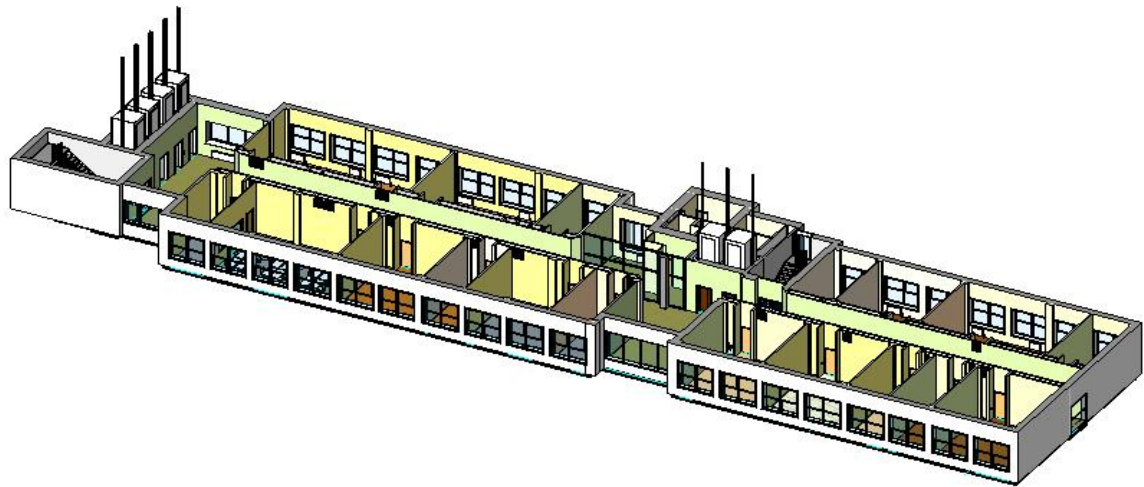




GJØVIK UNIVERSITY COLLEGE

Bachelor Thesis 2010

BuildingSMART: 3D model of Vilnius Gediminas Technical University



Aušra Morkūnaitė

20.05.2010

Summary

Title:	BuildingSMART: 3D model of Vilnius Gediminas Technical University
Date:	20.05.10
Author:	Aušra Morkūnaitė
Supervisors:	George Preiss, Arminas Stanionis
Employer:	Høgskolen I Gjøvik Vilnius Gediminas Technical University
Contact Person:	George Preiss, Arminas Stanionis, Vilma Zubinaitė
Attachments:	0
Availability:	Open

Abstract:

Construction and Architecture industry is changing all the time. New technologies have a huge impact to those changes. Many engineers accepted a challenge to start using new BuildingSMART software. Nowadays it is not enough to create a 3D model of building. This model has to be 'SMART'. That was my main target too. To create a 'SMART' model I chose one floor of Vilnius Gediminas Technical University building. I used Autodesk Revit Architecture and Autodesk Revit MEP software, which gave me an opportunity not only to create a 3D model, but also to add all the information about this building.

Preface

This report describes process and results of the bachelor project of student from Lithuania at Geodesy and Cartography Department at Vilnius Gediminas Technical University, which is writing bachelor thesis at Geomatics Department at Gjøvik University College. The project includes 20 ECTS.

The project is carried by one bachelor student from Lithuania Vilnius Gediminas Technical University: Aušra Morkūnaitė. The supervisors of the project are a lecturer at Gjøvik University College, George Preiss and a lecturer at Vilnius Gediminas Technical University, Arminas Stanionis.

This project has started on January 2010 in Vilnius Gediminas Technical University, Lithuania. I did measurements of my university for this project there. In Gjøvik University College I continued this project from March 2010.

During this project I have made informative 3D model of one floor of my University in Lithuania. I think it will be very interesting, useful and innovative for the academic staff, students and workers of my University.

I would like to thank my supervisors, George Preiss and Arminas Stanionis, for lots of great ideas and support during my project.

Gjøvik University College, 20 May 2010

Aušra Morkūnaitė

Contents

Summary	2
Preface	3
1. Introduction	5
1.1. Chapter summary	5
1.2. Background.....	6
2. Process	7
2.1. Definitions	7
2.2. The measurements.....	8
2.2.1. The Building.....	8
2.2.2. The Equipment and Resources.....	9
2.2.3. Collecting the Information	11
2.2.4. Specific Problems and Difficulties	12
2.3. The Sketches.....	12
2.4. The 2D AutoCAD Model	13
2.5. The 3D Revit Model.....	14
2.5.1. Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010.....	14
2.5.2. 3D Model of University	15
3. Different Methods of using 3D Model	16
3.1. Creating a 3D Model using Architectural Design	16
3.2. Different specialists working on the same model.....	16
3.3. The Schedules.....	17
4. Specific Problems addressed in this Project and Vision of Solution	19
4.1. Knowledge of 3D Modeling Software	19
4.2. Knowledge of Structural Building, Electrical and Plumbing Fixture	19
4.3. Information needed	20
4.4. Difficulties creating existing building model	20
5. Conclusions	21
6. Bibliography	22
7. Appendix	23

1. Introduction

1.1. Chapter summary

Chapter 1 – Introduction

Provides background information about the project. It shortly describes project aim, resources and place where project was done.

Chapter 2 – Process

An overview of project process. Measurements in Lithuania and creating a 3D model in Gjøvik.

Chapter 3 – Different methods of using 3D model

An overview of different ways to use 3D model created with Autodesk Revit software.

Chapter 4 – Specific problems addressed in this project and vision of solution

List of problems and difficulties during the project and the way to solve it.

Chapter 5 – Conclusions

Conclusions of the project, opinions and suggestions.

Chapter 6 - Bibliography

An overview of all literature researched during the project.

Chapter 7 - Appendix

An overview of some appendixes to the project.

1.2. Background

This bachelor thesis is a final task of studying Geodesy in Vilnius Gediminas Technical University (VGTU) in 2006-2010.

In this project I created a digital 3D model of one floor of this University with Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010 and made it usable for different aims. This 3D model is the 3rd floor in Environmental Engineer faculty. VGTU is one of the well known Universities in Lithuania, it was built in 1969, and it was the first University for engineers in Lithuania.

This 3D model is based on data of measurements, which I did three months ago with Leica Disto D2 Laser Distance measurer which is with true 1,5 mm accuracy and measuring range up to 60 metres.

2. Process

I could describe the project process in these main steps:

1. Do the measurements.
2. Draw the sketches.
3. Import the 2D AutoCAD project file to Revit.
4. Create a 3D model with Revit.

Also you can see a project process in Figure 1.

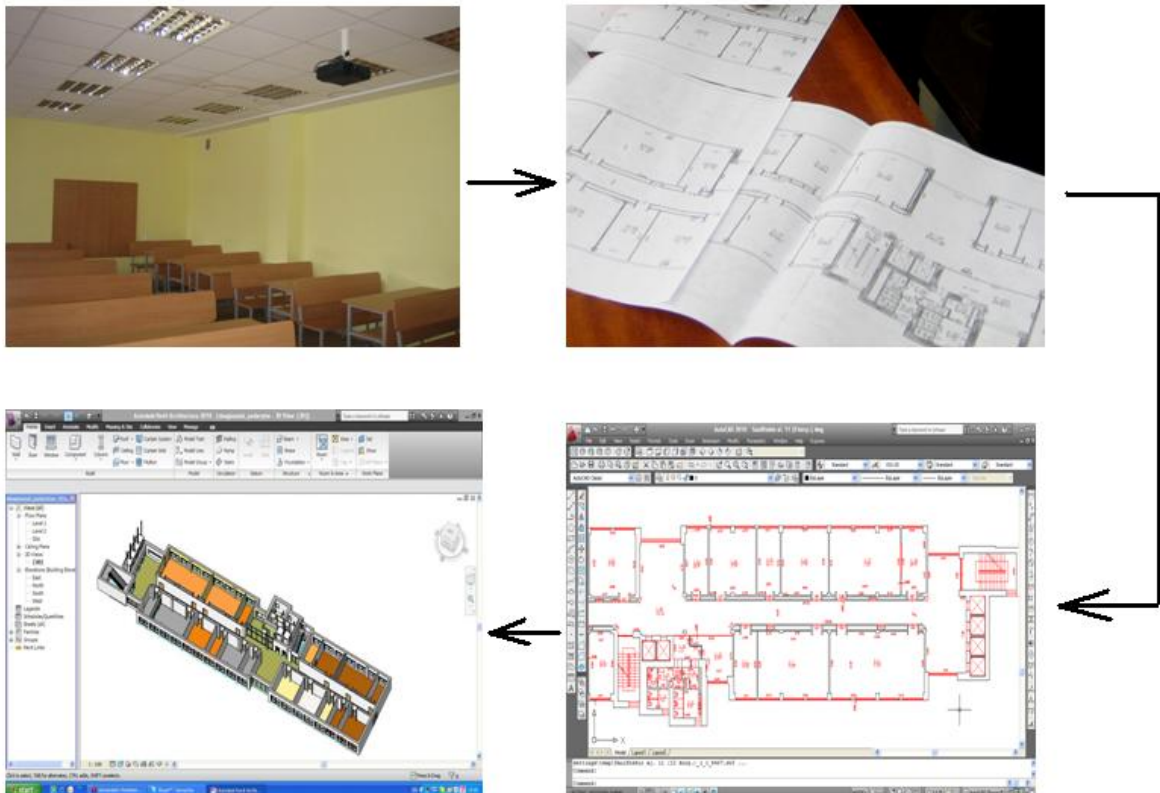


FIGURE 1. The project process.

2.1. Definitions

3D – (3 Dimensional) Refers to objects that are rendered visually on paper, film or on screen in three planes (X, Y and Z). In the computer, a 2D drawing program can be used to illustrate a 3D object; however, in order to interactively rotate an object in all axes, it must be created as a 3D drawing in a 3D drawing program.

2D – (2 Dimensional) Refers to visual objects that are constructed on two planes (X and Y; width and height). Two-dimensional structures are used for 2D images and to simulate 3D images.

3D Modeling- In 3D computer graphics, 3D modeling is the process of developing a mathematical representation of any three-dimensional surface of object (either inanimate or living) via specialized software. The product is called a 3D model. It can be displayed as a two-dimensional image through a process called 3D rendering or used in a computer simulation of physical phenomena. The model can also be physically created using 3D Printing devices.

Building Information Modeling (BIM) - is the process of generating and managing building data during its life cycle. Typically it uses three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction. The process produces the Building Information Model (also abbreviated BIM), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components.

2.2. The measurements

2.2.1. The Building

The main task doing my final thesis in Lithuania, was to do the measurements of one floor in Vilnius Gediminas Technical University (VGTU). It is one of the oldest, well known and most popular Universities in Lithuania.

In 1990 the Vilnius Civil Engineering Institute became Vilnius Technical University, which on August 22, 1996 was awarded the name of Gediminas, Great Duke of Lithuania. At present the University includes 8 faculties, Aviation Institute named after A.Gustaitis, International Studies Centre, Centre for Continuous Education, 10 research institutes and 19 laboratories. On Sept 1, 2005 over 14 849 students came to the University's classrooms, with 3 491 of them being first-year students. Teaching staff numbers 919, including 50 Research fellows. There are also 117 Doctors Habil and Professors, 508 Doctors or Associate Professors, 75 Lectors and 248 Assistants.

The University provides 88 programmes for diploma engineers, undregraduate and graduate (Bachelor and Master) studies in the fields of Humanity Sciences, Physical Sciences, Social Sciences, Technological Sciences, Biomedical Sciences and Art Sciences. Every year VGTU is provided with more various facilities. Thus, according to Resolution No 860 of Lithuanian Government, the University has got the building of 9073 m² in 1/26 Traku str.

VGTU is also a research Institute of Geodesy. The activities of the Institute are mostly related to establishment of National Geodetic Reference and solution of related scientific problems. Such activities are coordinated by the National Land Board at the Ministry of Agriculture.

University has 8 faculties, the measurements were done in Environmental Engineering faculty, at 3rd floor. There are 17 classrooms, one long corridor, 6 elevators and two stairs entrances, one toilets hall. The 3rd floor is 66 meters long and from 2 to 11 meters width. The all surface area of the floor is 1124 m². The biggest class is 75 m² and the smallest one's area is only 18 m². I started to do that in January 2010 and it took about 6 weeks to measure it. All classrooms, cabinets and corridor were measured.

2.2.2. The Equipment and Resources

For doing the building measurements in Vilnius Gediminas Technical University, equipment which complies with the requirements was Leica Disto D2 Laser Distance measurer.

It is the smallest laser distance meter in the world. The compact and handy base model was specifically designed for indoor applications. Shortcut keys for addition, subtraction, area and volume calculation make measuring fast and very reliable. The last 10 measurements are also stored. As with all Leica laser distance meters, the laser dot is clearly visible. You can always see your targeting point, even if the target object is in a hard to access area.

Leica Disto D2 Laser Distance measurer has many advantages:

- **Quick and easy**
You can measure distances at the touch of a button and calculate areas or volumes.
- **Measure from edges or corners**
With the flip-out end-piece you are equipped for any measuring situation.
- **Small and handy**
Thanks to its ergonomic and compact design with soft grip, the Leica Disto D2 sits securely in your hand and fits into any pocket.
- **Clear display**
The results are shown on a 3-line display. The illuminated display is easily readable, even in the dark.
- **Simply clever**
Minimum / maximum measurements, tracking and storage of results made my work much easier.

All this equipment features are described in Figure 2. And see the photo of the Leica Disto D2 in Figure 3.

Features	Your advantages
Measuring range 0.05 m up to 60 m (0.16 ft up to 197 ft) typ. accuracy ± 1.5 mm (± 0.06 in)	Precise, fast and reliable indoor measurements
Shortcut keys	Easy-to-use and rapid access to frequently used functions
Illuminated 3-line display	Measured values can be read even in the dark
Flip-out end-piece	Measure from edges or corners
Stake out function	Stake-out equal distances
Time delay release	Measure without shake
Simple Pythagorean functions	Indirect height and width measurements for inaccessible positions
IP 54	Splash and dust proof

FIGURE 2. The features of Leica Disto D2 measurer.



FIGURE 3. Leica Disto D2 Laser Distance measurer.

After measurements there were sketches of each all auditorium and corridor on paper. To create a digital intelligent model, I used Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010 software. All information about this software I found in book ‘Revit Architecture 2010. No experience required‘ which I was lending from Gjøvik University College library.

‘Revit Architecture 2010: No Experience Required‘ is the perfect step-by-step introduction to the very latest version of Autodesk's revolutionary Revit Architecture software. Through a continuous, easy-to-follow tutorial, I learned Revit by planning and developing my University building – was doing everything from designing to documenting to presenting the final project. I followed the tutorial sequentially or sometimes jumped in at any chapter. Either way, I got a thorough grounding in Revit's tools and quickly could master tasks that professionals face all the time.

2.2.3. Collecting the Information

Details about building materials and the purpose for using each classroom and cabinet were carefully noted. There were checked the floor cover material, noted the color of the walls, ceilings. Furthermore, the information about all the communications, heaters, sinks, lamps, doors and windows were collected. In every classroom or cabinet were measured the position of sockets, lighting switches, ventilation holes, sinks, windows and doors. After measured few windows, was noticed that there is standard of sill height, and was found only few types of the doors. The same were with the heaters, there are only two different length of them in that floor. The type of the windows everywhere is the same, only the number of them depends on the classroom or cabinet size.

The different situation is in the corridor. Windows and doors are bigger there. Doors are made from plastic there and have the same size window close. The windows are bigger there as well, somewhere there is window through all height of the wall, else they are made from three or four sections. The information about material of the walls, columns, floor, roof, windows, doors and classrooms finishes I get from old documents about University. There is a list where everything is noted. See figure 4.

Konstruktyvinių elementų pavadinimas	Konstruktyvinių elementų užbaigimo ir techninio stovio aprašymas	Data					D:
		lyg	su	vi	lyg	su	
Pamatai	Plastikiniai, smėlio, pušiniai, klijiniai						
Sienos	Plėtinis, natūrali, medinė, apdailinti, bet. apdailinti, natūrali, glet, klijiniai						
Pervaros	Smėlio, beton, panel, plėtinis, natūrali						
Stogų konstrukcija dangų	Apdailinti, natūrali, natūrali, natūrali						
Perdengimas	Smėlio, natūrali, natūrali, natūrali						
Grindys	Smėlio, natūrali, natūrali, natūrali, natūrali						
Langai	Apdailinti, natūrali, natūrali, natūrali						
Vidaus santchnikos ir elektros įrenginiai	Elektra, vandentiekis, kanalizacija, cent. šilumos						
Durys	Medinė, faneruoti, natūrali, natūrali, natūrali						
Apdailos darbai	Smėlio, natūrali, natūrali, natūrali, natūrali, natūrali						
Kiti darbai	Plėtinis, natūrali, natūrali						

FIGURE 4. The list with information about different parts of University.

2.2.4. Specific Problems and Difficulties

The main difficulties during the measurement process were these:

- No possibility to get all the dimensions. There were a lot of classrooms or cabinets where furniture disturbed to measure for example all four lengths of the walls. The biggest barrier was the large bookcases, which are built-in the wall and there is no chance to pull it from there and measure that place. I think this is a main difficulty when you are measuring already built and living building.
- I did the measurements with Leica Disto D2 Laser Distance measurer, which was totally new for me at the beginning. Moreover I haven't had any previous experience at building measurements. Fortunately the measurer was really easy to use and after few days I could use it more quickly and easier. The method and rules of measuring buildings I found in Republic of Lithuania Real Estate Cadastre Rules.
- Another difficulty which I confronted with, was that I did measurements alone. Sometimes there was not enough one person to get dimension which I needed. When measurer's laser couldn't reach some edge or corner I asked other student to help me, just by keeping white sheet of paper close to that problematic place, that laser could have a surface to strike from.
- The most difficult places to measure were corridor and stair's hall. There were a lot of different heights, many stairs. Furthermore the corridor is 66 meters long and the Leica Disto D2 Laser Distance measurer only can measure distances shorter than 60 metres. That means that I could measure corridor only then I divided it to different parts.

2.3. The Sketches

One of the most important things in this project was doing the sketches. Every time when I was measuring the class, on the same time I was drawing the sketches. Every classroom has two type of sketches. The first is similar to 2D plan, just to show the main distances in a room, like width and length, and the other is more like 3D model, to show the height and position of different elements. See Figure 5 and Figure 6.

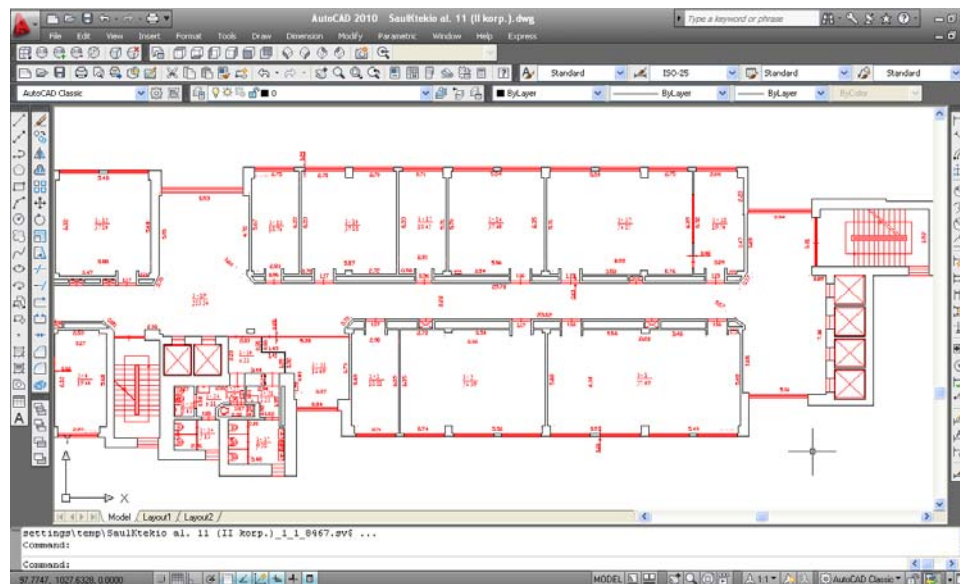


FIGURE 7. AutoCAD 2D model of University.

2.5. The 3D Revit Model

2.5.1. Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010

It is no longer news that the implementation of 3D building models in the construction and the architecture industry has put enough pressure on the rest of them who are yet to resort to using technology. The debate or the argument on the mechanization of an industry is pointless compared to the benefits that using this software offer. Apart from giving you the ability to visualize your idea, a 3D building model also helps in resolving geometrical problems at an early stage.

In this project to create a 3D building model I was using Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010 software.

Autodesk Revit Architecture software helps you explore early design concepts and forms, and more accurately maintain your vision through design, documentation, and construction. Make a change, and it's automatically updated across the project. See Figure 8. Use the essential building information modeling (BIM) data that Autodesk Revit Architecture software provides to support sustainable design, clash detection, construction planning, and fabrication.

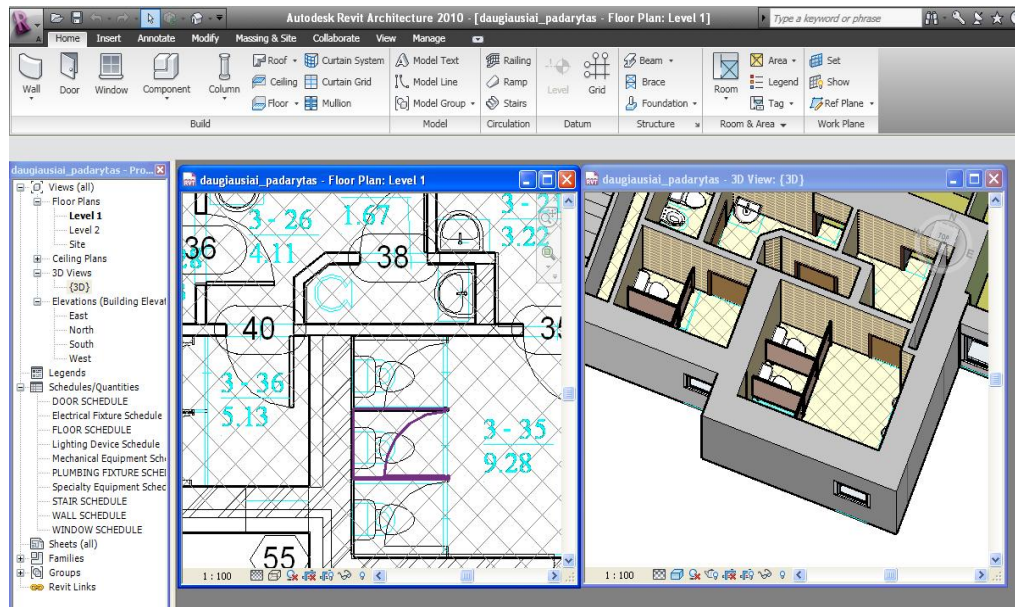


FIGURE 8. Changes automatically update in your model.

I find out that if I want to put all the communications in my model, I need another version of this software – Autodesk Revit MEP 2010. Autodesk Revit MEP - electrical engineering and plumbing design software is the building information modeling (BIM) solution for mechanical, electrical, and plumbing (MEP) engineers. Revit MEP offers purpose-built tools for building systems design and analysis. With the parametric change management technology in Revit MEP, you can coordinate modifications more consistently across the model.

2.5.2. 3D Model of University

In every country the Real Estate Industry needs innovation, creativity to develop accurate, effective and impressive buildings, especially if it is a scholarly institution, which should always represent new and modern design, technologies and practical use. Probably the best way to do it – to create that building as a 3D model.

3D building models are quick to develop. Moreover – they are easy in implementing these building models into real estate activities. This will allow better efficiency and accuracy in construction work. And most important, 3D models are flexible to use.

Vilnius Gediminas Technical University hasn't a 3D model yet, but it would be really useful to make it. Only measurement data, qualified specialist and 3D modeling software is needed.

3. Different Methods of using 3D Model

3.1. Creating a 3D Model using Architectural Design

Architectural design is an art of creating models, concepts and information about the future building. In this method architects convert handmade sketches and paper based design into digital formats. Using architectural design architects create 3D models for different purposes like to set up interior design, exterior design and floor plan design. Customized architectural design models allow users to make changes as per requirements. Furthermore 3D Architectural rendering allows you to beautify your interior and exterior designs. 3D Architectural Modeling becomes an indispensable tool for the architectural industry to visualize building models. Using the 3D Architectural rendering in my project helped me to change some interior details, like the color of the walls, floor cover, I could even create a classroom with furniture. See Figure 9.

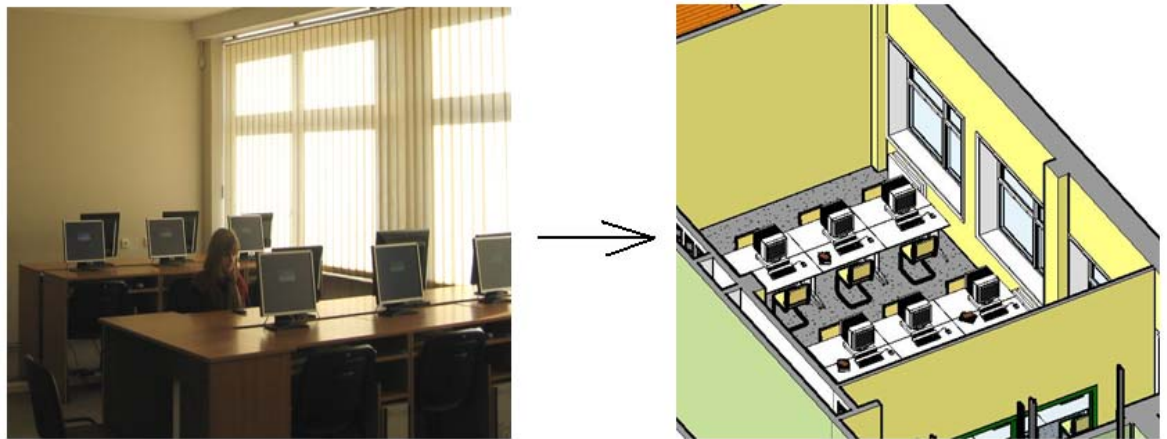


FIGURE 9. Picture of one classroom in University and its model.

3.2. Different specialists working on the same model

3D rendering is a fabulous technique that allows users to view moving objects of their future building on a computer. One can easily arrange interior and exterior objects by using proper 3D models. Greatly it allows 360-degree panoramic views to visualize your interior and exterior. Moreover, it lets a few engineers work with the same model at the same time. Specialists have to work on the net and have an administrator, who is responsible for giving a permit to do all the changes of the model.

It is very usable not only for different kinds of specialists, but even for the same ones. If the project is very big and the job is divided, in the end everything should be connected. See Figure 10.

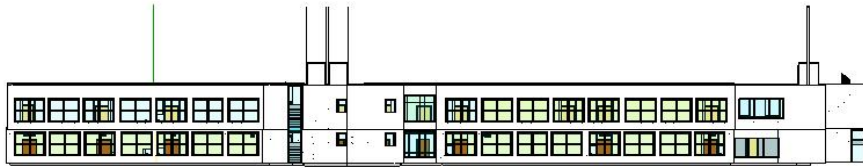


FIGURE 10. The 2nd and the 3rd floor of University connected to one model.

Then with the same project is working different engineers it is very important to know all the changes on 'real time' as well. Architect, civil engineer, measurement engineer and electric engineer could work with the same project and put in it any necessary details or components.

3.3. The Schedules

The best thing about Revit schedules is that I could add for example the door to the model and have that door automatically show up in the schedule. Every time I placed a door to the model it was automatically tagged with a sequential door number. And that door already has most of the information I need. This is the power of Building Information Modeling. This is even going beyond 3D modeling.

I can schedule almost any item in the model, not only doors or windows. This is very useful because along with schedule comes the ability to quantify materials, square footages, measurements, models or any other information about the item. In my model I created these schedules:

- Door schedule
- Windows schedule
- Floor schedule
- Ceiling schedule
- Wall schedule
- Stair schedule
- Electrical fixture schedule
- Lighting device schedule
- Mechanical equipments schedule
- Plumbing fixture schedule
- Specialty equipments schedule.

Almost every schedule has different fields, which is specific for only that item.

See Figure 11. All schedules you can find in Appendix.

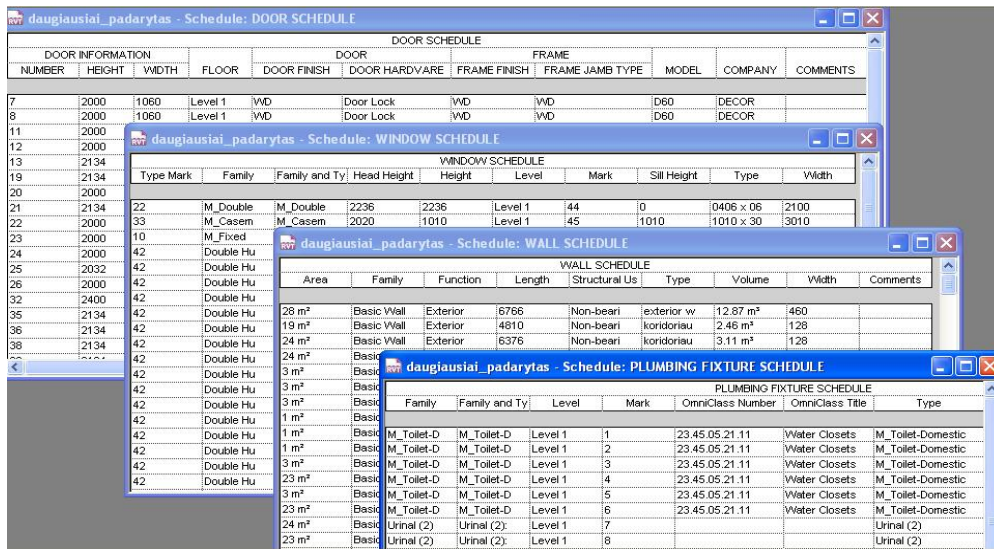


FIGURE 11. Different Schedules in Revit.

Now lets take a look at door schedule. See Figure 12. This schedule has fields which describe the door best. First of all you can see a door number in the model, after that goes door measurements – height and width, then place where that door is built in – on which floor. Further you can find door and frame material, it is usually written in potted words (WD means wood, PT-painted, PL-plastic). You can even find information about such a small details like door hardware. The most useful information for cases then you have to change the door in building you can find in ‘Model’ and ‘Company’ fields. If you know the model of the door is just few minutes job to search for it on the internet and find a place where to buy exactly that type of door. And you can always add a comment about each door in the model. There you could write every change which was done or any other useful information.

DOOR SCHEDULE											
DOOR INFORMATION			DOOR				FRAME		MODEL	COMPANY	COMMENTS
NUMBER	HEIGHT	WIDTH	FLOOR	DOOR FINISH	DOOR HARDVARE	FRAME FINISH	FRAME JAMB TYPE				
7	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
8	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
11	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
12	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
13	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
19	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
20	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
21	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
22	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
23	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
24	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
25	2032	712	Level 1	PT	Door Knob	PT	WD	D70	KARMEN	INTERIOR	
26	2000	900	Level 1	PT	Door Knob	PT	WD	D70	KARMEN	INTERIOR	
32	2400	2900	Level 1	PL	Door Lever	PL	PL	D250	PAOLO	INTERIOR	
35	2134	890	Level 1	PL	Door Lever	PL	PL	D70	DECOR		
36	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR		
38	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR		
39	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR		
40	2134	890	Level 1	WD	Door Lever	WD	WD	D70	DECOR		
41	2134	890	Level 1	WD	Door Lever	WD	WD	D70	DECOR		
42	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
43	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
44	2400	1900	Level 1	PL	Door Lever	PL	PL	D250	PAOLO		
45	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
46	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
47	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
48	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR		
49	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR		

FIGURE 12. The Door Schedule.

4. Specific Problems addressed in this Project and Vision of Solution

4.1. Knowledge of 3D Modeling Software

I consider that the biggest challenge is that I do not have any previous knowledge of building measurements and of the 3D modeling software Autodesk Revit Architecture 2010 or Autodesk Revit MEP 2010.

All information about this software I found in book „Revit Architecture 2010. No experience required“, which I was lending from Gjøvik University College library. It helped me a lot, because in this book I found simple step-by-step explanation how to create a 3D model. I started with a main construction elements, such a floor, walls, then I putted windows and doors, stairs, toilets and sinks. After that followed all electrical fixture, mechanical equipment, plumbing fixture, lighting device and speciality equipment. In this book I also found instructions how to create a schedules for all items. Then I got experienced in Revit Architecture, I started working with Revit MEP. It was not so difficult and challenging, because both softwares are based on same methods of creating model.

4.2. Knowledge of Structural Building, Electrical and Plumbing Fixture

To create the 3D model of University I had know all the materials of the walls or the floor. It is very problematical when the building is already built. If there is no possibility to find information in documents, the only way is to do the assays or take apart the wall and to see. Both methods are really expensive and could require stop using the building for some time. Fortunately I get information from papers.

It is not enough to have knowledge only of structural building. To create real model you have to know a lot of about HVAC too, because heating or ventilation is necessary in building like University. You have to put in all communications and have information about their type or any other characteristic. Moreover you have to have knowledge of thermal physics, because during the walls creating process you must choose right materials, thermal layers, schedule where could be thermal bridges. Plumbing knowledge is what you need as well.

It is important to know what kind of duct you need, choose the right diameter of it. It is difficult to find engineer who could have knowledge of everything. Good news are that using Revit the same project could be divided for different kind engineers and connected after every do their job.

4.3. Information needed

While you are creating already existing building 3D model you have to have knowledge which I wrote about in chapter 4.2. Furthermore you must get information about constructions practically used in building, their main characteristics and features. To get this information you have to be skilled at management, because you will not avoid communication with object builders, managers or owner.

4.4. Difficulties creating existing building model

I utilized BIM for already existing building. The first step was doing the measurements and after that modeling the existing structure. There were several issues with that. The obvious one is guaranteeing 100% accuracy. This is especially important because I created model of only one floor of University, and another floor was done by my colleague. To get accurate connected model we both had to do our model as accurate as possible. We did measurements with Leica Disto D2 Laser Distance measurer, but now I see another and more quickly way to do it – use laser scanning, and already get 3D model from it.

More difficulties I had then I wanted to get information about building. Especially information about ducts or electrical fixture. There was no possibility to see or to check where and how all wires go, because they all are covered by walls. Meanwhile creating a new building model should be much easier and not require so many knowledge of different kind of engineering.

5. Conclusions

In this project I created a digital 3D model of one floor of Vilnius Gediminas Technical University with Autodesk Revit Architecture 2010 and Autodesk Revit MEP 2010 and made it usable for different aims. This 3D model was based on measurements, made in December 2009 with Leica Disto D2 Laser Distance measurer.

Doing this project gave me great experience in BuildingSMART. It is difficult to describe how many new things I learned about it. I think the most useful thing what I got from this project – it is that despite all difficulties, now I can clearly see the advantages and disadvantages of BuildingSMART.

BuildingSMART is all about the sharing of information between engineers and across the software applications that they commonly use for design, construction and even procurement or maintenance. The most important advantage of BuildingSMART is data interoperability. But I can see one disadvantage here as well. While on the same project is working few engineers and sharing the information it costs more.

Moreover I found that I cannot associate BIM with a 3D model of an architectural design, because it can be so much more than that. A BIM model is a place to store and keep up to date all the information about a building, and that can include also ductwork, electrical installation, energy consumption, even occupancy or whatever information you need to collect regarding a building.

What surprised me, that in fact many BIM building projects do not start with a model made by a CAD system, but from information about a client's requirement for and project brief long before anything about geometry like, shape number of stories, floor plan etc. has been created. This collection of information is also a BIM. During this project I realized that BIM is different for already existing and new buildings. Creating an Intelligent Model of already built building is much more difficult than to do the same for new, only projected building.

All these remarks, notices and knowledges I got during this project gave me great experience and I think it will be really useful for my future and my career as an engineer.

6. Bibliography

- Revit Architecture 2010: No Experience Required, Eric Wing 2009.
- BIM Handbook, C.Eastman, P.Teicholz, R.Sacks, K.Liston 2008.
- Architectural Design, Architectural Design Models for Quality Outputs,article by Nelson Thomas 2010.
- <http://usa.autodesk.com/adsk/servlet/pc/index?id=3781831&siteID=123112> [Accessed].
- http://www.pcmag.com/encyclopedia_term/0,2542,t=2D&i=36988,00.asp [Accessed].
- http://en.wikipedia.org/wiki/Building_Information_Modeling [Accessed].
- Introducing Revit Architecture 2010. BIM for Beginner, Dzambazova T., Krygiel E., Demchak G. 2009.
- Mastering Revit Architecture 2010, Demchak G., Dzambazova T., Krygiel E. 2009.
- <http://www.buildingsmart.com/bim> [Accessed].
- <http://www.ap.vgtu.lt/lt/34173/Istorija> [Accessed].
- http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=213099 [Accessed].
- <http://www.laser-scanning-buildings.co.uk/> [Accessed].

7. Appendix

Appendix A. Door schedule.

DOOR SCHEDULE										
DOOR INFORMATION			FLOOR	DOOR		FRAME		MODEL	COMPANY	COMMENTS
NUMBER	HEIGHT	WIDTH		DOOR FINISH	DOOR HARDVARE	FRAME FINISH	FRAME JAMB TYPE			
7	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
8	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
11	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
12	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
13	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
19	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
20	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
21	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
22	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
23	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
24	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
25	2032	712	Level 1	PT	Door Knob	PT	WD	D70	KARMEN	INTERIOR
26	2000	900	Level 1	PT	Door Knob	PT	WD	D70	KARMEN	INTERIOR
32	2400	2900	Level 1	PL	Door Lever	PL	PL	D250	PAOLO	
35	2134	890	Level 1	PL	Door Lever	PL	PL	D70	DECOR	
36	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR	
38	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR	
39	2134	890	Level 1	WD	Door Lock	WD	WD	D70	DECOR	
40	2134	890	Level 1	WD	Door Lever	WD	WD	D70	DECOR	
41	2134	890	Level 1	WD	Door Lever	WD	WD	D70	DECOR	
42	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
43	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
44	2400	1900	Level 1	PL	Door Lever	PL	PL	D250	PAOLO	
45	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
46	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
47	2000	1060	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
48	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR	
49	2134	864	Level 1	WD	Door Lock	WD	WD	D60	DECOR	

Appendix B. Floor schedule.

FLOOR SCHEDULE								
Area	Family	Family and Ty	Function	Level	Perimeter	Type	Vertical Proje	Volume
257 m ²	Floor	Floor: ilgas	Interior	Level 1	171746	ilgas korid	Default	93.42 m ³
26 m ²	Floor	Floor: ilgas	Interior	Level 1	23789	ilgas korid	Default	9.57 m ³
42 m ²	Floor	Floor: tual	Interior	Level 1	31362	tualetu	Default	15.23 m ³
84 m ²	Floor	Floor: 316-	Interior	Level 1	37912	316-317	Default	30.33 m ³
41 m ²	Floor	Floor: 315	Interior	Level 1	25652	315	Default	14.88 m ³
21 m ²	Floor	Floor: 315	Interior	Level 1	19660	315	Default	7.50 m ³
61 m ²	Floor	Floor: 316-	Interior	Level 1	31521	316-317	Default	22.27 m ³
21 m ²	Floor	Floor: 315	Interior	Level 1	20086	315	Default	7.58 m ³
145 m ²	Floor	Floor: 301-	Interior	Level 1	55897	301-302	Default	52.60 m ³
24 m ²	Floor	Floor: 304	Interior	Level 1	20312	304 (2)	Default	8.55 m ³
123 m ²	Floor	Floor: 305-	Interior	Level 1	49814	305-306	Default	44.72 m ³
62 m ²	Floor	Floor: 308	Interior	Level 1	31802	308	Default	22.44 m ³
20 m ²	Floor	Floor: 309	Interior	Level 1	19538	309 ir 311	Default	7.38 m ³
41 m ²	Floor	Floor: 310	Interior	Level 1	25570	310	Default	14.78 m ³
42 m ²	Floor	Floor: 309	Interior	Level 1	25879	309 ir 311	Default	15.35 m ³
8 m ²	Floor	Floor: ilgas	Interior	Level 1	12000	ilgas korid	Default	2.83 m ³

Appendix C. Plumbing Fixture schedule.

PLUMBING FIXTURE SCHEDULE									
Family	Family and Ty	Level	Mark	OmniClass Number	OmniClass Title	Type	Vent Connect	Waste Conne	Comments
M_Toilet-D	M_Toilet-D	Level 1	1	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
M_Toilet-D	M_Toilet-D	Level 1	2	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
M_Toilet-D	M_Toilet-D	Level 1	3	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
M_Toilet-D	M_Toilet-D	Level 1	4	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
M_Toilet-D	M_Toilet-D	Level 1	5	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
M_Toilet-D	M_Toilet-D	Level 1	6	23.45.05.21.11	Water Closets	M_Toilet-Domestic	✓	✓	
Urinal (2)	Urinal (2):	Level 1	7			Urinal (2)	✓	✓	
Urinal (2)	Urinal (2):	Level 1	8			Urinal (2)	✓	✓	
Urinal (2)	Urinal (2):	Level 1	11			Urinal (2)	✓	✓	
Bidet - 01	Bidet - 01:	Level 1	12			Bidet - 01	✓	✓	
Lavabo su	Lavabo su	Level 1	13			Lavabo sur pied	✓	✓	
Lavabo su	Lavabo su	Level 1	15			Lavabo sur pied	✓	✓	
Lavabo su	Lavabo su	Level 1	16			Lavabo sur pied	✓	✓	
Lavabo su	Lavabo su	Level 1	17			Lavabo sur pied	✓	✓	
Sink - Bat	Sink - Bath	Level 1	20			Sink - Bathroom (✓	✓	
Sink - Bat	Sink - Bath	Level 1	22			Sink - Bathroom (✓	✓	
Sink - Bat	Sink - Bath	Level 1	23			Sink - Bathroom (✓	✓	
Sink - Bat	Sink - Bath	Level 1	24			Sink - Bathroom (✓	✓	
Sink - Van	Sink - Vani	Level 1	25			500 x 440mm	✓	✓	
Sink - Bat	Sink - Bath	Level 1	26			Sink - Bathroom (✓	✓	
Sink - Bat	Sink - Bath	Level 1	27			Sink - Bathroom (✓	✓	

Appendix D. Stairs schedule.

STAIR SCHEDULE						
Actual Num	Actual Riser	Base Level	Family	Family and Ty	Width	Type
21	182	Level 1	Stair	Stair: 190	1000	190mm ma
18	182	Level 1	Stair	Stair: 190	1000	190mm ma

Appendix E. Lighting Devices schedule.

Lighting Device Schedule							
Electrical Data	Family	Family and Ty	Level	OmniClass Number	OmniClass Title	Type	Comments
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Three Wa	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Single Pole	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Single Pole	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Single Pole	
120 V/1-0 VA	M_Lighting	M_Lighting	Level 1	23.80.50.11.14	Switches	Single Pole	

Appendix F. Wall schedule.

WALL SCHEDULE								
Area	Family	Function	Length	Structural Us	Type	Volume	Width	Comments
28 m²	Basic Wall	Exterior	6766	Non-beari	exterior w	12.87 m³	460	
19 m²	Basic Wall	Exterior	4810	Non-beari	koridoriau	2.46 m³	128	
24 m²	Basic Wall	Exterior	6376	Non-beari	koridoriau	3.11 m³	128	
24 m²	Basic Wall	Exterior	6366	Non-beari	koridoriau	3.11 m³	128	
3 m²	Basic Wall	Exterior	846	Non-beari	koridoriau	0.40 m³	128	
3 m²	Basic Wall	Exterior	796	Non-beari	koridoriau	0.37 m³	128	
3 m²	Basic Wall	Exterior	796	Non-beari	koridoriau	0.37 m³	128	
1 m²	Basic Wall	Exterior	376	Non-beari	koridoriau	0.12 m³	128	
1 m²	Basic Wall	Exterior	376	Non-beari	koridoriau	0.12 m³	128	
1 m²	Basic Wall	Exterior	376	Non-beari	koridoriau	0.12 m³	128	
3 m²	Basic Wall	Exterior	796	Non-beari	koridoriau	0.37 m³	128	
23 m²	Basic Wall	Exterior	5720	Non-beari	koridoriau	2.93 m³	128	
3 m²	Basic Wall	Exterior	796	Non-beari	koridoriau	0.37 m³	128	
23 m²	Basic Wall	Exterior	5710	Non-beari	koridoriau	2.92 m³	128	
24 m²	Basic Wall	Exterior	6390	Non-beari	koridoriau	3.12 m³	128	
23 m²	Basic Wall	Exterior	5710	Non-beari	koridoriau	2.92 m³	128	
3 m²	Basic Wall	Exterior	746	Non-beari	koridoriau	0.35 m³	128	
3 m²	Basic Wall	Exterior	926	Non-beari	koridoriau	0.44 m³	128	
3 m²	Basic Wall	Exterior	906	Non-beari	koridoriau	0.43 m³	128	
3 m²	Basic Wall	Exterior	876	Non-beari	koridoriau	0.42 m³	128	
14 m²	Basic Wall	Exterior	3585	Non-beari	koridoriau	1.78 m³	128	
24 m²	Basic Wall	Exterior	6405	Non-beari	koridoriau	3.12 m³	128	
3 m²	Basic Wall	Exterior	926	Non-beari	koridoriau	0.44 m³	128	
24 m²	Basic Wall	Exterior	6375	Non-beari	koridoriau	3.12 m³	128	
2 m²	Basic Wall	Exterior	580	Non-beari	koridoriau	0.30 m³	128	
3 m²	Basic Wall	Exterior	924	Non-beari	koridoriau	0.44 m³	128	
4 m²	Basic Wall	Exterior	944	Non-beari	koridoriau	0.45 m³	128	
4 m²	Basic Wall	Exterior	944	Non-beari	koridoriau	0.45 m³	128	
30 m²	Basic Wall	Exterior	7640	Non-beari	Generic -	2.70 m³	90	
2 m²	Basic Wall	Exterior	539	Non-beari	Generic -	0.22 m³	130	
23 m²	Basic Wall	Exterior	5700	Non-beari	Generic -	3.42 m³	150	
15 m²	Basic Wall	Exterior	3660	Non-beari	koridoriau	1.87 m³	128	

Appendix G. Electrical Fixtures schedule.

Electrical Fixture Schedule								
Mark	Electrical Data	Family	Family and Ty	Keynote	Level	OmniClass Nu	OmniClass Titl	Type
1	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
2	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
3	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
5	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
6	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
7	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
8	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
9	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
10	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
11	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
12	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
13	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
14	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
15	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
16	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
17	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
18	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
19	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
20	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
21	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
22	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
23	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
24	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
25	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
26	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
27	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
28	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
29	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
30	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
31	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
32	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V
33	120 V/1-0 VA	M_Electrica	M_Electric	16200	Level 1	23.80.00.00	Electric Powe	120 V

Appendix H. Mechanical Equipment schedule.

Mechanical Equipment Schedule								
Mark	Family	Keynote	Level	Radiator Height	Radiator Length	Radiator Type	Type	Comments
2	Radiator C	T	Level 1	500	1000	Double	1000	
3	Radiator C	T	Level 1	500	700	Double	7000	
4	Radiator C	T	Level 1	500	2050	Double	300 x 200	
7	Radiator C	T	Level 1	500	1000	Double	1000	
8	Radiator C	T	Level 1	500	700	Double	7000	
9	Radiator C	T	Level 1	500	1000	Double	1000	
10	Radiator C	T	Level 1	500	700	Double	7000	
11	Radiator C	T	Level 1	500	1000	Double	1000	
12	Radiator C	T	Level 1	500	1000	Double	1000	
14	Radiator C	T	Level 1	500	700	Double	7000	
15	Radiator C	T	Level 1	500	1000	Double	1000	
16	Radiator C	T	Level 1	500	1000	Double	1000	
17	Radiator C	T	Level 1	500	700	Double	7000	
18	Radiator C	T	Level 1	500	700	Double	7000	
19	Radiator C	T	Level 1	500	1000	Double	1000	
20	Radiator C	T	Level 1	500	1000	Double	1000	
21	Radiator C	T	Level 1	500	700	Double	7000	
22	Radiator C	T	Level 1	500	700	Double	7000	
23	Radiator C	T	Level 1	500	700	Double	7000	
24	Radiator C	T	Level 1	500	700	Double	7000	
25	Radiator C	T	Level 1	500	700	Double	7000	
26	Radiator C	T	Level 1	500	700	Double	7000	
27	Radiator C	T	Level 1	500	700	Double	7000	
28	Radiator C	T	Level 1	500	700	Double	7000	
30	Radiator C	T	Level 1	500	1000	Double	1000	
31	Radiator C	T	Level 1	500	700	Double	7000	
32	Radiator C	T	Level 1	500	700	Double	7000	
33	Radiator C	T	Level 1	500	1000	Double	1000	
34	Radiator C	T	Level 1	500	700	Double	7000	
35	Radiator C	T	Level 1	500	700	Double	7000	
36	Radiator C	T	Level 1	500	700	Double	7000	

Appendix I. Specialty Equipment Schedule.

Specialty Equipment Schedule				
Family	Family and Ty	Level	Type	Comments
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	
Elevator-EI	Elevator-EI	Level 1	2000 lbs 3	