Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Max Simon Ketelaar
Student number	4379691

Studio		
Name / Theme	Generative configuration design	
Main mentor	Shervin Azadi	Computational design
Second mentor	Eleonora Brembilla	Daylight modelling/simulation
Argumentation of choice of the studio	Operations research, MCDA, programming, and configurative and generative design are interesting to me. These are also relatively new fields in a building engineering context and likely to become more and more relevant in an increasingly digital world	

Graduation project	
Title of the graduation project	A generative methodology for layout design of affordable development projects using multi-criteria decision analysis.
Goal	
Location:	The primary case study / testing area is the greenfield area southeast of the Delft train station
The posed problem,	How to value and maximize ground usage efficiency in a multi-criteria decision space to minimize construction and rent costs and maximize solar and programmatic performance.
research questions and	See below
design assignment in which these result.	See below

There is a general shortage of affordable housing in the Netherlands – mostly starter housing. Even when accounting for available retrofitting and redevelopment, some new additions to the building stock have to be made.

To maximize yields on the available ground, a design workflow is needed to help make the decisions that affect the value of real estate as early as possible in the design process. The aim of this thesis is to find out:

- What performance indicators [hard/soft, quantity/quality, preference, requirement] can be taken into account, which ones should always be taken into account for affordable housing and solar and programmatic performance
- How these indicators can be quantified/modeled and then combined for analysis using different multi-criteria decision analysis [MCDA] methods
- How the analysis of these indicators can help generate configurations that can be used practically in a design setting.

These research questions will be studied within the confines of a representative case study in the Randstad, specifically the Delft station area.

Process

Method description

First a literature review is conducted to research the state of MCDA, solar simulations, appraisals, and generative design in the building industry. After this, the key performance indicators are identified. These are projected costs, solar performance, and configurative performance. For each of these, scores need to be aggregated and then compared using different MCDA methods. The resulting values for the independent variables are then used to generate different designs (configurations), and these designs can then be evaluated on how well they perform per different MCDA method. From this, the research can conclude with suggestions on what methods perform best for what purpose and in what context. The results are then validated by reapplying the method to a different case study.

Literature and general practical preference

The literature reviewed up to this point covers different fields:

MCDA: Different algorithms in differing contexts including mixed integer linear programming (MILP), NSGA-ii, MCDM-23, artificial neural networks, (fuzzy) AHP, TOPSIS, COPRAS, MAUT and others. One paper in particular; "*Multi-Criteria Analysis of Design Solutions in Architecture and Engineering: Review of Applications and a Case Study*" was very helpful in creating an overview of the available methods and their uses.

For the price projecting system, *hedonic analysis* was studied which attempts to break down pricing of combined products by their individual parts or aspects. "*ANN+GIS: An automated system for property valuation"* describes the usage of hedonics, and "*Hedonic analysis of housing markets"* further details how this method can be used to establish prices. Due to the high amount of specific data required, it is decided not to apply this technique and instead look for an alternative method of appraisal.

The case study "*Generative urban design: integrating financial and energy goals for automated neighborhood layout"* is a starting point for a combined solar and configurative approach to generative layout design. These two aspects have to be further researched to make a definitive decision on what method is to be used to evaluate the performance of the design.

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)?**

Multi-criteria decision analysis has been widely applied to other industries, but in construction (engineering) less so. The large amount of diverging actors and factors in construction design and engineering are fertile ground for research into MCDA methods. With an increasing adoption of digital methods from the industry, this topic within the field of Building technology is increasingly relevant with regular new research and development. The benefits of this to the industry are promising but consistency and reproducibility remain issues. It is therefore important to conduct more research on this topic and the application thereof, as well as the implications this has on a practical level.

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

There is a general shortage of affordable housing in the Netherlands – mostly starter housing. Even when accounting for available retrofitting and redevelopment, some new additions to the building stock have to be made.

To keep housing costs low, the Dutch government in the past has implemented social housing as a way to provide for this low segment. In recent years, social housing construction has subsided due to a liberalization of the housing market and increasing labour and ground costs. It is therefore now unattractive to build in this segment for municipalities and developers.

An increased value of affordable housing (value in the broad sense i.e. price/quality relations), it will be more attractive to build and therefore availability should go up and/or prices go down for affordable housing

Time planning

See attached file

Graduation project Max

Phase	Content	Month: / Week:	Process
P1			**100%**
	Draft graduation plan		100%
	Conceptual research/design framework		100%
	First literature study results		100%
	Filing & backup organization		100%
	Presentation		100%
	P2 registration: before november 13th		100%
P2			**70%**
	Graduation plan		100%
	~~Structural mechanics resit~~		100%
	Design task (context, programme of requirements, draft design, reference projects)		50%
	Report (research framework + literature study)		50%
	Presentation		50%
P3			**18%**
	Structural mechanics exercise (22-1)		0%
	A: price projecting system		50%
	B: solar performance indicator		10%
	C: configurative performance indicator		10%
	D: decision support system		10%
	Draft reflection		0%
	Design by research (vv) results		10%
	Conceptual thesis report		0%
	Plan for the remaining graduation timespan		0%
	Apply for P4: april 9th		0%
P4			**0%**
	Final reflection		0%
	Final design (results based on process, testing of concept and design)		0%
	Draft final thesis report (research results prcesses + conclusions drawn)		0%
	Presentation		0%
	Go/noGo for P5: may 28th		0%
P5			**0%**
	Final presentation of the design: before july 9th		0%
	Final thesis report		0%
	Verbal and digital final presentation		0%