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	Anna Konstantopoulou
Student number	5834384

Studio		
Name / Theme	Building Technology Design Graduation Studio	
Main mentor	Dr. Faidra Oikonomopoulou	Structural Cast Glass
Second mentor	Dr. Mariana Popescu	Digital fabrication – CNC knitted formworks
Argumentation of choice of the studio	I chose the Building Technology Design Graduation Studio due to my enthusiasm for advanced research and design projects. Recognizing the transformative impact of technology on architectural practices, I am motivated to explore how it influences the design of buildings. The studio's focus on structural and façade design, sustainability, and digital manufacturing aligns perfectly with my goal of acquiring the knowledge and skills necessary to design in the context of modern world environments. I chose this studio to engage myself in this dynamic sector and contribute to the changing scene of architectural innovation through the lens of advanced fabrication techniques.	

Graduation project	
Title of the graduation project	Freeform Transparency: introducing a novel fabrication technique for curved glass utilizing knitted moulds
Goal	
Location:	There are two possible case studies. Depending on the outcome of the experiments, a glass component will be developed for a facade or roof component, and therefore, the appropriate case study will be chosen. For façade component, the corrugated glass façade of *Casa da Musica* in Porto is chosen. For roof component, the steel

	roof of the *Manchester Library* is selected to be replaced with glass.
The posed problem,	Despite all the advancements in glass curving methods, there are plenty of limitations in creating freeform buildings. Most of the buildings with 3-dimensionally shaped glass envelopes comprise of panels of similar curvature that form the final shape, which leads to repetition in the facades. More fluid freeform envelopes are tessellated, and the final 3dimensionality is achieved by using smalls planar glass panels. Geometrically, it has been proven in research that glass can achieve great curvatures with the right combination of temperature and mould. Several built examples also prove that freeform glass envelopes are feasible, however, the main problem/negative aspect of them is the extremely high manufacturing cost. Freeform shapes are divided into panels which are unique surfaces and, therefore, require individual moulds. Adjustable moulds which might be a solution to lowering the cost of manufacturing are a technology well developed for other materials, whereas for glass, while they exist, they are not fully proven to work on large scale in the industry and they are not easily accessible. Currently, there is no known manufacturing technique for freeform non-standardized glass panels that can achieve extreme geometries and remain simple in the manufacturing of the mould itself, therefore, not increasing the cost of the process at a high level.
research questions and	As stated above, currently there is no way to curve glass in freeform non standardized panels in a simple way. However, research on other materials shows great promise in what may be feasible by combing flexible moulds with glass. This leads to the main research question of this thesis which is:

	Can a novel fabrication technique be developed to enable the cost-effective production of freeform, non-standardized curved glass components? Is it feasible to create a knitted mold for glass slumping? To be able to answer to this question, the following sub questions emerge and will guide this research: • Which are the geometrical limitations of this method? • Which is the best combination of materials for the mould in terms of glass surface quality, coatings/release agents for de-moulding, final achieved geometry and possibility of texture on glass? • How can this fabrication method be improved in terms of visual & aesthetic quality, structural redundancy & sustainability?
design assignment in which these result.	The final design will refer to the design of the façade or roof glass component. It will describe both the findings of the experimental process that lead to the design, but also the final details of assembly and connections between different panels manufactured in such way.

[This should be formulated in such a way that the graduation project can answer these questions.
The definition of the problem has to be significant to a clearly defined area of research and design.]

Process

Method description

In order to explore this topic, the thesis is divided into three main parts.

The first is a literature review, which will serve as the foundation, comprising of extensive research on relevant papers and publication. Existing glass curving techniques will be analyzed and compared qualitatively in terms of a set of criteria for visual, geometrical freedom and structural aspects. Moulds currently used for glass curving will be thoroughly researched, as well as flexible moulds used for other materials. Similarly, moulds will be qualitatively assessed with a set of criteria on visual, geometrical freedom, fabrication limitations and sustainability aspects. Furthermore, suitable textiles and coatings for knitted moulds to be used for glass will be examined.

The second part is an experimental part. Lab experiments will be conducted to determine if this novel fabrication technique is feasible, under which conditions and which are the limitations.

The final part of the thesis is prototyping. Given a selected case study and depending on the findings of the experiments, a prototype will be developed for a glass panel to be used as façade or roof element.

Literature and general practical references

Different resources will be explored for the main topics of the literature review.

The full list of references to be consulted is:

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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)?

By bridging the gap between the studio's emphasis on sustainable practices and my specific focus on innovative glass fabrication, my project contributes to the broader objectives of the BT master track and the Master of Science in Architecture, Urbanism, and Building Sciences (MSc AUBS) program.

My graduation project topic is based on a novel curved glass fabrication method, which was directly influenced by the courses I took in structural design for glass structures and facade design. This is consistent with the objective of the Building Technology (BT) master program, which stresses advanced technology and new approaches to building design. My investigation into cutting-edge fabrication processes for curved glass is linked to the BT studio's larger focus on digital manufacturing.

This thesis seeks to react to the architectural trend of fluid architecture, which challenges traditional geometrical complexity and manufacturing limitations. The objective is to provide a novel fabrication process for freeform curved glass that substantially reduces the cost of manufacturing non-standardized components.

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

My graduation work has a broader social, professional, and scientific context, making it relevant outside academia. Socially, my study on a novel fabrication technology for curved glass corresponds to the growing need for sustainable and aesthetically pleasing building solutions. My work contributes to the larger societal goals of resource efficiency and environmental responsibility by presenting a method that provides cost-effective options for making non-standardized components of geometric complexity. As the industry embraces technology innovations, my study offers a practical and forward-thinking approach to meeting the changing needs of fluid architecture.

Scientifically, my graduation work contributes to the growing body of knowledge in the field of building technology. It introduces a new perspective on fabrication methods for curved glass, adding valuable insights to the ongoing discussion on sustainable construction practices. This research has the potential to inspire further studies and advancements in the broader scientific community, fostering innovation and pushing the boundaries of what is achievable in architectural design and construction with glass.