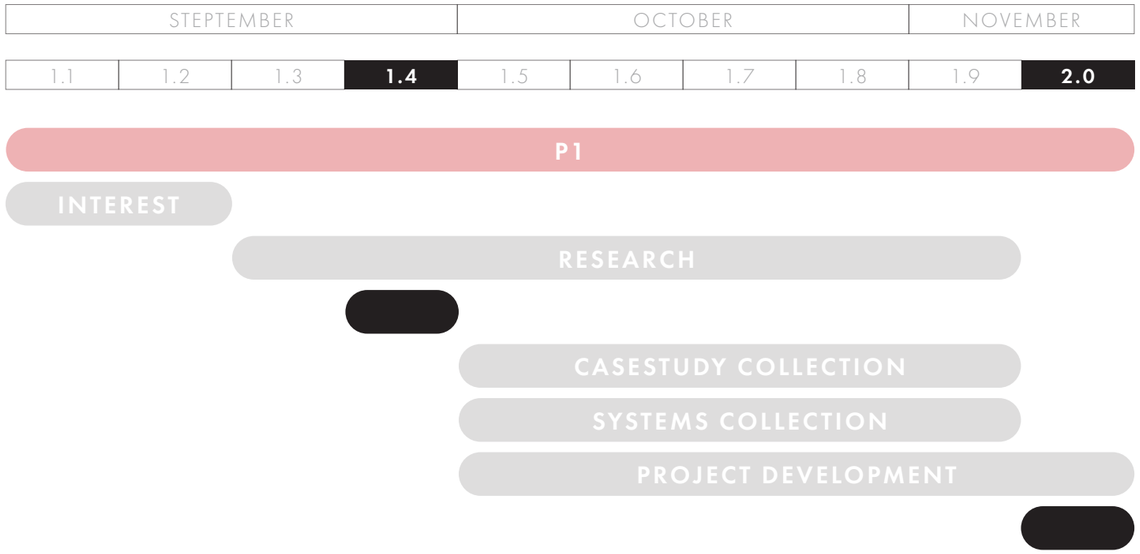
P2

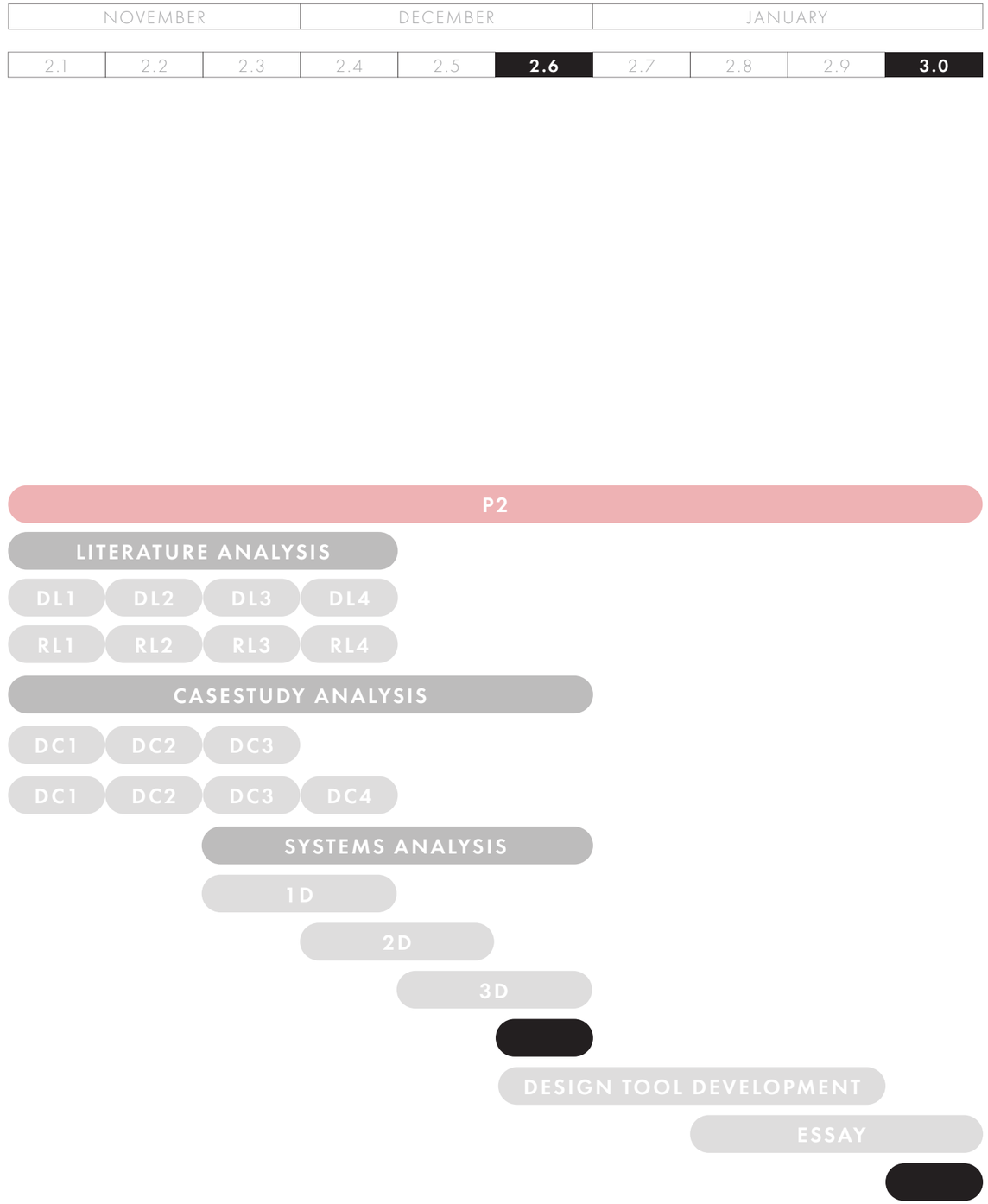
P3

P4

P5

RESEARCH PLAN





DL# = Design Literature
RL# = Research Literature
DC# = Design Casestudy
RC# = Research Casestudy
= Major Milestone
= Phase Duration

RESEARCH PLAN

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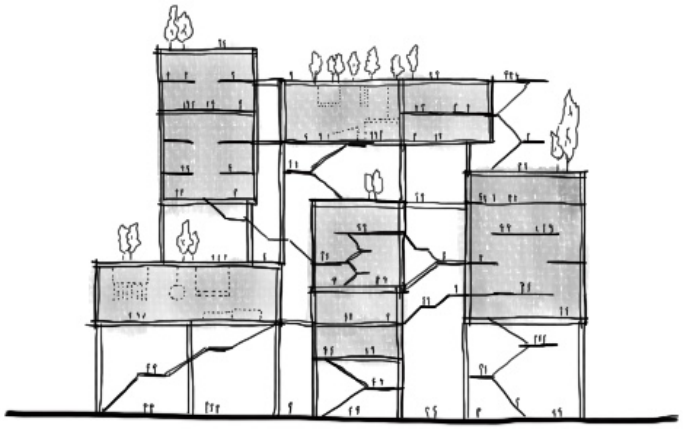

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