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

<table>
<thead>
<tr>
<th>Name</th>
<th>Ankur Gupta</th>
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</thead>
<tbody>
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### Studio

<table>
<thead>
<tr>
<th>Name / Theme</th>
<th>Circular economy</th>
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<tbody>
<tr>
<td>Teachers / tutors</td>
<td>Tillmann Klien, Peter Russel</td>
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<tr>
<td>Argumentation of choice of the studio</td>
<td>I wanted to solve a technical problem which hinders the sustainable development. Questioning of complex work-flows related to construction and procurement and proposing simplified work-flows for sustainability and efficiency is the aim of this choice.</td>
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### Graduation project

<table>
<thead>
<tr>
<th>Title of the graduation project</th>
<th>Iteration of material banks for circular future: A tool for bridging the gap of material pool and circular design.</th>
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### Goal

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<tr>
<th>Location:</th>
<th>Delft</th>
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<tr>
<td>The posed problem,</td>
<td>Construction and demolition activities in Europe accounts for 25%-30% of all waste that is generated. It is also the most heavy waste stream as compared to others. According to the Circular material use rate Netherlands is 26.7 % circular. And according to government goals Netherlands wants to become 100% circular by 2050. To achieve such an ambitious goal several aspects from business models, procurement, ownership needs to be accessed. Use of Cradle to cradle certified material is encouraged. As architects, we focus on demountable and flexible design. As engineers we can also work on circular</td>
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building products. Meanwhile contractors are also focus on circular demolition of old buildings. This results in pool of material that is existing in built environment which we design not keeping in mind of re-use but potentially certain materials retains the quality for re-use as a different function than they served before.

The future of building design will need to be conscious about the environmental impact and this will directly affect the architecture profession. As circularity will become necessity, we would be required to keep in mind the available material stock and build from that. New skills and tools will be required to make not only procurement but also information at early design stage would be required for either form development or building performance analysis.

Hence, we need to learn how to re-use building components and build from that, like we do it with ‘lego bricks’. Currently there are some companies that sell vintage building materials, but this needs to scale up, both in respect to variety, category and quality information.

| research questions and | 1. Can we accelerate circular flow of materials by proposing re-use at design/engineering stage?  
|                       | a. How do we calculate the progress of circularity while using vintage material as compared to virgin material?  
|                       | b. How do we integrate use of vintage material at early stage of design and detail?  
|                       | c. What are the possible and essential decision-making parameters to use second-hand material v/s virgin material?  
|                       | d. How do we grade circularity v/s energy efficiency and how do we prioritize consideration at early design stage?  
|                       | e. Does circularity rating include environmental impacts of a product? should it?  
|                       | f. What are the requirements of other stakeholders during/to use second hand material?  
|                       | 2. What are BIM standards for maintaining databases?  
|                       | a. How do we create the database of material and how it can be integrated actively with BIM models?  
|                       | b. What are material banks and how are they maintained?  
|                       | c. How do we ensure expansion and not reduction of life-span of a product? |
| design assignment in which these result. | A digital tool, connecting the material database and design model; which will let you freely explore material options based on various parameters such as physical, geometrical, social and economic. Furthermore, compares the environmental impacts of a new equivalent product.

This can currently be visualized as a custom BIM component that is attached to a modeling software and gives access to an online cloud server with the pool of information. This cloud interface can be filtered based on various parameters and when you make a choice, that product can directly be transferred to the BIM model. |

**Process**

**Method description**

The research can clearly be defined in three stages, these are further elaborated in time planning:

**Stage 1:**
Study of existing 'circular' façade products in market, state-of-the-art building products information management.

Cross-categorization of façade components w.r.t compatibility. Existing market for second-hand building components and their limitations.

Review of current relatively significant developed or developing projects related to material banks/passport.

Case studies related to circular building approach.

**Stage 2:**
Creating a digital database of vintage materials and adding researched parameters of the previous stage.

Setting up a flow-chart for the input and output functioning of the digital tool.
**Stage3:**

Development of digital tool to alter Revit components with material database.

Using a case for displaying the potential of the tool and future possibilities

Two parallel searches were conducted. Firstly, the current published articles on circular building process. Some case studies were collected that were available online and were in Europe. Articles and reports from European commission were collected that explains the circularity goals and status of flow of raw material for construction. Management of construction and Demolition waste, measurability of circularity at EU level were also studied. Re-use and recycle potential and their impact on circularity for CDW was prioritized in these studies.

Second search was done on the state-of-the-art BIM tools and customization platforms that are available and widely used in architecture, engineering and construction. Data management, detail levels were also kept in mind. Webinars related to custom BIM components for Autodesk Revit were watched and a list possible tools were made by the end of this research.

For in-depth knowledge and technical consultation ABT company was collaborated with for state-of-the-art building information modeling. Several meetings were scheduled with experts from BIM, plugin development, sustainability experts. Michael Tabak member of Architecture and Sustainability group at ABT introduced me to various possible cases and people that would be essential to meet with respect to the topic. After the meeting with Sandra from ABT, she explained the potential challenges like level of detail, existing material banks, IFC classes, NL/sfb codes etc. These were later in cooperated with the list of parameters for the smart material bank proposal. Jeroen van Kuik is BIM moduler with 20 years of experience. After meeting with him, he introduced me to the MIM ABT tool for calculating environmental impact of new structural components. It is a plugin for Autodesk revit software and made in-house. This will become one of the case studies at a later stage. Emergis project from ABT focuses on the re-use of a wooden structure from a demountable building. The wooden components were re-designed to form the structural concept of the new building. This is also included in the case study example of material re-use, focus on the challenges faced during the process is focused.

With reference and high recommendations from Tillmann Klien a meeting was conducted with BAM on 18th December in their Utrecht office. We met Ellen Masselink and Tom Blankendaal where Tillmann introduced everyone and the faculty. BAM is working on a so called Circular Building platform which they described as an “eBay” of building materials. It is an online platform where you can purchase used/ circular building materials. This knowledge will be considered after P2 for a possible collaboration based on fitness to what knowledge is further necessary to enrich the graduation project.

The collected literature is reviewed and compiled to serves as an overview of the pool of information that is available. From this report priorities will be set based on the direction that
needs to be addressed deeply and define the limitation of the research. As it is not possible to answer all the questions related to circular material use. Clear distinctions need to be made with respect to what answers can be expected from the research.

In order to understand architectural relationship between different building components. A building needs to be dismantled digitally and possible attributed needs to be identified to build a relationship between different components. With this a hierarchy of information needs to be maintained for different relationships. Identifying level and kind of detail required at early design stage for building performance analysis and aesthetical critics. This will then alter the type of information that we need from the material to automate the database.

Once the tool is developed, a chosen design project either self or from the faculty supervisors or guest supervisor will be accessed. This stage is focused more on what kind of workflow is present to finish a project using the designed tool, what are the level of details required and technical requirements for analysis. What changes do we need to make to the database for a version 2.0. These required changes will be documented as conclusion and future scope of the project. This thesis will not repeat the cycle of building the database again after this stage.

Development of further potential use of the tool and what does it mean for architectural design will carried out at the end of the design assignment. Documentation of step-wise process of the use of the tool and key criterion for decision-making will be done. While listing down the limitations and scope of future development.

**Literature and general practical preference**

Since the theme of circularity is fairy new and in development, literature related to EU dictated goals and ambitions is read first. Status of circularity in Netherlands and guidelines for Construction and Demolition waste is studied. Circularity certification (like SWAN) was studied to be aware of the requirements to assess second-hand building materials. Wood, glass, Aluminum and steel is being focused on while going through these documents.

Case studies of past circular projects and challenges related to procurement, construction and demolition is considered. Books and guidelines published my municipalities or companies related to circular future building and measurability of circularity is read. All updated versions were considered as the knowledge is still in development.

Other literature related to state-of-the-art BIM tools and customization platforms were studied. Apart from the articles, webinars are also watched with relation to current developments of custom BIM components and tools that enable that. Only new published webinars and reports are read related to this to avoid technical clashes and outdated knowledge.

**Reflection**

**Relevance**
To ensure circular flow of building materials and making Netherlands a self-sustaining economy we all need to work together. Current trends of architecture, engineering and construction are divided professions and roles. Construction and demolition companies are usually the owners of the discarded materials which ends up in landfill or recycle if potential of re-use is unknown and inaccessible. Providing the access of these discarded materials at early design/engineering stage would provide the opportunity to add value to the products and give a second life which wasn’t thought of before. Also, this will teach us how to design while keeping in mind the sustainability gains of re-using a second-hand material.

Time planning

Other than Sustainable graduation studio I will be attending ARB206 The Berlage sessions which will begin in Q3 which are week 4.2 to 5.4. It is 3 ECTS course with a series of lecture ending with submission of an essay. The time planning for the graduation studio is given as follows:

November

**Week 1.1 & 1.2**

Preparation of the proposal and conceptual idea for the final outcome of thesis. I gave my [P1 presentation](#) on 13th Nov; with support from Tillman Klein, Peter Russel and Boris Bahre, I proposed a platform for building a circular future. In short, I explained how we need to make **smart material banks** to give access to **designers and engineers** so we incorporate circularity at early design stage, while using the existing material stock instead of producing brand new profiles every time. Through my proposal material becomes smart by giving them a **digital identity** and comparing them with a proposed design. In the end I concluded that, first we need to **re-use** the existing materials circularly, rather than producing ‘circular’ details from scratch and that’s why this thesis (CBP) is relevant to be built to accelerate the flow of second-hand material.

**Week 1.3 & 1.4**

Literature related to circularity goals of EU and Netherlands and, review on state-of-the-art custom BIM tools.

December

**Week 2.1**

Listing down parameters that are required to be given to any material component. For example, geometrical, physical, social and economic.

**Week 2.2**

Meetings and interviews for industry knowledge on circularity and BIM.
Week 2.3
More industry meetings and compilation of literature.

Week 2.4
Holidays

January
Week 3.1
Holidays

Week 3.2
P2 presentation and development of parameters for material database. A flowchart of proposed inputs/outputs will be made.

Week 3.3 & 3.4
Dismantling information from a building case. And identifying possible attributes that physically or functionally connects different components. A fast method for building the database need to be identified.

February
Week 4.1
Building the database as per set attributes and parameters.

A decision needs to be made about the software platform that needs to be used to gimmick the potential of the tool.

Week 4.2 & 4.3
Dismantling information from other building cases and feeding into the material bank.

Week 4.4
Two parallel assignment will be done. Firstly, the merging of different building components into one and what parameters will be affected due to that.

March
Week 5.1 & 5.2
Secondly, A lighter version of the tool will be made using Grasshopper and rhinoceros 3D for the P3 presentation in the end of march.

A decision will be made on the choice of further development and necessity with respect to the design project. If by this time, enough knowledge w.r.t to advanced coding platform is
not gained, then more generic coding platform will be used to prove the concept and future potential.

**Week 5.3 & 5.4**
Development of the tool

April

**Week 6.1 & 6.2**
Development of the tool

**Week 6.3**
Development of the tool

**Week 6.4**
Testing the tool with a design project.

May

**Week 7.1**
Development of further potential use of the tool and what does it mean for architectural design. Documentation of step-wise process of the use of the tool and key criterion for decision-making.

**Week 7.2**
Documentation of the process and final thesis report.

Press release package for the tool.

Draft of the thesis report.

**P4 presentation.**

**Week 7.3 & 7.4**
Final report peer-review and corrections.

June

Thesis defense.