

Building Design Process using CAD and Graphic Programs

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Abstract

AutoCAD, with more than 3 Million licenses purchased worldwide, is the most widely used CAD software. AutoCAD is used across a range of industries, including architects, project managers and engineers and among other professions, with 750 training centers established worldwide. Nowadays you can hardly imagine an architectural design process without using this software. In the present article we describe some details of creating building designs with 2D and 3D CAD programs using the example of own basic work in AutoCAD. Our description will comprise the Building design processing techniques from architectural to structural, electrical and engineering design.

Keywords: Graphics Design, AutoCAD Graphics, 3D Modeling, 3D Environment

Introduction

The purpose of every designer's and architect's work is to make the result of a drawing clear and visible. The methods and the processes of the drawing depend on its object, but the principle is the same when we create drawings for a building, a car or the furniture. The importance is the result of the drawing, not the drawing on its own. Considering that the work can still be done without drawings, in that case accurate calculation will be next to almost impossible to achieve and the result we get will be inconsistent to the desires of its creator(s) and its customers. Drawing allows avoiding mistakes, calculating the result, and doing the work exactly, in the right and intended way. Software like AutoCAD makes this work easier. But a software can be used in different ways and sometimes with too many choices to make. What we need is a method of using the right options and choosing the way for our particular purpose of drawing to be realized. In this respect, the main point of our discussion in this paper is how to draw creatively and at the same time exactly using the CAD and graphic software products, how to choose the right options to get a result of a drawing which doesn't differ from the drawing purpose. The present article will be structured in this way: first, we give a short explanation about AutoCAD and other CAD graphic software products. In the section II we deal with the methods of using CAD software products and some scientific research base about the Georgian and international experiences using this programs. In the 3rd section we describe details of using CAD programs in the different stages of the architectural work: Creating the Sketches and draft design for client to be-

gin the long term design process and creating Building working Drawings (3.1), drawing the elements of the building by using the libraries of Architectural desktop creating the specifications of the building, creating neighboring design and visualizations, For each part of the section [Finkelstein, 2011] and thus for each stage of architectural work discussed in this paper we will show the results of our drawings and use the examples from our (architectural) working experience with CAD and graphic programs. In the last section we evaluate the advantages using this software for the particular stages of the architectural work described in previous sections.

The Main Content

The article includes the overview of designing process (example of building design process) main stages of designing work using AutoCAD, article begins with overview of designing process, working methodology, example of two small buildings that were designed mainly in AutoCAD and in other additional programs, the article discusses the whole designing process including supervising and shows the result of realized buildings. Next article is about the designing and supervising process in general, and then ends with summary about CAD programs achievements and disadvantages or disadvantages. The article shows the whole process of design and construction work using CAD and graphic programs.

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Image 1

(Grain processing complex architects M. Giorgobiani, M. Lazashvili)


Image 2

(Grain processing complex night view architects M. Giorgobiani, M. Lazashvili)

Building Design Process and CAD Graphic Programs

The main stages of the building design Process are based on an architectural work. However, the architectural design is not enough to construct a building. The designing and architectural work begins from the sketches and drawings that can be made manually or by CAD programs. The drawings are considered only for clients who want to visualize the building (the look and visual style, the plans and renting spaces of the building as well.) At this working stage an architect calculates the main areas allowed from the plot. Afterwards begins a long term design process including: Architectural drawings for building Process, Structural Design (that is always Integral of the architectural work), a design for heating ventilations and air conditions - HVAC (optional), designing electrical, plumbing and water supply systems, Fire Protection etc. - depending on client's desire.

Modern CAD (Computer Aided Design) Programs allows that all of the stages and design parts are viable using computer. There are several CAD Programs for this purpose. But in the present article we only review the abilities of AutoCAD for performing the described working stages.

As mentioned above, AutoCAD [1],[2] is the most widely used program for this purpose. The program is used all around the world and is next to Autodesk Revit [3],[6], ArchiCAD. This is the most popular software among the designers. AutoCAD is developed and marketed by "Autodesk Inc."- an American multinational software corporation focusing on 3D. Autodesk is also the developer of the 3D visualization software 3D max; so that the drawing made in AutoCAD can be easily exported to 3D max or other 3 dimensional programs [1],[2],[4]. This programs allow to create high quality renderings that cannot be done by AutoCAD - AutoCAD has a rendering function as well, but of the less quality than 3D max. (Image 1,2) Autodesk has also developed a few vertical programs (AutoCAD Architecture, AutoCAD Civil 3D, AutoCAD Electrical, AutoCAD eccscad, AutoCAD Map 3D, AutoCAD

Mechanical, AutoCAD MEP, AutoCAD Structural Detailing, AutoCAD Utility Design, AutoCAD P&ID and AutoCAD Plant 3D) [5] for discipline-specific enhance-

ments. For example, AutoCAD Architecture (formerly Architectural Desktop) permits architectural designers to draw 3D objects, such as walls, doors and windows, with more intelligent data associated with them rather than simple objects, such as lines and circles. The data can be programmed to represent specific architectural products sold in the construction industry, or extracted into a data file for pricing, materials estimation, and other values related to the objects represented. Additional tools generate standard 2D drawings, such as elevations and sections, from a 3D architectural model. Similarly, Civil Design, Civil Design 3D, and Civil Design Professional support data-specific objects, facilitating easy standard civil engineering calculations and representations. Civil 3D was originally developed as an AutoCAD add-on by a company in New Hampshire called Softdesk (originally DCA). Softdesk was acquired by Autodesk, and Civil 3D was further evolved.

Working Methodology

All the CAD programs offer it's specific methodology of work. Some of them differ from each other more or less. There are too many options in this programs usable in the context of the different designing works or allowing to work at the same drawing in different ways. In this view it's difficult for an architect to find an appropriate way to create and realize his concept using the advantages of the modern technology.

Own working experience, experiences of others (individuals and communities) and research data support us very much in this case. That doesn't mean that there must be a formula how to create an architectural design. Designing and architecture still remain a kind of art. Choosing a style is a question of an artist's individual preferences. What we want and have to know is: what result can I get if I go this or another way? That's already a question of knowledge and science.

To answer this question we should overview the advantages and options of both manual and soft-ware based drawings:

1. Sketch drawings are mostly to be made manually. Software based drawing only what program pro-



Image 3
Office Building for HVAC equipments in Tbilisi) architect - M. Giorgobiani



Image 4
Office Building for HVAC equipments in Tbilisi (night view) architect - M. Giorgobiani

poses. Handmade sketch is free, you have not to draw according proposed frames, so you can create something especial.

2. However, a handmade drawing hardly allows creating a 3D work. On paper you can draw everything but to see the real result, a handmade sketch should be imported into 3D. AutoCAD has great possibilities working in 3D –it even allows importing 3D from other programs. Sometimes it's easy to use other program in 3D modeling, because some commands are easy to follow in 3D. Therefore, there is no real as on to concentrate on only one program while AutoCAD allows importing objects (Image 3,4).

3. Renderings: There are number of programs that can render the work created in CAD programs including AutoCAD, so one can use which one is better according to working purpose. Sometimes architectural renderings are desired, sometimes – realistic renderings. It depends on artist's imagination and the preferences.

4. Working drawings in 2D or in 3D complete the whole work. Without it a building cannot be realized. This work is to be improved by computer, because handmade drawings need too much working time.

We also shouldn't forget that designing often is a part of a team work and a team project that implies [1],[2],[4]. collaboration with people from neighboring profession fields, sometimes from different countries as well. Respecting this, for a successful team work the following requirements are needed:

1. A possibility to use one program as main language of different fields and different countries.
2. A possibility to use different programs that will be combined and exported in one program finally
3. A possibility use the same program for team work of the different field.

AutoCAD allow fulfilling all this requirements. In this case an integrative working methodology used AutoCAD and other software options seems to be an appropriate way to work. [1],[2],[4]. Thus, the drawing methodology should combine all of the drawing type sand options to find a better and short time way to

complete the work and avoid the mistakes. That's what we want to discuss and show in this article: how does the methodology function in the practice? What result we can get, when we use such an integrative method of drawing in the different stages of an architectural work.

Our considerations about this question are based on a long term observation of drawers in Construction industry and own working experience: Observation is concentrated on the time of last 15 years, (AutoCAD is available since 1982) but first was not so widely used and so comfortable, last 15 years coincides with the period of large-scale building construction works in Georgia, where Efficiency of the CAD programs is reflected on each year, these period leave the country number of ugly buildings, along the buildings Especially In recent years, that were Important for cities and towns And are the interesting architectural appearance that are published Leading journals of the world, also the period allowed the country make the difficult type of building, that could be hardly realized before (non ordinary geometrical forms)

This period showed the advantages and disadvantages of computer aided design, not only in Georgia, CAD programs has been globally used at this time, program developed, also developed the standards of working in programs, but all of the drawers should be concentrated on result that needs some more job than only draw using computer. The last years experience and observation on designing companies shows that company which uses computer opportunities uses all of the work, mainly has architects who create sketches, a 3D modeler who creates renderings and 3D models that is based on architects sketches or AutoCAD 3d models created by architects, which is artistically processed in graphic design programs or even in sketches depends on design style.

The research observation of two large Georgian companies comparing to other Georgian and foreign companies shows that this work is most effective when it's created together by team, this saves time and avoids mistakes. Some of companies, even leading companies order some kind of their works e.g. ren-

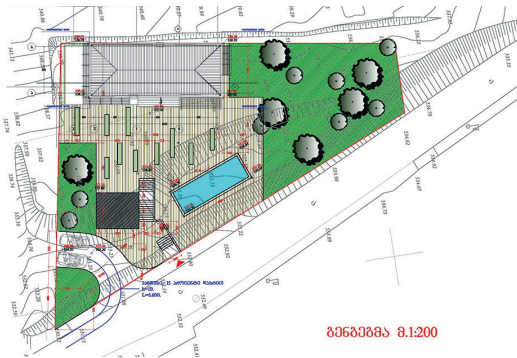


Image 5, 6
(Residential House in Mtskheta House Masterplan and Visualization Architect - M. Giorgobiani)

derings when they are not concentrated of it, mostly it's done by foreign companies that mainly order renders in china or other oriental countries, or some of them order working drawings the specialists who are good on practice and not good in art.

Using AutoCAD in Details

In the following section we describe different stages of the architectural work using AUTOCAD.

I-st and II-nd stage Architectural Concept Design

An architectural concept design means to draw the Sketches and draft design for client to begin the long term design process of creating working Drawings for the building.

Before establishing CAD and Graphic programs this work was done by a person who drew the sketches, perspective views and plans only manually. This long term period set us the Phenomenal architectural masterpieces. However, this buildings were done by the genius artists, who could highly imagine the design building and were far ahead than any modern computer programs allow this. But an architectural

design needs precise and as far as possible phenomenal decisions, that you can hardly imagine without using a software.

Before the architects were concentrated on facades that are reflected on old ordinary design, today to realize the fantasy of a designer is much more easy than it was before. Because one can imagine the whole building and show clients using this programs and also use the 3D of buildings at building processes.

The works you see below was shown as the examples of advantages of CAD workings, there were large and small buildings. To overview the details of the building process let us use examples of two little villas.

On the images (5,6,7,8) you can see a sketch and 3D visualization of a building project for the simple villas (Image 5,6,7,8) and its realizations in Mtskheta (Image 8, Image 9) and Tbilisi (Image 10). Because not having too many details as large buildings have the result of an architectural working using computer can be easily overviewed.

These buildings (Images 9, 10 and 11) must be differed from each other because the first one was supervised by an architect, an author of the design and second one was realized without supervising and architect saw the result when it was already realized.



Image 7
(Residential House in Tbilisi Hand Made Skecth Architect - M. Giorgobiani)



Image 8
(Residential House in Tbilisi 3D model Architect - M. Giorgobiani)



Image 9
Residential House in Mtskheta Realized Architect - M. Giorgobiani



Image 10
Residential House in Mtskheta Realized Architect - M. Giorgobiani



Image 8
Residential House in Mtskheta by Architect - M. Giorgobiani

Supervising and architect saw the result when it was already realized. Design began with sketches and 3D concepts endorsed by customers, the sketches were shown above. The plans of these buildings and visualization were developed at the same time, after handmade sketches the architect began creating the plans that in AutoCAD allowed to be 2D and 3D at the same time. Hence the plans and 3D model were developed at the same time so that it was realized from first time what does the building exterior look caused in Plans, this avoided wasting time with drawing something that could be impossible to finalize. These main drawings (Images 12,13,14) allowed finalizing work and create all of the drawings that are made ordinary for the building including facades, sections, working plans and specifications as well, there was also a need of detailing some nuances. Without these nuances building could not be of look on the same way.

According to a famous architect Ludwig Mies van der Rohe "Devil is in the details" - so a building look needs exact specifications and details: in these examples first in Mtskheta House (fixing and exact location of great curtain wall, balcony and other railing details in courtyard, wooden façade cover style, outdoor pergolas and glassed terrace roofing as well as

curtain wall details, glassed balconies, ceiling details and levels' structural description in Tbilisi house, when we look at the pictures or renders this doesn't seem difficult, but all of the details needed exact locations otherwise the design of the buildings could be quite different. These work was done by a drawer using new possibilities of AutoCAD to cut the 3D to sections and create the specifications or 2D details using Architectural Desktop Tool Palletes, and other commands included in AutoCAD.

After that a civil Engineer begin to work with buildings' structures and competed work using the same program, the same file in Architectural Desktop Navigator System. After finishing this work began interior design process in the same way, from sketches, and then completing by electrical drawings, flooring and ceiling specifications and detailed drawings, calculation of all of the work prices including material price and workers' price, an outdoor pool design and a landscape design, that was finalized during the building process starting point. Finishing these works allowed to order the materials that were abroad and needed time to be brought into the country, so builders and designers didn't waste their times and didn't choose only the materials only in place, but choose the materials that were more acceptable for their design. These works allowed builders saving time. When the building was realized which had only a few inconsistency from the drawings, all of the works implemented using the following Programs, vertical (AutoCAD), 3D modeling (AutoCAD, 3D max,) renderer (3DS max vary Renderer), Graphic-Photoshop, Corel draw, Calculating Program MS Excel.

The work was performed by the team of an architect, civil engineer, electrical engineer, HVAC designer in a very short time, work of each field continued only 3 or 4 days, per each stage and each field of work.

This was the result of mixed programs that were based on AutoCAD because each work was exported there or imported from, and team work using the same program. Design time of these projects lasted only few days, building process about a half of an year, but the result is the realized building look that doesn't differ

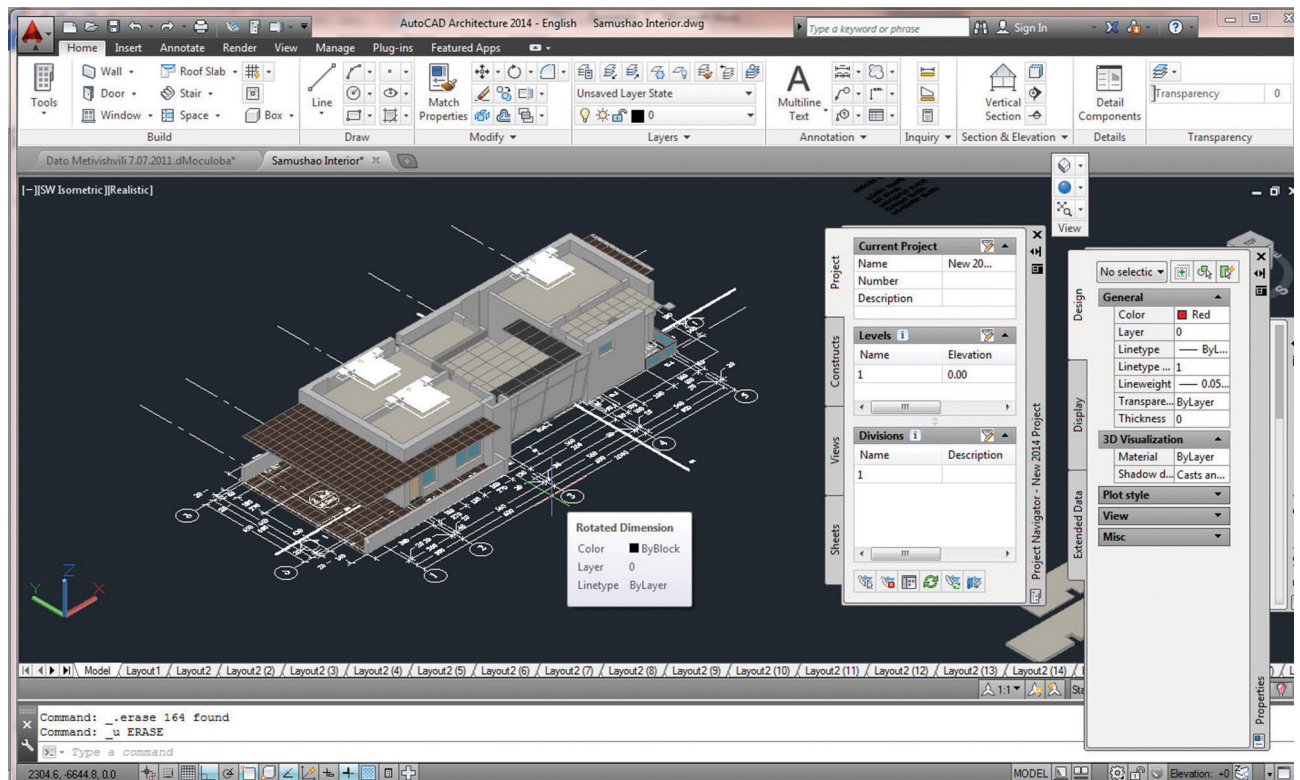


Image 13
(3D model of Mtskheta building)

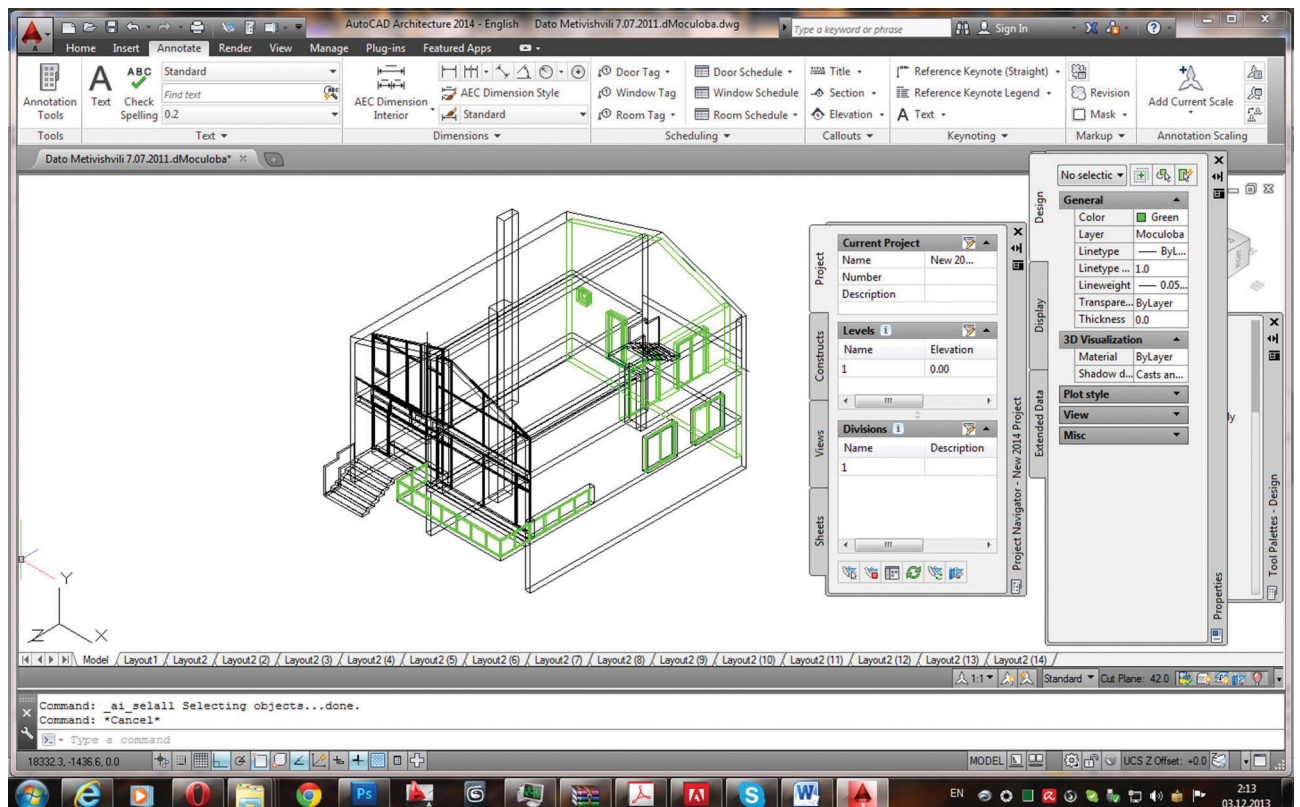


Image 14
(3D model of Mtskheta building)

from first sketches. The work is creatively and practically and the designing process short time doesn't reflect badly on the result. After these few days designers begin other works, that was created in such a short time as well, of course large buildings need more time to work, but the design process time reduced us-

ing CAD programs but Efficiency of work Increased. Now to design the building that needed years to finalize drawings can be easily finished in months, and if a designer is quite creative the Efficiency of his work is rises. The process of designing large and short scale buildings this way allows us thinking that Efficiency

and success of each work depends of combining human Resources of different field, such as team work and allow the team work in a free way, but use the same Opportunities, that allows to complete work in correct way, Not hinder the creativity, and do the work without mistakes and Unplanned events during each work.

Conclusion

To create the building for comfortable, practical use and with a nice look, we use with the materials what is in our hands at this time. The result is better when the group of people works on something as one, live is more easy by that.

Nowadays it's easy to build, but it is difficult to combine group of people with the same wish. Constructional work depends on this and has the standards that are used too many years when people realized how to build, how to draw with same standards and how to connect each other and work on something like one as it was at the beginning Modern computer programs on each field allows work easily and do team work in a short time. CAD programs and AutoCAD also allow this, and makes work easier. Standards and methods were founded before, but using a software makes to follow the standards and to see the result not only with an human imagination but to see exactly the result, and then go to realize it. Our experience we described shows that's its possible, when we combine different 3D and 2D options depending on our working purpose.

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