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.

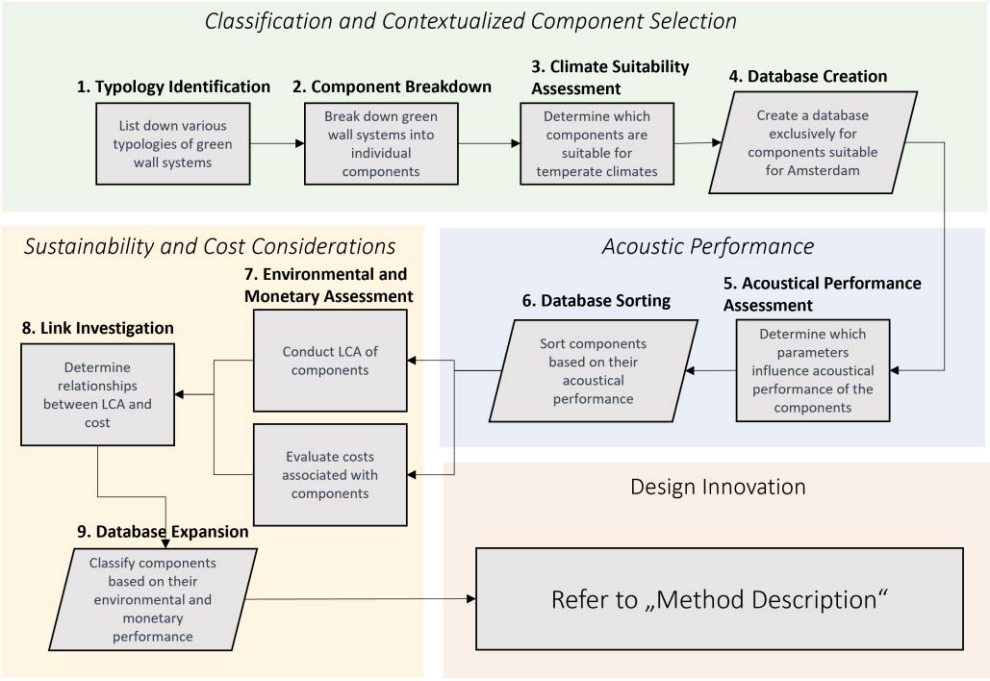
The graduation plan consists of at least the following data/segments:

Personal information	
Name	Sofia Markson
Student number	5691362

Studio		
Name / Theme	Building Technology / Urban Comfort	
Main mentor	Dr.ir. M.C. Lugten	Architecture and the Built Environment: *Environmental Technology and Design*
Second mentor	Dr.ir. M. Ottele	Civil Engineering & Geosciences: *Materials and Environment*
Third mentor	Ir. A. Balderrama	Architecture and the Built Environment: *Architectural Technology*
Argumentation of choice of the studio	Selecting this studio for my graduation project aligns with my aim to enhance the acoustical environment in metropolitan areas, specifically through the integration of green wall technology. Increased air traffic and vehicular activity have amplified noise pollution, posing a significant threat to public health. Consequently, my focus centers on sustainable tools that efficiently mitigate noise pollution, emphasizing the imperative for cost-effective and environmentally friendly solutions.	

Graduation project	
Title of the graduation project	Optimization of the Green Wall Systems for Noise Mitigation in Urban Environments
Goal	
Location:	Amsterdam (case study)
The posed problem,	Green walls gain popularity for transforming urban spaces, combating concrete monotony, and alleviating urban desiccation through biophilic design. Green walls do more than enhance aesthetics; they are crucial for promoting biodiversity, purifying air, regulating temperature, reducing

	energy consumption, and mitigating greenhouse gas emissions. These essential functions contribute to their widespread adoption. Despite this, green walls also possess a positive acoustical effect, acting as noise attenuation layers. Buildings and roads, constructed with acoustically rigid materials, reflect traffic noise, thereby significantly amplifying environmental/urban noise. However, the positive acoustical effect of green walls, crucial for noise reduction in urban areas, lacks in-depth scrutiny. The variation in noise attenuation effectiveness across different green wall structure types is evident but understudied. To address this gap, a concise quantitative assessment is needed, evaluating green wall systems for outdoor use based on cost, environmental impact, and acoustical efficiency. Critical to this assessment is defining the specific application area, considering the climate sensitivity of green walls. Living organisms - plants, require tailored design and maintenance to thrive in local climate conditions. Seasonal variations in temperature, daylight, and precipitation must be factored in for adaptability, ensuring year-round plant health. This not only boosts sustainability but also minimizes maintenance costs and reduces the risk of system failure, safeguarding investments, and overall system integrity.
research questions and	**<u>Main Research Question:</u>** - How to configure green wall façade systems to optimize their acoustic performance while balancing cost and environmental impact? **<u>Sub-Research Questions:</u>** *Classification and Contextualized Component Selection:* - How are green wall systems classified, and what are their corresponding components? - How should the selection of green wall components (plant species and substrates) be determined in Amsterdam? *Acoustic Performance:* - How do the individual components of green walls contribute to the overall acoustic performance of the system, and which specific components exhibit the greatest potential for effectively attenuating noise? - What are the underlying acoustic principles that govern the effectiveness of green wall systems in noise attenuation?

	Sustainability and Cost Considerations: - How do different green wall systems perform across the four life cycle phases: Production, Use, Maintenance, and End of Life? - What factors contribute to the costs of green wall systems in each life cycle phase? *Design Innovation:* - How can engineering principles be leveraged to innovate and create novel green wall systems with enhanced acoustic properties?
design assignment in which these result.	The established research questions will help to identify several design solutions for green wall systems. The design components of these green walls will undergo thorough investigation as depicted:  As a result of the investigation, multiple design proposals will be formulated. The evaluation of these design proposals will be conducted through impedance tube measurements. This approach enables the acoustical parameters of individual green wall components to be utilized as input for the Transfer Matrix. Ultimately, the application of this engineering principle will refine the proposed designs, transforming them into innovative solutions. Subsequently, the Transfer Matrix will be the core element of the tool, which will deliver the optimal dimensions, specifically the thickness, of the green wall system to meet the required noise attenuation benchmark in targeted urban areas of Amsterdam.

Process

Method description

The primary objective of this thesis is to develop a digital tool for optimal green wall design decisions, emphasizing quantitative acoustical performance and sustainability assessment through a comprehensive approach:

1. **Development of the Design Proposals:**

- **Objective:** Investigate correlations between different green wall types and the performance of their components, specifically assessing acoustics, environmental impact, and cost factors.
- **Process:** Relationships between these domains are established to generate design proposals for green wall systems suitable for the Amsterdam area.
- **Outcome:** Justified design proposals through the interconnected analysis of various domains.

2. **Acoustical Validation of the Design Proposals:**

- **Objective:** Design proposals are assessed in terms of acoustic performance.
- **Process:**
  - Impedance tube measurements are utilized to determine the effective speed of sound and characteristic impedance of soil and plant samples separately.
  - The Transfer Matrix Method is applied to calculate normal incidence return loss of the design proposals.
    - The green wall system's transfer matrix is obtained as the product of individual samples' transfer matrices.
  - A heat map is generated to illustrate the influence of layer thickness on the return loss per frequency.
- **Outcome:** Design proposals are validated with a focus on acoustic performance.

3. **Advancement of the Design Proposals:**

- **Objective**: Revision of initial design proposals to enhance acoustical performance.
- **Process**:
  - Utilizing the measured characteristics of the components to reconfigure the initial design proposals.
  - Establishing a foundation for promoting innovation and the development of more novel green wall systems based on the obtained parameters.
- **Outcome:** The configuration of green wall components that yields the highest overall acoustical performance for the facade system

4. **Development of the Tool:**

- **Objective:** A digital tool for optimal green wall design decisions is developed.
- **Framework:**
  - Amsterdam is selected as a case study due to the availability of diverse noise exposure data.
  - Noise data is combined with the open street map of Amsterdam.

    - Users are enabled to insert specific neighborhoods or streets to visualize the urban noise situation.
    - Noise environment information is incorporated to allow users to select preferred green wall systems.
    - Recommendations for optimal layer dimensioning based on the selected green wall system are provided.
    - Estimations of environmental burden and potential costs for the chosen design configuration are included.
- **Outcome:** A user-friendly tool is created, allowing users to make informed decisions about green wall designs considering acoustics, environmental impact, and cost.

Literature and general practical references

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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)?

My graduation project on mitigating urban noise pollution directly aligns with my master track in Building Technology (BT) as this research is closely linked to the building physics domain, emphasizing the integration of acoustical engineering with technology. The secondary focus on sustainability and cost-effectiveness contributes to the broader mission within built environment, echoing the environmental concerns within the sector. Additionally, this holistic approach extends its impact to the field of urbanism by offering practical tools to enhance living conditions in the metropolitan areas.

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

My graduation work holds great importance in a larger context as it closely aligns with the Environmental Policy of the European Union. Urban greening is a crucial aspect of the strategy to reduce carbon emissions and significantly contributes to improving the overall health of cities. This connection is particularly significant, demonstrated by the active participation of European cities in initiatives like the European Commission's green city awards. Successful cities in these initiatives contribute to environmental enhancement, tackle pollution, and bolster resilience against climate change. Therefore, advocating for the promotion of green wall solutions becomes essential, aligning seamlessly with these strategic goals. As urbanization speeds up, green infrastructure is not just about making cities look better; rather, through engineering approaches, it transforms into a versatile solution that aligns with the global mission.