Saimaa University of Applied Sciences
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THE COMPARISON OF THE ARCHITECTURAL DESIGN SOFTWARES

Bachelor's Thesis 2015

ABSTRACT
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Saimaa University of Applied Sciences, Lappeenranta
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There are a lot of ways of building project creation and design. A large amount of offered software mislead, especially, students and young architects suffer because of this. There are different requirements of software knowledge in various companies. So, the main aim of this thesis work was the comparison of the best and the most universal software for architects and designers in the early design phase.

The thesis work bases on two ways for the achievement of this task. They were connected to one. The first way was the sociological survey of few architects, engineers, companies, usual users of architectural design software and students. Their ideas, comments, experience and preferences were considered in this thesis work. The second way was the own project via offered software. There were three programs for direct creation and three programs for following rendering and visualization: ArchiCAD, Revit and SketchUp for the first comparison, Artlantis, Lumion and V-Ray for the second one. Each program was considered on several points, such as architect-engineer cooperation, tools equipment, elapsed time for creation of typical model, etc.

The result of the work is a table with points for each index and with overall point for each program, which was calculated via percent importance. The results are close to each other. Thus the user has to select the most comfortable software by himself. Each decision depends on the importance of indexes of the program.

Keywords: Architectural software, ArchiCAD, Revit, SketchUp, Artlantis, Lumion, V-Ray, Design of buildings, Software comparison, Architectural modeling.

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1 INTRODUCTION

The choice of own useful software depends on a lot of factors. Basically students learn a few programs during studying. A job offer or a design team puts condition to a new designer in the matter of software use. But anyway the question about the most useful program for design and creation exists.

The aim of this thesis work is determination of the most comfortable and the most universal architectural software. The comparison of programs helps in this. Three model based programs for creation are: ArchiCAD, Revit and SketchUp. Also there are three programs for following rendering and visualization: Artlantis, Lumion and V-Ray. Comparison is made on the following points: tools, elapsed time for typical model creation, abilities of architect-engineer cooperation, exporting abilities, component and members offered libraries, intuitive creation, etc.

Determination of each index bases on two constituting ways. The first one is the experience of architects and engineers, comments and requirements of some building companies, views of architectural software usual users and understanding of students. The survey was conducted. Each opinion has influence on this thesis work. The second way is own creation and design via considered software. Own estimations also affect the overall comparison.

The result of comparison work is a table with points of each index and with overall points for each program. All calculations are made with percent importance.

Thus the received results would help in the determination of the most comfortable software for the architect. Each designer is able to understand the most priority properties for himself. Requirements are based on own abilities and wishes, also on job offer or design team opportunities.

2 CONSIDERATION OF SOFTWARE CHOICES

Determination of the most popular software was done via a survey. Figure 1 and Figure 2 show the percentage of use of different software by architects, companies, users and students. Quantity of respondents is showed in Table 1:

Table 1. Quantity of respondents and their nationality

	Russia	Finland	Germany	Estonia	Sweden
Companies	5	2	2	1	1
Students	8	1	2	1	-
Architects and engineers	4	-	-	2	-
				Totally	**29**

Survey contained two questions: about building design software use and about visualization software use. Each respondent chosen used programs. The results have been summarized in the charts.
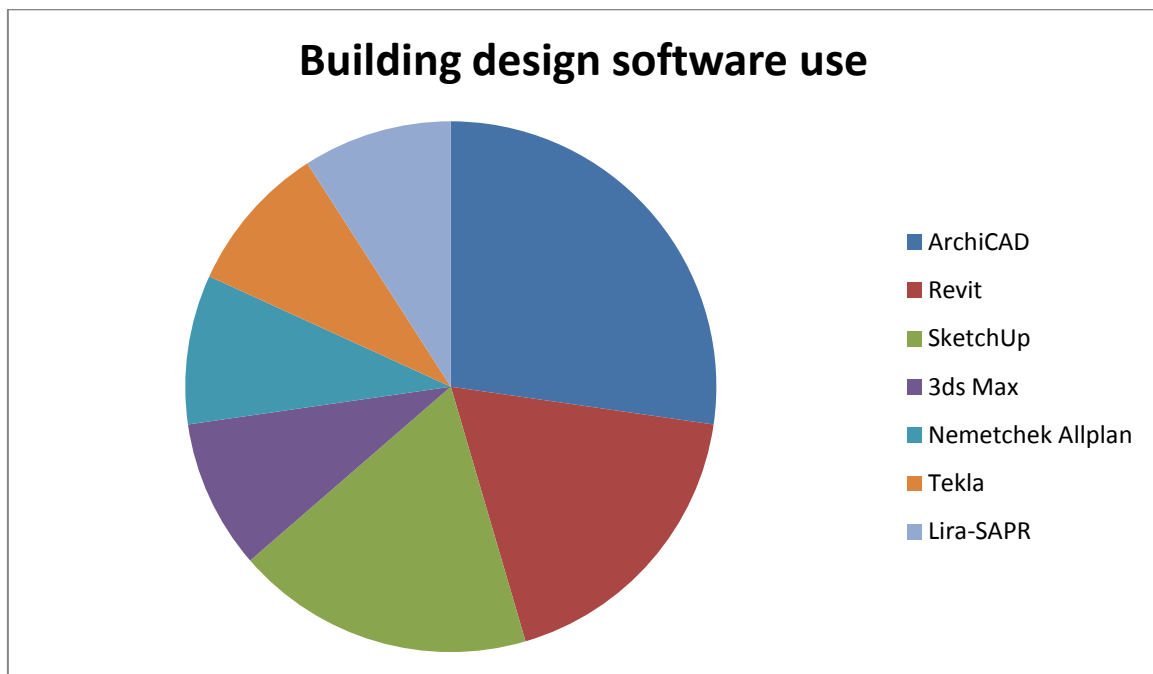

Figure 1. Architectural design software use

Figure 1 shows the most popular software for building design. ArchiCAD is the choice of 30% of users. Revit and SketchUp have the same quantity of users (near 20%). Another

software choice depends on the region of use. Nemetchek Allplan is very popular in Germany, Tekla in Finland and Sweden, Lira-SAPR is a very useful program in Russia. Tekla and Lira-SAPR can be used in architectural design, but this software is mostly for structural design. It is very useful in industrial projects. Estonian users prefer 3ds Max and ArchiCAD. 3ds Max is a very difficult program, it is very useful for complex animation projects. So great functionality is not always needed, so that it is not a very common software.

ArchiCAD, Revit and SketchUp become leaders of survey. So that the comparison of architectural design software will be based on them.

Figure 2 shows the users' choice of rendering software. Artlantis is very popular because of direct coordination with ArchiCAD. Lumion is a very useful software, it is very common in Europe (Germany, Finland, Sweden, Estonia), but it is not really distributed in Russia. V-Ray is an easy tool for fast render; it occurs in many projects by architects in all countries.
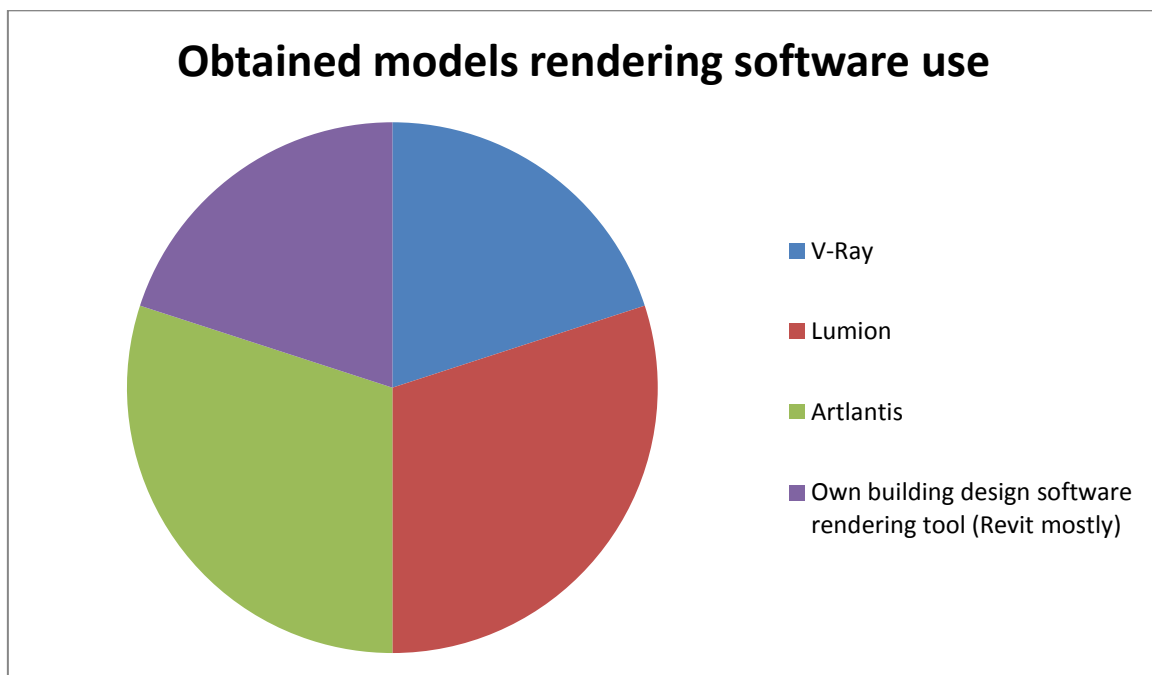

Figure 2. Obtained models rendering software use

Thus these figures show software, which is more useful for a large amount of users. This choice was taken for comparison.

Figure 3 shows exporting abilities between architectural design software and obtained models rendering software. Blue line is a way of this thesis work (ArchiCAD-Artlantis, Revit-Lumion, SketchUp-V-Ray). Green line shows direct exporting abilities. It means, that user may export from one program to another one without third program. Non-direct exporting is not on this figure, but these abilities exist. For example, it is possible to export from Revit to V-Ray via SketchUp. Also there are a lot of formats, which are able to export. But this manner is suboptimal, there are a lot of bugs.
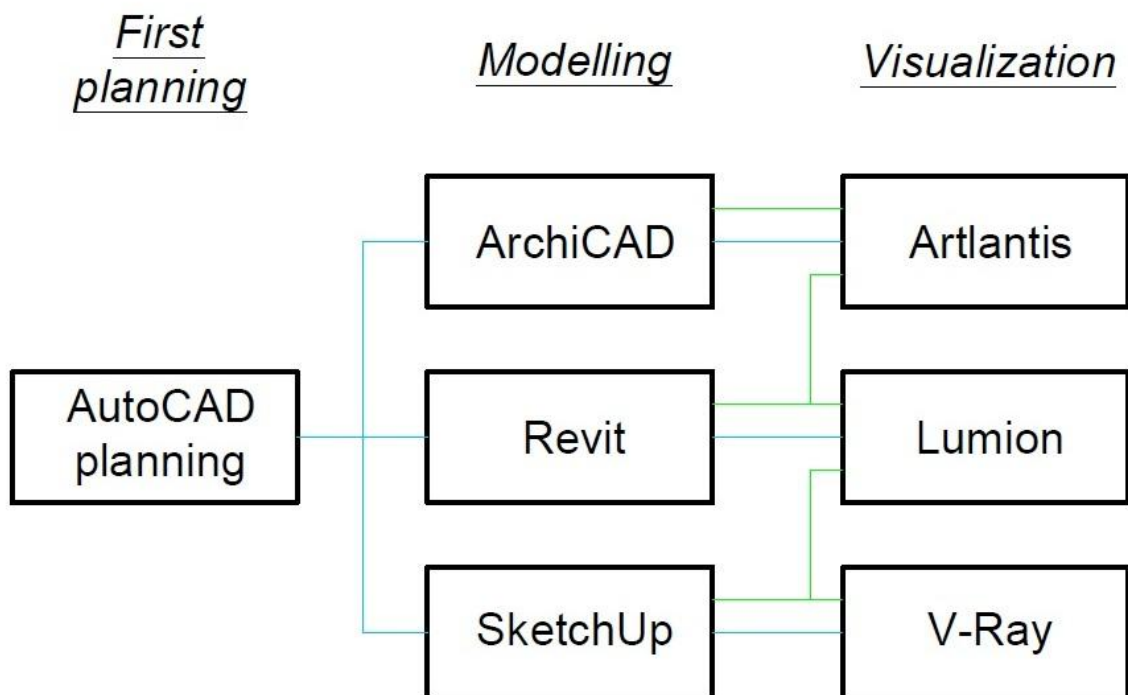
Figure 3. Scheme of software interaction

3 SOFTWARE DESCRIPTIONS

3.1 ArchiCAD

ArchiCAD was released by Graphisoft. The first version was presented in 1984 with the title "Radar CH" and it worked only for water supply systems. Nowadays the latest version is ArchiCAD 18 and this product represents a complex solution for the design of buildings and structures.[1]

The conception of ArchiCAD is that the user creates the 3D model building via tools that have analogues in real life: walls, columns, windows, etc. After finishing the program allows extracting various information from the project: floor plans, facades, sections, etc. The model from ArchiCAD may be interacted with engineering programs via IFC-file format. The tool kit is very easy. Each title is clear; it helps to create a model. The library is big enough to perform and realize any idea. Windows and doors are attached to their plane: wall or roof. So that automatic alignment of these members is provided. The main idea of coordination is the main axes binding. The user may create an axes grid for further object building with distances relative to this grid.

The main advantage of ArchiCAD is interrelation between all parts of the project. This technology allows to work not with separate drawings, but with the overall project. Each change will appear on each part or view of the full project. Also there is a big amount of settings, so that each object may be set according to requirements. The big disadvantage is inability of multi-various design. ArchiCAD enables to have one architectural decision in one file. But, actually, it can be avoided by using different layers. But this way is more difficult and bulky. Exporting abilities to other software are very low. There are no direct connections with some popular programs for visualization, for example. Also there are many users, who think, that the price of the license (nearby 5000 euros) is too high. But Graphisoft offers many free versions: for students and teachers, demo-versions, test version, start edition version, etc. So that the user may try this product before purchase.

Anyway the ArchiCAD is one of the most popular design products in the world. This popularity may be only because of usefulness and usability. The Graphisoft develops this program line and there is a new version each year, most of them are with new tools and new ways to creation.[2]

3.2 Revit

Revit is the main competitor of ArchiCAD. To be honest, these programs are quite similar. Revit is the product of company Autodesk, the largest producer of software for designers, builders and engineers. For example, the main drawing software AutoCAD is the product of Autodesk too. The first version of Revit was released in 2000. And this program was created like a competitor for ArchiCAD. And this fact may be realized by tools and creation ways in Revit – they are very similar to ArchiCAD.[3] The same axes

grids, real life analogues tools (walls, columns, etc.) and so on. The main idea was to have a very useful program but cheaper. It worked.

The main contrast of Revit is the information content about all stages of the life cycle of a building from conception to decommissioning. This information is very useful for maintenance and managers of the building during operation. Also since 2013 MEP-version of Revit connected with Revit Structure and Revit Architecture to one program. So that Revit became the fullest product for design. ArchiCAD needs other software for the creation of different parts of a building. And, of course, projects from Revit may be interacted to IFC-files. Autodesk is a very strong competitor for Graphisoft. For example, the tool Morph, which helps to create volumetric structures, in ArchiCAD was created only after Revit.[4]

Revit license is more expensive than ArchiCAD one now. It is near 6000 euros. But the user will have three programs for this price. Another disadvantage of this program is a small library of objects. But each object may be corrected, so that it is not a big problem. Navigation in a project is very difficult because of a big amount of copies, views and plans.

Revit is becoming more popular recently. This product offers new ideas and ways and takes the best solutions. But there are a lot of architects and designers, who used ArchiCAD, probably, in an old fashioned way or because of habit. There are many types of people, and someone prefers one product, but the other more oriented another one.

3.3 SketchUp

SketchUp has a completely another structure of work. The main emphasis is on intuitive use of this program. The user has to subconsciously know how to create own idea. Apparently this ability made SketchUp very popular and useful. The user can make decisions without any special knowledge in architectural or structure fields. Also SketchUp very is useful for companies who create furniture and interior items.

The first version was released in 2000 by a small company @Last Software. But the popularity came after purchase of SketchUp by Google. A little bit later Google sold this software to Trimble Navigation, and now this company develops SketchUp (the latest version SketchUp 15 was released in 2014). There are two versions: free for no-commercial use and the official license costs nearby 700 euros. The main difference between them is the permission to export to another file formats for the official version.[5]

SketchUp has almost no preliminary setting windows. The user may keep dimensions and properties during projecting or later. It is very useful to create own idea first and only then edit it. Also the key feature of SketchUp (which is even patented) is a tool Push/Pull which allows creating a 3D object via contour only by one action. There are no analogues in the popular software. SketchUp has no usual tools like Walls, Columns or Floors. The user has to create each part of the project. Sometimes it is faster and more comfortable, for example in custom structures. But there are situations, when other software is more useful.

SketchUp is the best in the first stages of the project, when it is necessary to see and explain the main idea and there is not much time. It is possible to create interior structures and plans, but it is very difficult, needs a big amount of time, and also the user needs to design in few layers for later presentation of interior structures. Also SketchUp cannot calculate any construction parts. But there is ability to export a ready project to AutoCAD for follow works, calculations and export to programs and file formats. The large components library is a significant advantage. The user may add anything, which will make the project more realistic.

Thus SketchUp may be the first program stage. This software is very useful to show own main idea and to follow export. Also it is applicable for presentations because of ability to create a large project with worthy entourage.

4 CREATION PROCESS

The comparison of abilities and advantages of each software bases on design. There is one typical model which was created in the proposed programs. The analysis consists of spent time comparison, actions during creation, software tools, additional abilities, import possibility and accordance of requirements. The typical plans were done via AutoCAD. It represents a single-family house with two storeys. AutoCAD model consists of plans and facades (Figures 4-9). The communications, deep, roof and foundation structures are not important in this work.
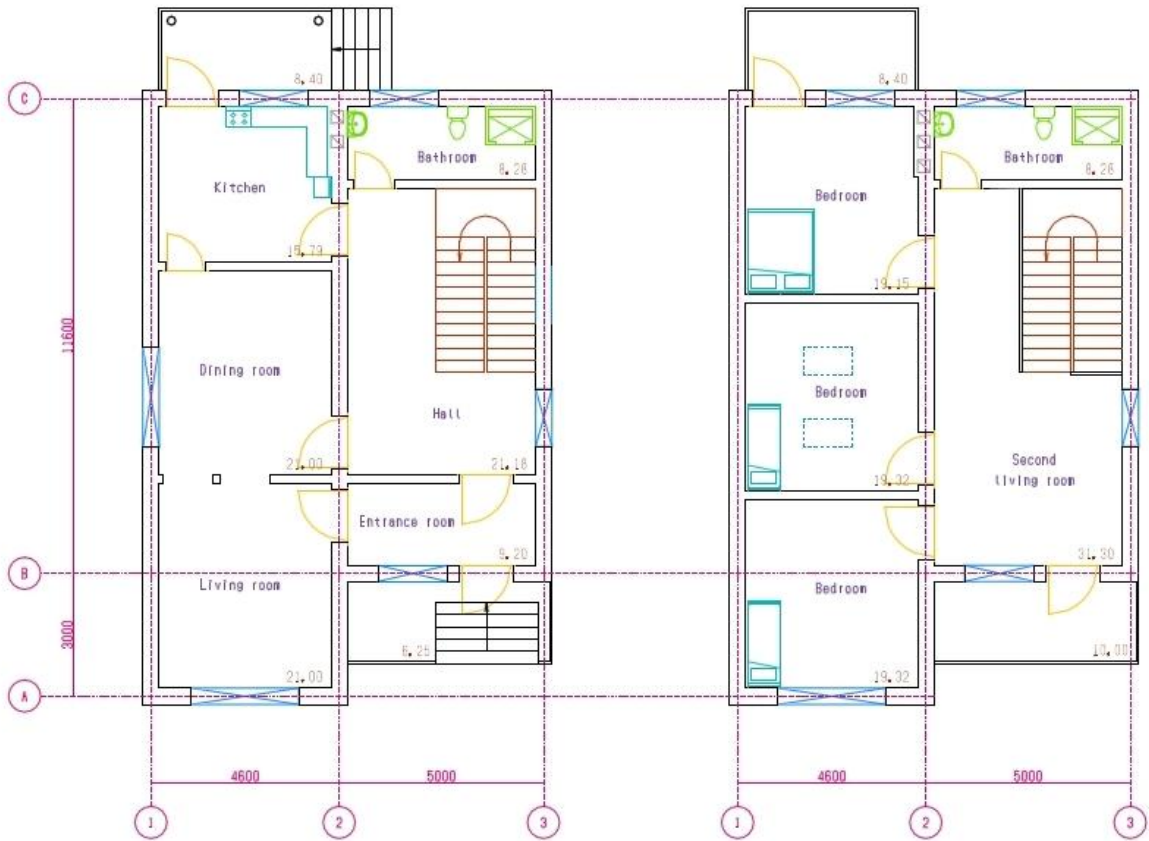
Figures 4-5. Plans of the first and the second floors of original AutoCAD model

Figures 6-9. Facades of original AutoCAD model

There are two living rooms, three bedrooms, two bathrooms, a kitchen and a dining room, a hall and an entrance room in the model house. The overall area is 193.82 square meters. There are two exits (the main one and from the kitchen). Also there are two balconies. There is a ventilation shaft going to the attic, serving kitchen and both bathrooms. The approximate dimensions on horizontal surface are 10x15 meters. The height of the house is approximately 10 meters. There are 11 ordinary windows and two mansard ones.

The material of external walls is concrete with heat, moisture and sound insulations. The plaster covers it. The structure of the house is load-bearing walls one. The foundation is a shallow strip one.

There are several offbeat elements with this house. They were placed for more detailed and difficult checking of each program. These elements can help estimating the abilities of the software via necessity of individual components creation. Members of checking are five-angle windows, mansard windows, columns, low-placed roof, no-ordinary second floor, arches between dining room and living room, two staircases, etc.

The plans were done via AutoCAD. It is very simple and serves only for the general perception of the house idea. Plans and facades were drawn by easy lines without deep drawing of elements. All dimensions were calculated by AutoCAD for further using in architectural programs. Also AutoCAD is a checking for ready models: software allows importing data to this program. Then the comparison of the first project and the finished one will be done.

4.1 ArchiCAD

The first step of creation in ArchiCAD was axes set. This process is very common and important, so it is very fast. The program allows automatically filling the name of the axe and putting dimensions between them. The next step is height marks determination. ArchiCAD automatically prepares floor plans on these marks. Also the user has to estimate the roof height mark for further construction.

The wall creation consists of wall type, wall width and wall composition. Also ArchiCAD allows estimating wall bearing. Floor slabs and beams may be chosen by the same way. ArchiCAD has an own windows and doors library, which even can be augmented via downloading extra elements. All windows and doors may be edited and changed. There are many parameters and properties: material, width, height, etc. All members

are binding to axes. Staircases may be created via a special tool with a comfortable setting list.

ArchiCAD is a complex tool of full project creation. It is able to connect exterior and interior designs to one picture. Also ArchiCAD can prepare all drawings, specifications and other needed construction lists for engineers.

Offbeat elements are not a big problem for ArchiCAD. Non-standard windows can be created via connection of two windows from the library. The low-placed roof was created via a special tool very fast, but ArchiCAD did not connect it with interior structures. So the user has to control it. The additional roof over window was created very fast also. ArchiCAD automatically put it to the right place.

ArchiCAD models can be exported to a lot of formats: DWG of AutoCAD, IFC-files, Revit, SketchUp, etc. But there are no direct connections with visualization software except Artlantis. ArchiCAD allows few designers working in one project. But there are some bugs. The first one is "loss" of elements on 3D-viewing or after exporting. The second one is inability to create an album by printing. In general printing is a big problem for ArchiCAD users. Revit offers automatic creation of lists and albums.

ArchiCAD has its own visualization tool. To be honest it is not very good in comparison with Revit's one. But Artlantis offers a better variant for ArchiCAD models. But unfortunately ArchiCAD cannot work with Lumion and V-Ray directly. But it is possible to export the model to .COLLADA-format. It is a really long process and there are many bugs and "losses" after this. So that Artlantis is the best decision for the visualization of ArchiCAD models.

The project process took about two hours. But if this model contains all structures, foundations, communications, etc. the time spending will be approximately 5-7 hours. Also it is very important to create an around area for location estimation. After finish the user has completed the model which can be very useful in the following construction process. ArchiCAD is very useful in communication between the architect and the engineer.

Figure 10. ArchiCAD ready model

ArchiCAD ready model without rendering looks not very special. There are no sky, material edition, shadows and reflections. But this model is illustrative: it shows idea.

Figure 11. ArchiCAD model with own ArchiCAD's rendering tool application

The rendering tool is really weak; there are not too many differences between the ready model and the after-rendering one. Shadows are not really good, material edition does not give any realistic views.

4.2 Revit

The official self-teacher of Autodesk for Revit advises to start by height marks. The user has to understand the overall height of the building and at least the approximate height of floors and the lowest mark of roof. Also it is very useful to add height marks of ceilings for further design. Of course, it is possible to change heights later if it is necessary.

Further steps are looking like the same ones in ArchiCAD. The set of axes is also very easy. Any auto filling is there. It is able to name or change each axe. The wall creation bases on the previous setting of properties. The library consists of standard walls: brick, wood, concrete, etc. Revit allows changing width, composition and bearing ability. So that, the user is able to create own walls. The same abilities provide for floor slabs and beams. But the user has to add all elements from the library before start. And there are many problems to connect these elements with program tools. There are many bugs even in the latest version.

It is possible to create exterior and interior structures too. Revit connects all members to the full project. Also this program creates drawings and specifications. It is very useful for future construction. But Revit is the program for architects mostly, so that the engineer has to check all this data after creation. Sometimes Revit cannot catch architect's idea and prepares strange drawings.

Revit has a big library with windows and doors. The user is able to change each ready component to his own idea. Components are attached to axes with exact dimensions. Also there are height marks of each member. There is a special tool Roof there. It is very useful in creation. All properties may be changed.

Revit is very difficult in offbeat elements creation. The additional roof part over window did not want to stay on correct position. Fortunately one five-angle window was in Revit's library, but another one needed to be created. So that the user has to create his own object via Revit's constructor, but it takes a lot of time. The staircase was created very fast via a special tool, having few stair models. One of the advantages of Revit is

the fast ability to create mansard windows – there is a special tool too, but this tool is only in the latest versions.

Special attention is given to low-placed roof. Revit automatically built interior and exterior structures. So that it is a very big advantage.

The full project takes about two hours. And the ready model is not a sketch, like the same in ArchiCAD. But in case of a real design the user has to create more details, to explain each component. Architects say that the same project, but in full version, takes about 5-7 hours. But there is a ready full project in the result, which can be given to expertise and for building.

Revit allows exporting to IFC-format. Also this program can be used for further working in AutoCAD, in visualization software (Lumion, Artlantis) and even in ArchiCAD and SketchUp. But there are few bugs. Sometimes Revit "loses" elements, for example, in case of overlaying of column and beam. But the newer program version is the better situation.

Revit has its own visualization tool. There is an overall opinion that this visualization is not very good. But it is much better in comparison with ArchiCAD's visualization tool.

Figure 12. Revit ready model

Revit ready model is quite understandable. It looks a little bit awkward. In comparison with ArchiCAD ready model it loses.

Figure 13. Revit model with own Revit's rendering tool application

The rendering tool is much better. Thus there is an interesting situation: own picture of ArchiCAD is better than Revit's one, but after-rendering image of Revit is more realistic than ArchiCAD's one.

4.3 SketchUp

SketchUp has absolutely another structure. The user, working with other programs, cannot understand the project process first. And there are many architects who are not able to estimate all advantages of this software.

The first step is creation of the overall contour of the building. After this the user may erect it via tool Push/Pull. Thus during 2-3 minutes the architect may have a 3D model like a sketch. Further work is related with edit and adds of new elements.

All members have to be created by the user mostly. The process is not very long or difficult, but an architect has to be fluent in all points and properties of his building. SketchUp cannot correct. It cannot determine mistakes and cannot point to the defects.

Each new member may be saved like a component and be very useful in the project. Also it helps to determine project in the separate objects.

Windows and doors, standard and offbeat ones were created during 5-7 minutes each. The further installation to position took not very long. SketchUp uses element binding. The user just needs to know the dimension from corner to door edge, for example. It is very useful for a fast project without special calculations. The roof was created via contours with following stretching.

But SketchUp has a very big problem with element turning. The special tool works very long. Also there is a difficulty to turn the needed member in right surface to right direction. And in case this element is not a component, the contact to member other elements will follow it after re-placing. So that the user has to control this aspect.

SketchUp has a very rich library, which is named 3D Warehouse. It consists of ready 3D models of anything what the user can imagine: from kitchen stuff and toys to real buildings, skyscrapers and even factories and bridges. The architect has the ability to create his own idea with minimal time spending. All components can be changed and edited.

It is possible to create a full project in SketchUp, meaning exterior and interior. But it is really difficult because of hard layers systems. So it is better to use Revit or ArchiCAD. Users of SketchUp create or exterior or interior dividedly mostly.

Although SketchUp is a very useful tool, it has a lot of restrictions. Also the user has to know many aspects of work such as library, tools equipment, etc. The experienced user is able to create very fast. For example, our typical model was done in forty-five minutes. But it is only exterior. Also SketchUp does not prepare drawings, views or sections. So the user needs to export the ready model to AutoCAD or IFC-format for following engineering work.

It is possible to compare works in SketchUp and in ArchiCAD or Revit with driving a car with different gearboxes. The work in ArchiCAD and Revit is like driving with automatic gearbox. Everything is controlled by a mechanism. It is comfortable, easier, but the user does not control his action. Also the mechanism can break. Anyway the user has to check his work. The creation via "mechanical gearbox" allows controlling the whole project and understanding each stage and part. Thus each user can choose a more comfortable variant and way for working.

SketchUp works very well with Lumion. It is possible to create exterior and interior dividedly, then edit them. The last step will be the creation of videos and pictures for presentation. This union allows to design very fast with the biggest quality.

Figure 14. SketchUp ready model

SketchUp does not have its own rendering tool. The ready model looks really a "cartoon". These spruces are "home" components of this program. Of course, it is possible to download other trees from 3D Warehouse. All members of the house were created manually by easy tools, but it looks good anyway.

5 VISUALIZATION PROCESS

The commercial designing and advertising are directly connected. The architect has to create a project which is able to amaze and spur to buy. Architectural ideas often satisfy wishes of the biggest part of population. For example there is not a big amount of people who would like to live in a house with triangle windows or with oblique walls. So the architect needs to understand desires, create interesting projects, but he cannot overdo it.

The resulting models are very useful for further projecting. They allow evaluating advantages or disadvantages of a building, catching the general structure and idea,

understand volumes and approximate costs. But these models cannot be presentable because of their technical subtext and, frankly, unsatisfactory graphic style. Each variant is angular, rough and nonrealistic. But it is possible to convert models via visualization software. It helps to give paints, set shadows and reflections, add entourage. To be honest, each project was created for further sales. Sales oblige advertising. Felicitous and gorgeous advertising needs perfect and understandable pictures of the project. These images have to show each advantage of the designed building, demonstrate it from the best point of view, so that the architecture, sales and advertising are very close to each other. This position has determined the necessity of using visualization software.

5.1 Artlantis

Even a newbie is able to make a good 3D visualization via Artlantis. This software uses intuitive creation. Also it is really fast and does not need large performance of computer such as Lumion, for example.

Artlantis works with each considered program. Also it is possible to create a model in AutoCAD or 3ds Max and to export it to Artlantis.

Artlantis allows setting each part of the project. It takes the library of materials from the original program after exporting and offers to edit it. Also it is possible to add extra components from own Artlantis's library. It consists of a big amount of elements, such as trees, cars, people, etc. Members can be replaced, edited and changed. There are abilities of movements setting for video creation.

Artlantis is a very common software for visualization because of wide distribution, good advertising and large amount of advantages, such as intuitive creation, fast working process and modest requirements. The direct connection with ArchiCAD supports this software because of the biggest popularity of Graphisoft's product. There a lot of official projects done via this union.[6]

Artlantis has a worthy quality of a ready model. It supports real-time creation, which helps to estimate own work. Also there are few interesting effects, such as pastel, sketch or color auto-setting. Artlantis allows reloading automatically during work in case the original model is changed.

Figure 15. ArchiCAD model with Artlantis's rendering

ArchiCAD and Artlantis make a worthy union. The model has pastel halftones after rendering. It is a highlight of Artlantis. The background and trees were done with Artlantis. Also materials of the model were edited by it. Everything looks really realistic.

5.2 Lumion

Lumion is a very popular software for architects. According to statistics from their website, 51 of the 100 largest architectural firms use Lumion. The functionality astounds. Lumion is able to create videos and HD-quality pictures. This program can convert a sketch model to a realistic image close to a photo even. Also there is a big advantage: Lumion works in real-time.[7]

Lumion works with Revit and SketchUp models. But also it is possible to export there projects from 3ds Max, Maya or another software, which supports .COLLADA-format. Lumion takes the material library of the model after exporting. The user has to edit materials to Lumion's standards. Lumion's material library is very rich. It consists of

wood, stone, glass, nature, etc. Each material can be edited by reflection, regeneration, color, light abilities, scale, etc. The ready model looks very realistic.

Also Lumion has a big library of additional members: technique, people, cars, furniture, flowers, trees, etc. Everything may be edited and placed to right location. These components give the life to the model. But unfortunately there are no extra libraries.

The landscape in Lumion can be edited very fast. There are some tools for ponds, mountains or forests.

The big advantage of Lumion is an ability to choose nature and weather condition. There are special tools for sun, sky, clouds, water, wind, etc. The user may add rain or snow.

After all manipulations the user has a live model. To be honest it looks like a very good photo. Lumion ensures all shadows, glare and reflection.

Lumion allows reloading during the visualization process in case the original model changes. But, unfortunately, there is no automatic process. Sometimes reloading is may take a big amount of time because of severity or complexity of the model.

Lumion offers creating videos. There is a special tool for this. The user has to make some images on the tentative camera way. Then the program makes a video this way. The user may make movements of objects during video. Unfortunately it works only with Lumion's components; this program cannot accept components from other software like a separate object. People and cars can move in any directions. Movements of sun and clouds may be accelerated. It is possible to add waves of the sea, river or swimming pool.

All this beauty has another party. Lumion is a very heavy program. Not each computer can provide work of this software. Not each operating system can work with this even. There are too many requirements. To be honest Lumion is a very whimsical program. It may work on one day and not on another day.

Thus Lumion is the best solution for visualization in case having very strong computer equipment for this. Lumion is the shortest way to create decent presentation for the high level even.

Figure 16. Revit model with Lumion's rendering

Revit model was taken for this rendering. The quality of this picture is very high. Entourage was made by Lumion. Sky, sun and shadows were done by special tools. All materials were edited: realistic plaster, tile, stone, glass, wood. The full design took about 15 minutes. Downloading of this picture took about 15 minutes, too. And it is not a maximum quality even. Downloading of images with bigger entourage and effects takes 1 hour sometimes. Video can be prepared during 7-12 hours. But the result is perfect.

5.3 V-Ray

V-Ray is much easier than Lumion or Artlantis. V-Ray allows creating realistic pictures and works like a plugin for the main program, such as SketchUp, Maya, 3ds Max, etc. It is possible to use this software for Revit or ArchiCAD, but only after exporting to .COLLADA-format. But this way is difficult and there is a big probability to lose few elements.

V-Ray is an example of manual user work requirement. This program takes material library after exporting and provides ability to edit each material. There are approximately 100 points. The most popular ones are Reflection and Translucence. But also it is possible to change shades, the color of reflection, light settings, etc. So the user has to understand the physical rules of light.

V-Ray does not have own components or objects. Each part and member has to be created in another program. Also there are no complex solutions for scene edition. V-

Ray requires downloading pictures for sky and grass. The user has to set each one. And there is no ability to create in real-time, all changes will be seen only after rendering.

V-Ray offers to choose the ready picture quality. It is possible to choose the largest quality, but the process of rendering will be increased. Also V-Ray cannot work with big models. It becomes very slow or unsubscribed to work.

But the advantage of this program is not high requirement to equipment. In many cases V-Ray may be replaced by Photoshop, for example. But the ability to work like a plugin improves opportunities of V-Ray. So it is very useful for architects without strong computers.[8]

Figure 17. SketchUp model with V-Ray's rendering

SketchUp model was taken for this rendering. The model converted. It became more realistic. But it looks too "funny" in comparison with the results of Artlantis or Lumion. Probably it connects with entourage. But V-Ray does not have own library of components, so the user needs to put all members in the original model.

Reflections were done manually via a special setting tool. They make image more realistic. Also it is possible to change world lighting. Sky setting is very special. V-Ray requires putting HDRI-format image for this, but it is not work in some cases. It is some kind of a bug of this program.

5.4 Conclusion about visualization software

Artlantis and Lumion really have the similar tools kit. The first program is much easier and lighter meaning requirements and equipment loading. But Lumion is able to create images much better, videos and their edition is more applicable.

V-Ray has another field of work. It is mostly applicable in fast "surface" rendering. There are no extra abilities or components.

Each considered visualization program may be used with models of all popular design software. So the choice of the most useful program is not connected with importing abilities. But there is a problem with ArchiCAD mostly. This software needs to be exported to the third format before rendering in Lumion or V-Ray.

The overall comparison is very clear. Artlantis has a good union with ArchiCAD and users of one program mostly prefer the second. Lumion is very useful for all model types. It offers large abilities and ways of creation. V-Ray is an easy tool, like a plugin, for fast rendering of ready models, such as Photoshop, or own rendering tools of ArchiCAD and Revit. Probably, V-Ray is able to take the place of rendering tool for SketchUp.

6 OVERALL COMPARISON

The overall comparison bases on the survey data and after-modeling experience. The average points for each software index are presented in Figure 18.
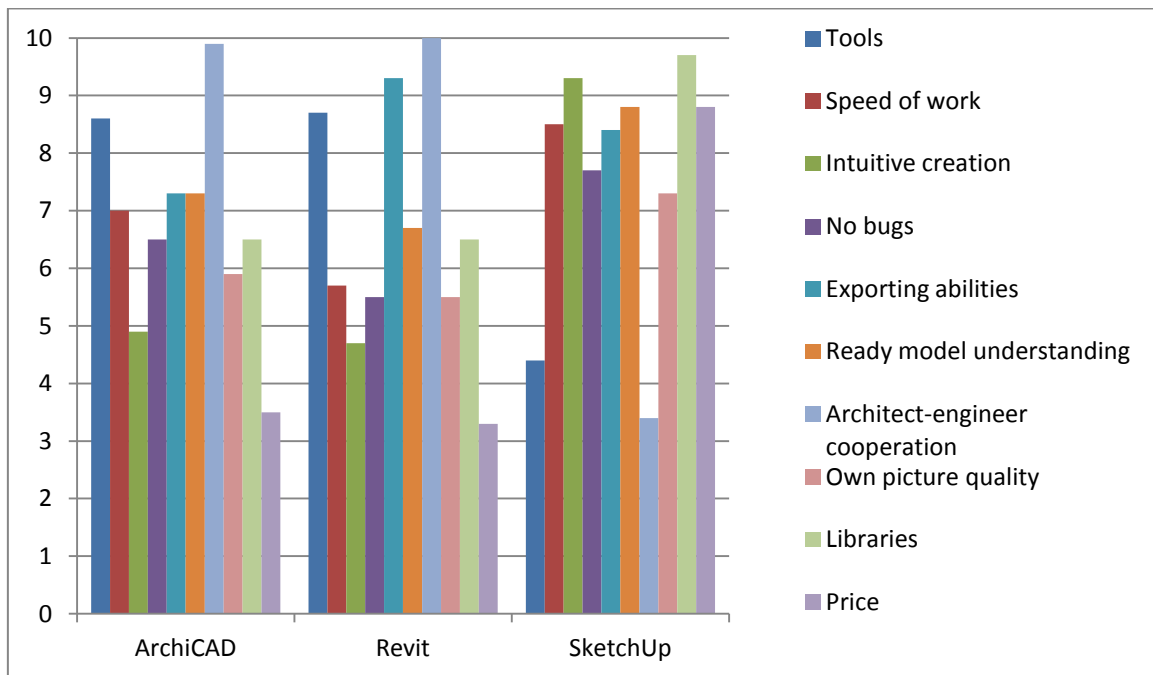

Figure 18. Average points for software indexes, received by survey

This survey was conducted separately for users of each program. Users of ArchiCAD, Revit and SketchUp estimated only their software. There was the same list for each group, consisting of 10 indexes. To be honest, all marks were very various, but the average point is very clear. The following estimation bases on this data mostly, but own experience after modeling took few corrections, but not large.

There are descriptions for each option further.

Tools: ArchiCAD and Revit have really the similar tools list, which consists of typical building parts equipment. SketchUp has an overall tools kit, which helps to create parts dividedly, but there are no special tools.

Speed of work: ArchiCAD has a very comfortable tools menu, which increased performance. Revit's menu is a little bit obscure. SketchUp uses intuitive location of tools; it helps to work faster.

Intuitive creation: it is the biggest advantage of SketchUp, but the biggest disadvantage for ArchiCAD and Revit.

No bugs: during projecting and after exporting. ArchiCAD has a better situation than Revit, but anyway there are a few bugs. SketchUp does not have a lot of problems.

Exporting abilities: ArchiCAD cannot export models to some popular programs. But Revit and SketchUp can export to most of the programs.

Ready model understanding: ArchiCAD's and Revit's models look very specific. It hampers overall view and understanding. SketchUp's model looks very simple and understandable without any special adds.

Architect-engineer cooperation: no questions about Revit and ArchiCAD. These programs create drawings and specification, can be exported to IFC-format. SketchUp cannot prepare technique documentations, but it is able to export to IFC or AutoCAD.

Own picture quality: graphics of ArchiCAD and Revit are very simple, but ArchiCAD's one is little bit better. SketchUp has the "cartoon" graphics.

Libraries: SketchUp has the best one. ArchiCAD's library is bigger than Revit's one.

Price: SketchUp is the cheapest software for high-quality design. ArchiCAD is a little bit more expensive than Revit.

All these options were reduced to Table 2. This table considers points of each software and importance percentage for each option. Average points were received via calculation, where each point was multiplied by percent. Then all results of multiplications were added for each program separately.

Table 2. Overall comparison of software

Options	Importance percentage	ArchiCAD	Revit	SketchUp
		Points		
Tools	25	9	9	5
Speed of work	5	7	5	8
Intuitive creation	25	5	5	9
No bugs	5	7	6	8
Exporting abilities	10	7	9	9
Ready model understanding	5	7	7	9
Architect-engineer cooperation	10	10	10	4
Own picture quality	2	7	6	5
Libraries	10	7	6	9
Price	3	4	3	9
Average points		7,21	7,11	7,32

The overall comparison shows no large differences between programs. SketchUp has a little bit bigger average point because of importance percentage of option "Intuitive creation", but it really has fails in options "Tools" and "Architect-engineer cooperation". Apparently, ArchiCAD is a little bit better than Revit because of the popularity of this software. But ArchiCAD has fails in "Exporting abilities". Revit became an "average" program. Most of the important points of Revit are bigger or the same compared with other software.

7 CONCLUSIONS

Each user has own importance in software, which he applies. The overall comparison of this thesis work may be used for any architect by importance percent change. Each program has own advantages and disadvantages. Probably the use of different software during various stages of the project (idea, presentation, design, etc.) will be a good idea. The use of different software in their best field may increase performance.

Each program for building design supports IFC-format export. It is very important to create architect-engineer coordination during the project. But abilities of the program are very various. ArchiCAD and Revit create own coordination via preparing drawings, views and specifications. This process is very long. SketchUp uses intuitive creation and allows exporting to AutoCAD, for example.

It is very important for a lot of users to have big libraries for creation. SketchUp is a leader in this field because of own 3D Warehouse. But probably it is the best point for interior creation, but not for building design. SketchUp's components are not very flexible and they have no automatic settings for different properties of the building. But this field is the best one for Revit or ArchiCAD.

There were a lot of parallels between ArchiCAD and Revit. These programs are really the same and they are competitors for each other. But during the thesis work there were some differences in the tool list, exporting abilities, price and abilities of offbeat elements creation. Each user has to determine the most important for him.

The popularity of ArchiCAD is able to explain which factors are more important for users. Probably the reason of this popularity is the precedence of ArchiCAD. It is the oldest program in the comparison list of this thesis work. The best fields of ArchiCAD are tools list and architect-engineer coordination, but this program is very weak in intuitive creation and the worst in exporting abilities in comparison with other software. But ArchiCAD allows creating project, which can be continued for further building process. Also it is able to connect client, engineer, architect and builder to one group.

Revit catches up the ArchiCAD very fast. But the glory of the second is not the best. Apparently this factor impacts to popularity of this really good software. To be honest Revit is better than ArchiCAD in a lot of options, such as exporting abilities or own rendering opportunity. It is very useful for further building process and for connection between different members, such as client, builder, architect and engineer. Revit is able to prepare documentation for further maintenance even. But Revit behinds on speed of work and there are too many bugs. Also the library of elements in Revit is a little bit poorer than in ArchiCAD. But all these factors may be explained by not the largest popularity, so that creators prefer producing for ArchiCAD mostly.

SketchUp is completely another idea. So the first place in comparison is controversial, probably. The main advantage is intuitive creation. But each user has to achieve this ability of fast creation. New users "lost" in this program. Also there is no real ability to create a full project via SketchUp. But sometimes creation of exterior and interior separately is faster than the same in one project. But also there is a big disadvantage of SketchUp: it cannot create technical documentations and cannot correct. To be honest SketchUp is useful for fast projects for presentations and the first ideas, not more.

Rendering programs are very important for follow understandable, presentation and, probably, advertising. The compared software has various applications. V-Ray is mostly for images in case of weak technical support. Lumion is the best solution for fast visualization with the highest quality and abilities, such as HD-photos and videos. Arttlantis is perceived like a supplement for ArchiCAD, but the abilities of this program are very wide. Artlantis is a good competitor for Lumion. But ArchiCAD models cannot be exported to Lumion directly, so Artlantis satisfies the rendering needs of ArchiCAD's users.

Thus the main idea and the main conclusion of this thesis work is the ability of the user to choose. There is not absolute program for everyone. Probably, there will be a program, satisfying all requirements and needs of each architect, engineer or usual user, in the future. The user may even have to choose the most priority options for creation. Each program offers own advantages, but also disadvantages. But anyway the best view is the study of a few programs for own comparison. It will help in the right choice of the most own useful software.

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