# CREATING A 3D MODEL OF A BUILDING

Veera Keränen

Thesis
January 2015
Construction site management

TAMPEREEN AMMATTIKORKEAKOULU
Tampere University of Applied Sciences

**TIIVISTELMÄ**

Tampereen ammattikorkeakoulu
Rakennusalan työnjohto

KERÄNEN, VEERA:
Creating a 3D model of a building

Opinnäytetyö 24 sivua, joista liitteitä 7 sivua
Tammikuu 2015

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Tämän opinnäytetyön tarkoitus oli luoda 3D-malli asuinkerrostalorakennuksesta ArchiCAD 18 -ohjelmalla. Kyseinen rakennus on vuodelta 1871 ja se oli esimerkki rakennus Gruenderzeitiksi nimetyltä ajalta, joka alkoi Saksassa 1800-luvun lopulla ja päättyi 1900-luvun alussa. Tuona aikana väestönkasvu Saksan kaupungeissa oli nopeaa, mikä vaikutti myös rakentamiseen, sillä asuntojen tarve oli suurta.

Tähän opinnäytetyöhön luotiin rakennuksesta 3D-malli, joka koostuu viidestä kerroksesta, kellarista, katosta ja terassista. 3D-mallista saatiin selville, että rakennuksessa oli noin 500 $m^3$ tiilimuurausta ja sen kerrosala oli 245 $m^2$. Opinnäytetyön lähtötietomateriaalien mukana saatujen kuvien perusteella rakennuksen täydellinen peruskorjaus olisi tarpeellinen. Lisätietojen pohjalta voitiin kuitenkin huomata, että joitakin korjauksia oli jo tehty.

Opinnäytetyötä varten ei tehty vierailua alkuperäiselle rakennukselle. Vierailun ja paikallisiin rakennusviranomaisten asiakirjoihin tutustumisen avulla, voisi kehittää opinnäytetyötä.

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Avainsanat: 3D-malli, Gruenderzeit

**ABSTRACT**

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
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KERÄNEN, VEERA:
Creating a 3D model of a building

Bachelor's thesis 17 pages, appendices 7 pages
January 2015

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The idea of the thesis was to create a 3D model of a multi-storey residential building using ArchiCAD 18 software. The building was an example building from Gruenderzeit and was built in 1871. Gruenderzeit in Germany started in the late 1800s and ended in the first decade of 1900s. During this time in German cities the population growth was fast and it affected also construction because demand for more accommodation was high.

A 3D model consisting of 5 floors, basement, roof and terrace was created for the thesis. By taking out masses and areas from the 3D model it was found out that the building had approximately 500m³ of brickwork and that the Gross Floor Area was 245m². Based on the pictures provided with the thesis materials immediate full renovation of the building would be necessary. However, further information showed that some renovations have already been made.

No visit to the building site was done for the thesis. A visit and studying old documents from local building authorities could improve the thesis.

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Key words: 3D model, Gruenderzeit

**TABLE OF CONTENTS**

# 1 INTRODUCTION

This thesis was written in Jade Hochschule, in Oldenburg. The topic came from Prof. Dr.-Ing. Prueser. The idea of this thesis was to create a 3D model of a multi-storey residential building based on old 2D drawings. ArchiCAD 18 software was used for making the model.

The main part of the thesis was practical. It was the 3D model of the example building from Gruenderzeit. The thesis consists also of a general part which includes translation of the thesis instruction sheet, general information about the population development in Central Europe in the time frame between 1800 and 2000, information about materials and design elements used during Gruenderzeit. Furthermore, information about masses and areas of the example building as well as renovation suggestions are included in the thesis.

The extent of this thesis was 10 ECTS credits which equals to 300 hours of work. The time frame set for the thesis was 8 weeks. Approximately 2/3 of the time was spent for the 3D model and 1/3 for the theory part.

# 2 GENERAL PART

General part of the thesis consists of translation of the thesis instructions, the development of population in Central Europe and construction during Gruenderzeit. Population development and construction are connected because rapid growth of the population all over Europe during 19th century affected also the construction of buildings.

## 2.1 Translation of the task to English

The thesis instructions were given in German and they were as a part of the thesis translated from German to English. The instructions and the translation can be found as appendices in the end of the thesis (Appendix 1 Thesis instructions, Appendix 2 Translation of the instructions).

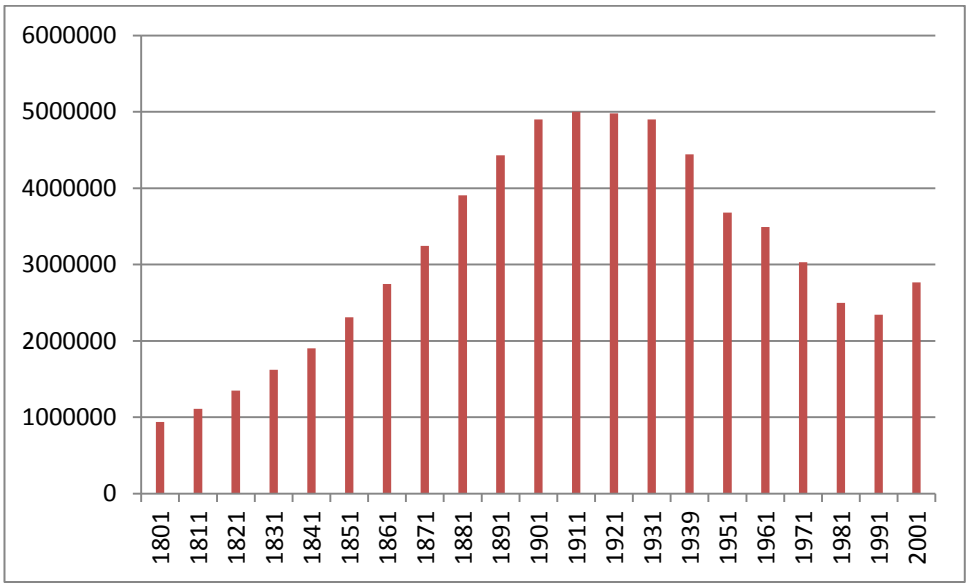
## 2.2 Population development in the Central Europe

Industrial revolution changed the society. Many items were possible to be produced using machines. Therefore people, especially craftsmen, closed their workshops and moved from countrysides to cities to work in factories. This created a massive need for accommodation in the cities. The population growth of cities was multiplied in just couple of decades. Breitling et al (2000, p. 73 - 74).

In the 19th century cities grew in size and population density when agriculture no longer provided enough of income. Many families were forced to move to crowded cities and live on rent. Especially poorer people were living in small apartments in narrow houses built straight next to each other. The landlords were often greedy and therefore apartments were lacking basic equipment. Without hygienic equipment, water pipes and toilets and with poor air circulation and lighting diseases were common in those building blocks. Breitling et al (2000, p. 74,80).

Office for National Statistics (2014) data was used for making Table 1 which shows Inner London population growth in the years between 1801 and 2001. The population grew rapidly from the beginning of the 19th century and was at its peak in the first decades of the 20th century. After that the city population started to decline before increasing again around the change of millennium.

TABLE 1. Inner London population growth




According to professor, Doctor Juergen Osterhammel (2012) the population in the German cities grew from 4,8% to 21,3% in the years between 1871 and 1910 (in cities with inhabitants over 10 000). Therefore, fast population growth in Germany happened during the Gruenderzeit. The city population started expanding a couple of decades later than in London.

Similar rapid population growth in the 19th century was seen in other countries in Europe as well. Wright (2014) states that in the 19th century France rural population decreased and Paris reached maximum population of approximately 2,8 million in the first half of the 20th century, after that people started to move to industrialized suburbs outside the city.

## 2.3 Construction during Gruenderzeit

As stated in the thesis instruction sheet Gruenderzeit in Germany started in the late 1800s and ended in the first decade of 1900s. According to Breitling et al (2000, p. 70) from the mid-19th century onwards the buildings were often constructed in old architectural styles but by using new technological innovations. Old styles were copied and mixed freely.

New building materials such as factory manufactured glass, cast iron, steel and later concrete had made it possible to create different kind of buildings than before. Ware-houses, factories and railway stations were not even considered to be architectural buildings in late 19th century. For the public architecture meant mostly the façade architecture. However a big difference from before was that with stronger materials it was possible to build higher buildings and make more use of limited square meters. Breitling et al (2000, p. 73,76 – 77).

# 3 MAIN PART

The main part of the thesis was to transform the old 2D documents to a 3D model by using ArchiCAD 18. Besides the thesis materials provided from Jade Hochschule, some information about the example building was collected from Internet.

## 3.1 The example building

The original building is located in Leipzig, Germany. It is a 5-floor residential building with a basement. It was built in 1871. As seen in the picture 1 Street view from Google maps (2008) the neighbour buildings have same architectural features and all buildings are some time ago renovated. Opposite to the example building is a park. The building is on the west side of Leipzig city centre. It is just couple of kilometers away from the main railway station which was according to City of Leipzig built 1902 - 1915.

PICTURE 1. Street view. Google maps (2014)

## 3.2 Creating the 3D model

With learning to use an unfamiliar software and studying the old drawings of the original building the 3D model was the most time consuming part of the thesis. The example 3D model was created using ArchiCAD 18 software. Old drawings of the building were used as base information for the modelling process. There were floor

layout plans, a section drawing and a roof elevation drawing provided for the thesis.

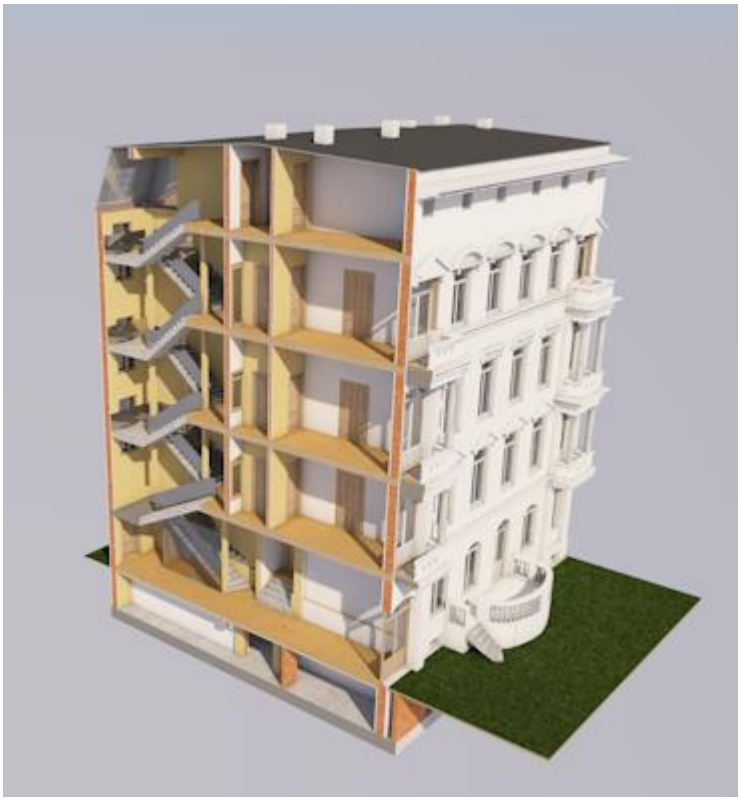
The modelling started from the ground floor and went upwards, the basement was created last. Pictures of the floor plans can be seen in the Appendix 3. After the floors, the stairs, the roof and the terrace were made. Details, such as façade and terrace decorations were added at the end. Last, the colours were changed to make the 3D model look more realistic. The front elevation of the building is shown in the picture 2.

PICTURE 2. Front elevation

### 3.2.1 Staircases

There was only one section drawing provided with material which was not taken from where the staircases are situated. Therefore without site visit the only possibility was to create the stairs using information from the floor plans. Staircases can be seen in the

section picture 3 and from Appendix 4.

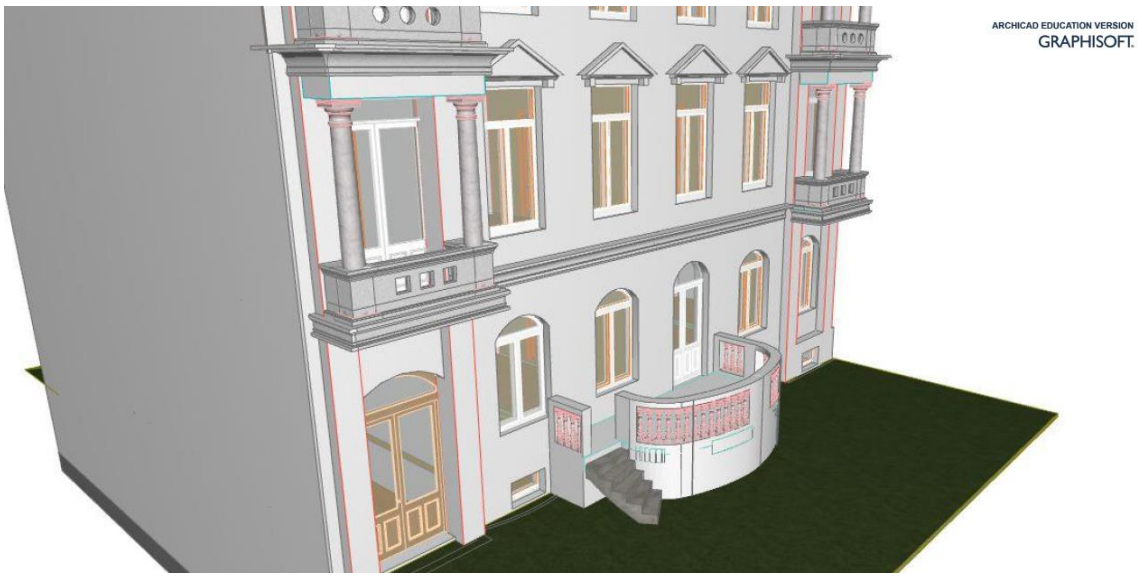


PICTURE 3. Section

### 3.2.2 Decorations

The front side of the building and the terrace are much decorated. In the original building there are columns, cornices and window ledges which are all decorated.

The 3D model was done based on the pictures from Google maps (2014) and from pictures which were provided with the thesis materials. Decorative details were done to make the model represent the Gruenderzeit but it was not possible to create exact details to the 3D model without better pictures or a site visit. Some decorative elements such as columns can be seen in the picture 4.




PICTURE 4. Decorations

### 3.2.3 The back side

The 2D documents were not showing the back elevation of the building and without site visit it was not possible to see how it looks in the original building. For the 3D model the back side was made according to the information from the old floor plan drawings. The back side of the 3D model is shown in picture 6.

PICTURE 6. The back side

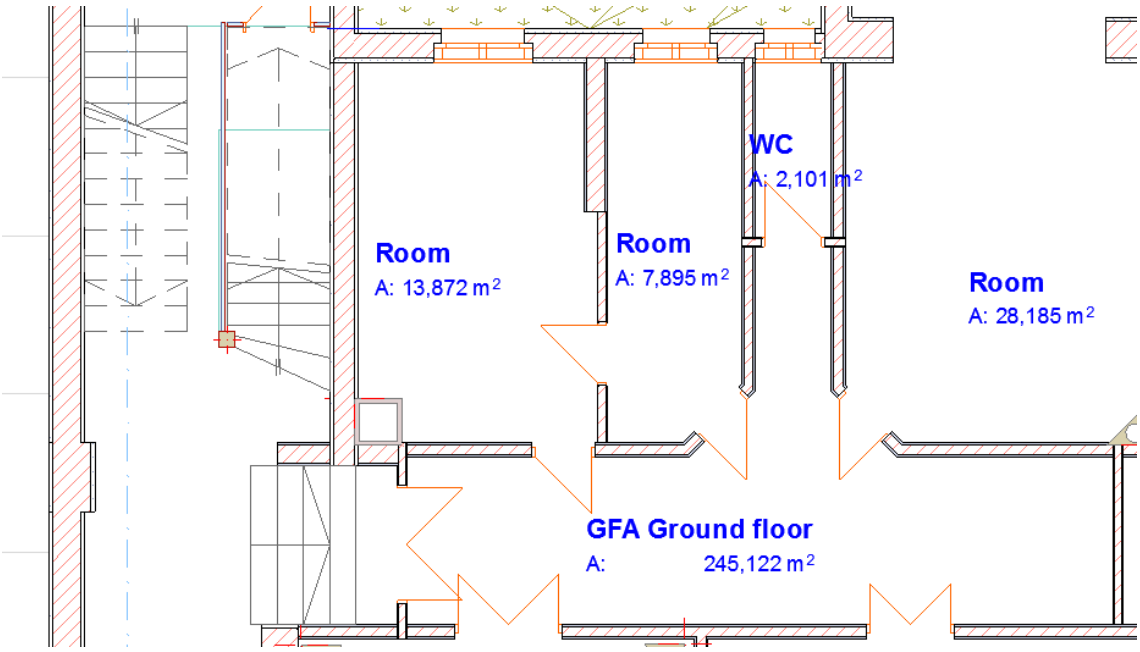
# 4 CONTINUING PART

This chapter contains masses and areas taken from the 3D model and renovation suggestions for the original building.

## 4.1 Obtainment of the masses and areas

It was possible to calculate areas and get masses of used materials from the 3D model. The walls of the building are made of brick. The whole building consists of approximately 500m³ of brick.

The Gross Floor Area measured from the ground floor of the building was 245m². The basement has a 13m² laundry room and other quite small spaces. The ground floor has 2 corridors, 6 rooms, a bathroom and a toilet. Rooms are 8 - 41m² in size. Example of a floor plan can be found in the picture 5. The 3 floors above ground floor are all similar to each other. They have 7 rooms, a toilet and 2 bathrooms. Room sizes are similar as in the ground floor. 4th floor has one bigger room of 67m² and several smaller rooms as well as a bathroom.




PICTURE 5. An example of a floor plan

## 4.2 Renovation suggestions

Without a site visit it is impossible to say what elements from the nowadays building are missing. Also for a full renovation plan further information and a site visit would be required. The street view from Google Maps (2008) revealed that the building has already been at least partly renovated some time ago.

According to Forsyth (2012, 53) brickwork repairs should be done only after extensive investigation of the reasons for the building damages. Based only on the pictures provided with the thesis materials one can say it would be necessary to start full renovation immediately if preserving the building is desired.

The pictures from thesis materials showed severe damages in the brickwork. Diagonal gaps between bricks could be caused by the movements of the ground. If the further investigation would support that theory the brick walls and the foundations would need to be strengthened to make sure that the building loads are evenly distributed.

There is black mould seen in the pictures as well. Also pieces of the render have fallen off from the walls. Forsyth (2012, 55) states that neglect and failure to maintain buildings causes masonry to become saturated with rain water, even more so if e.g. gutters are not cleaned regularly. Also according to Breitling *et al* (2000, 80) many houses of late 19$^{th}$ century did not have air conditioning. Both of these could be reasons for high moisture content and damages. In the example building the roof is quite flat which could, if the roof is leaking, have made these problems even worse.

# 5 DISCUSSION

The thesis relays heavily on the information that was possible to find in English from Internet. There was no site visit done for the thesis to see the real building and therefore the 3D model was created using only the old drawings and pictures from Google maps (2014).

To improve the 3D model a site visit would be a good start. Probably it would be also possible to find more drawings and documents of the building from local building authorities.

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**APPENDICES**

Appendix 1. Thesis instructions

Appendix 2. Translation of the instructions

Appendix 3. Floor plans

Appendix 4. Section

Appendix 1. Thesis instructions 1(2)

# Studienarbeit
# für Veera Keränen

Erasmus-Austauschstudentin

## 3d-Modellierung eines mehrgeschössigen Wohnhauses aus der Gründerzeit

Ausgabe durch: Prof. Dr.-Ing. H.-H. Prüser Jade Hochschule

*Die Arbeit wird auf Wunsch von Frau Keränen in englischer Sprache verfasst*

Aufgabenstellung:

Mit Gründerzeit beschreibt man in Deutschland den Zeitraum von ca. 1860 bis 1910. Eine Zeit, in der die industrielle Revolution die Gesellschaft grundlegend veränderte und dabei u.a. für einen starken Bevölkerungsanstieg in den Städten sorgte. Namensgebend war die Reichsgründung im Jahre 1871.
Diese Zeit war in Mitteleuropa durch Selbstbewusstsein, Optimismus und vorbehaltlosem Glauben in die eigene Stärke und den technischen Fortschritt geprägt. Das konkurrierende Großmachtstreben der Nationalstaaten, gepaart mit dem zügellosen Kolonialismus endete letztlich tödlich auf den Schlachtfeldern des 1. Weltkrieges.
In der vorliegenden Arbeit soll beispielhaft ein Haus aus der Gründerzeit anhand älterer Planunterlagen in eine 3d-Modellierung überführt werden.

Die Bearbeitung soll umfassen:

- Allgemeiner / vorbereitender Teil
  - Übersetzung dieser Aufgabenstellung in die englische Sprache
  - Internet-Recherche: Stellen Sie die Bevölkerungsentwicklung von 1800 bis 2000 in ausgewählten deutschen und europäischen Städten dar.
  - Internet-Recherche: Die Wohnhäuser der Gründerzeit stellten in erster Linie Wohnraum für die stark ansteigende Bevölkerung zur Verfügung. Welche Entwurfselemente und welche Baustoffe wurden eingesetzt? Mit wieviel Bewohnern pro m² wurde „kalkuliert"

- Hauptteil: Überführung von 2d-Planunterlagen in ein 3d-Modell
  - Sichtung der zur Verfügung gestellten 2d-Planunterlagen
  - Besorgung von Grundstücksdaten und Daten zur Nachbarbebauung und zur Verkehrserschließung (Detaillierungsgrad entsprechend Google-Earth etc. ist im Rahmen dieser Aufgabenstellung ausreichend.
  - Objektorientierte 3d Modellierung des Gebäudes mit Anwendung von Bauteilkatalogen.

- Weiterführender Teil (soweit im Zeitrahmen ableistbar)
  - Durchführung von Massen- und Flächenermittlungen anhand der 3d-Modellierung
  - Soweit im Modell erkennbar: Welche Elemente des heutigen Wohnungsbaus fehlen im Gebäude, welche Sanierungsmaßnahmen sind deshalb erforderlich?

Appendix 1. Thesis instructions 2(2)

**Hinweise:**

Während der Bearbeitung können geeignet aufbereitete Zwischenergebnisse durchgesprochen werden. So können in Absprache ggf. auch während der Bearbeitung spezielle Schwerpunkte gesetzt werden.

Es sind 2 Exemplare der Studienarbeit abzugeben. Hierzu zählt eine textliche Fassung, in der die Bearbeitung inhaltlich und auch anhand des Zeitaufwandes dokumentiert wird.

Ausgewählte Inhalte der Arbeit sind im Rahmen eines Kolloquiums anhand eines PowerPoint Vortrages vorzustellen.

Zum Kolloquium ist ein A1-Poster mitzubringen, auf dem die Arbeit vorgestellt wird. Das Poster kann in der Jade Hochschule ausgestellt werden.

Tag der Ausgabe: ... 12.11.2014
Tag der Abgabe: ... 07.01.2014

Oldenburg 11.11..2014

Prof. Dr.-Ing. H.-H. Prüser

Thema erhalten am: 12.11.2014

Seidel

Appendix 2. Translation of the instructions 1(2)

Thesis

Veera Keränen

Erasmus exchange student

**3D model of a multi-storey residential building from Gruenderzeit**

Prof. Dr.- Ing. H.-H. Prueser Jade Hochschule

The thesis is written in English by the request of Ms. Keränen

Instructions:

The time period between 1860 and 1910 in Germany is called the Gründerzeit. A time in which the industrial revolution changed the sociaty completely with a strong increase in the city population. Gründerzeit is named by 'Reichs' foundation in 1871. This time in Central Europe was characterized by selfesteem, optimism and unconditional believe in the own strenght and the technical progress. The compatitive willingness of the nations to become a superpowers combined with careless colonialism ended deathly in the battlefields of the First World War.

In this work an example building from the Gründerzeit has to be transferred from the old plans into a 3D model.

The work should contain:

General part/preparing part

- Translation of this task to English
- Internet research: show the development of the population from 1800 to 2000 in chosen German and European cities.
- Internet research: Houses from the Gründerzeit were offering in the first place an accommodation for the strong increase in population. What design elements and materials have been used? How many square meters per inhabitant have been ”calculated”?

Main part:Transformation from 2D documents to the 3D model

- Checking of the 2D documents that have been provided.
- Obtaining the site data of the neighbourhood constraction and of the traffic connection. Detail grade from Google Earth is sufficient.
- Object oriented 3D model of the building.

Continuing part: (if possible in the time frame)

- Obtainment of the masses and areas according to the 3D modelling.
- If it is possible to recognize in the model: What elements are in the nowadays building missing? What kind of renovation is necessary to do in the building?

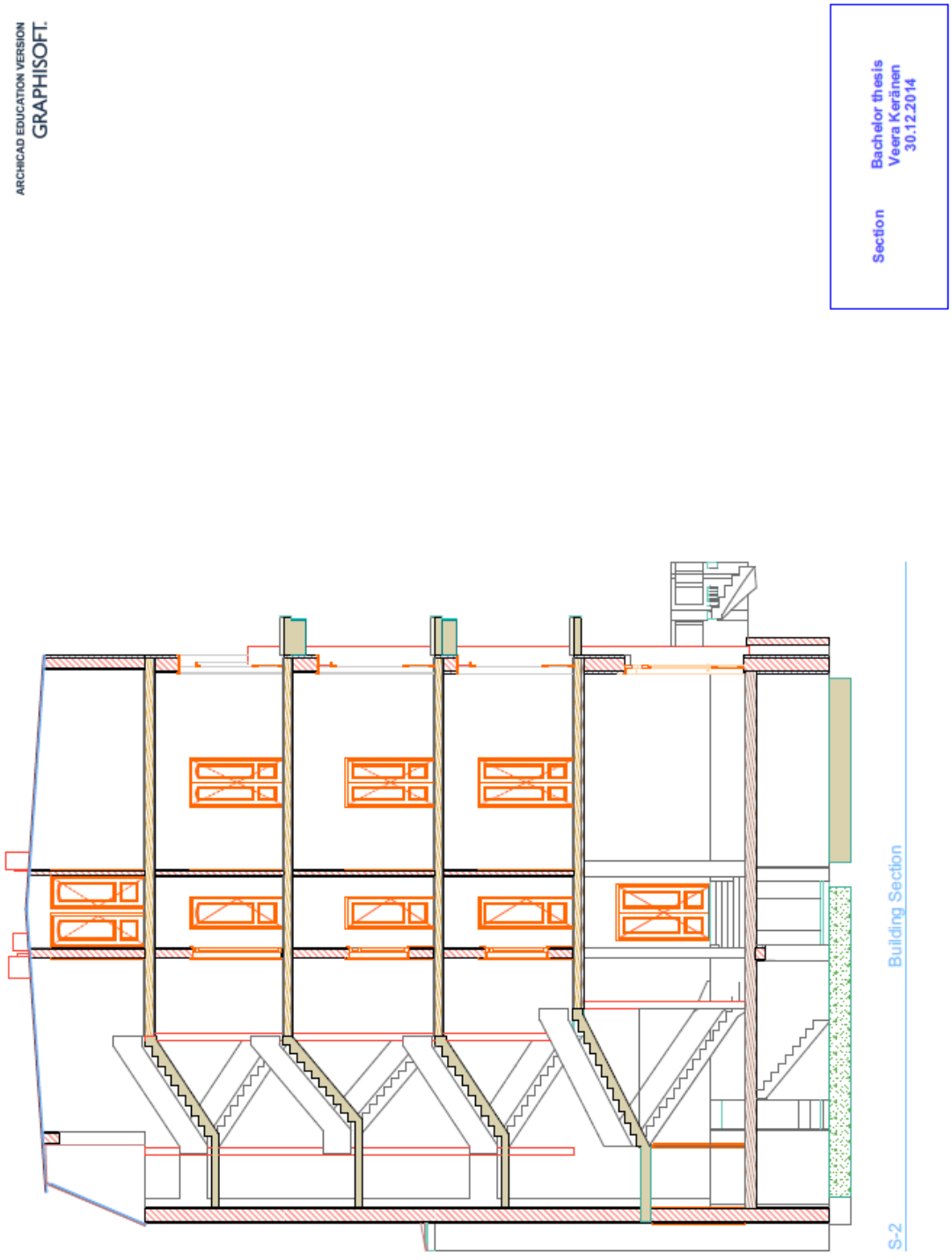
Marks:

During the work, intermediate results which are suitable can be discussed about. Therefore, specializations can be set in the discussions during work period. There are two versions of this study work to be handed in. This means a text version in which the work is documented by the content and also a record of time one needs for it.

Chosen topics from the work have to be presented in Power Point at the colloquium. An A1 poster has to be brought with to the colloquium and has to be presented. The poster can be hanged up somewhere in Jade Hochschule.

Appendix 3. Floor plans

Appendix 4. Section 1(2)



Appendix 4. Section 2(2)