**Graduation Plan: All tracks**

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

<table>
<thead>
<tr>
<th><strong>Personal information</strong></th>
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<tbody>
<tr>
<td><strong>Name</strong></td>
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<tr>
<td><strong>Student number</strong></td>
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<tr>
<td><strong>Telephone number</strong></td>
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<td><strong>E-mail address</strong></td>
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<tr>
<th><strong>Studio</strong></th>
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<tbody>
<tr>
<td><strong>Name / Theme</strong></td>
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<tr>
<td><strong>Teachers</strong></td>
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<td><strong>Argumentation of choice of the studio</strong></td>
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<tr>
<th><strong>Graduation project</strong></th>
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<tr>
<td><strong>Title of the graduation project</strong></td>
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<th><strong>Goal</strong></th>
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<td><strong>Location:</strong></td>
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<td><strong>The posed problem,</strong></td>
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| **research questions and design assignment in which these result.** | How can environmental sustainability of adaptive reuse and demolition and new build be compared with the use of a decision support model and what does this model need to entail? |

In order to answer the main research question correctly, a couple of detailed research questions are stated and subdivided among four themes:

**Sustainability**
- What is considered as sustainable development in the built environment?
- How is sustainability measured or assessed in the built environment?
- What entails environmental sustainability in the built environment?

**Assessment tools**
Which assessment tools are there?
What is missing in these tools?
What aspects can be reused in a new decision support model?

Building adaptation, demolition and new build
When are building adaptation and demolition sustainable?
How can building adaptation and demolition be made sustainable?
How can the difference between adaptation and demolition and new build be measured?
What is the difference between demolition and adaptation in relation to environmental sustainability?

Decision support model
What indicators are necessary in a decision support model?
How should a decision support model look like?

The desired and intended final result for this research is a decision support model that can help actors in the built environment to determine whether it is more sustainable to adaptively reuse or demolish a building. The target group of actors in the built environment include all actors that deal with sustainability decisions concerning office buildings, whether that is a client, a project manager, an investor or building owner.

This decision support model should not require a certain level of expertise to be able to use it. Because it should be easy to use, it should encourage actors in the built environment, whether they are a municipality, a project manager, an investor or a client, to use this in their decision making process about sustainability issues.

Process

Method description
This research started with a literature research to find background information about adaptive reuse and sustainability. From this point the decision had to be made what was most interesting to research.

The next step entailed making a conceptual model and formulating my research questions. With the help of a clear overview of my literature research, it became easier to formulate the main research question and the detailed research questions. While formulating my research questions I also made my conceptual model, which was a continuous process that was related to the literature research and these steps in the research influenced each other in their outcome. To conduct my research I decided that I want to use literature study, interviews, case studies and a simulation study as my research methods. The complete overview is shown in the figure below.
To make sure that all the research questions are answered properly during the whole process and at the right moment, a detailed model of research methods have been set up as shown in the figure below. In the middle are the two important variables that will be researched, namely adaptation and demolition and new build. Together they present the options that can be applied to an office building. For each option several aspects will be researched, which are stated in the green boxes. There is a clear distinction between the theoretical input on the left side and the empiric input on the right side. Finally the theoretic and empiric input and the output of the researched options will be the overall input for the decision support model.
Literature and general practical preference
The following references will be and are used for this research:
Conejos, Sheila, Langston, Craig, & Smith, Jim. (2011). Improving the implementation of adaptive reuse strategies for historic buildings.
Dixon, T., Britnell, J., & Watson, G.B. (2014). 'City-Wide’or ‘City-Blind’? Emergent Retrofit
Practices in the UK Commercial Property Sector EPSRC Retrofit 2050.


Reflection

Relevance

Scientific relevance: The objective of this graduation research is to research whether it is more environmentally sustainable to adapt a certain office building or to demolish it and build a new one. This comparison between adaptation and demolition and new build has been researched by W/E adviseurs in 2010 and by Sascha Jansz in 2012.

According to the results of W/E (2010) the difference in environmental load between adaptation and demolition and new build is minimal when the new energy label is between C-A. The Expected Service Life is of major influence on the results of the environmental load. This research has been conducted on reference office buildings with the context of actual office buildings, so no existing office buildings have been used in this study. Even though the results are clear, W/E adviseurs recommends conducting this study on existing office buildings in order to improve the results of this study. W/E adviseurs also think that the results of this study are applicable for 5 years (W/E, 2010).

Just like W/E (2010), Jansz (2012) also states that the impact of the Expected Service Life (ESL) is of great importance and influence in the measurement of environmental sustainability. When the environmental load caused by materials is deducted over the entire service life, a higher ESL
reduces the load per year for materials more than when the ESL is lower. The results of this research showed that for adaptation the environmental load of materials can be deducted over 125 years, while for demolition and new build this can be deducted over 201 years. It differs per case what strategy will be the most sustainable choice, but the bigger the difference in ESL, the bigger the advantage for strategies with a longer ESL will be (Jansz, 2012).

The added value of this graduation research is that the comparison between adaptation and demolition and new build will include the Expected Service Life and that the comparison will be conducted on actual office buildings. With the results of this comparison a decision support model will be developed to help actors in the built environment to make the right environmentally sustainable decision for an office building that is in need of an update. Therefore this research will add to the existing body of knowledge of the sustainability of different strategies and to the knowledge of sustainability assessment tools.

**Societal relevance:** It is a well-known fact that fossil fuels are becoming scarce and that the climate is changing. Worldwide there has been an increasing focus on strategies that address the causes of climate change. The built environment is responsible for approximately 45% of the total global Greenhouse Gas Emissions (GGE). In order to decrease the demand for energy, land and materials resulting from new developments in the construction industry, better care should be taken of existing buildings by extending their life expectancy and using less energy (Conejos, Langston, & Smith, 2014, p. 85; Wilkinson, Remøy, & Langston, 2014). Therefore adaptive reuse is very relevant in the current climate change agenda due to its ability to recycle existing buildings, which results in an overall saving of embodied energy and reducing the demand for natural resources (original sources: Ball, 2002; Bullen, 2007; Conejos, Langston, & Smith, 2011a,b; Douglas, 2006; Langston, 2008; UNEP, 2007).

Annually only 1-2% of newly constructed buildings are added to the existing stock. Even though this newly constructed buildings should include sustainable features in the design and operation phase, according to the typical rates of replacement most of the built environment that will exist in the year 2050 has already been built (Wilkinson et al., 2014, p. xiv).

Another important societal issue concerns office vacancy in the Netherlands. Long-term vacancy is very unfavourable because of the continuing energy use and maintenance while the building is not used for any function (Van der Voordt, Remøy, & Hendrikx, 2012, p. 33).

The intended effect of this research is to help solve vacancy and sustainability issues with office buildings by designing a decision support model that will help to make the right environmentally sustainable choice when it comes to existing office buildings. This model is intended to help to reduce vacancy in the Netherlands as well as to contribute to a more sustainable environment for future generations.

**Time planning**

In the figure below the planning for the complete research period is shown, including the critical path and other courses. As can be seen in this figure, the first critical moment is the P2, where the
research design and methods need to be finished in order to start the actual research in P3. Important there is the Quantitative Research Methods course also has an important deadline. After the P2 there are no other courses that will be part of research period. The next critical moment is halfway during the P4, when the interviews, the case studies and the simulation need to be finished. After that the research output is complete and can be processed. The research output must be complete a couple of weeks before the P4. Once this is finished the final product can be realised, which shows the fourth critical moment in the planning. And finally after the P4, the last finishing touch can be made in order to present the complete research at the P5 moment, which is the last critical moment.