

## Visualization of Design, Organization of Construction and Technological Solutions

<sup>1</sup>B.V. Zhadanovsky and S.A. Sinenko<sup>2</sup>

<sup>1</sup>Ph.D., Moscow State University of Civil Engineering (MSUCE), Department of Technology and Organization of Construction; Moscow, Yaroslavskoye sh., 26; [kuzhinmf@mail.ru](mailto:kuzhinmf@mail.ru)

<sup>2</sup>Ph.D., Moscow State University of Civil Engineering (MSUCE), Department of Technology and Organization of Construction; Moscow, Yaroslavskoye sh., 26; [sasin50@mail.ru](mailto:sasin50@mail.ru)

### ABSTRACT

The article considers some of software complexes for building master plan visualization as a whole and its components. Special focus is on possibility of increasing quality of design performance and wider number of technically unskilled users.

### INTRODUCTION

The quality and costs of construction project are mainly defined by a technology of design. Nowadays when PCs have appeared at workplaces of structure engineers and manufactory engineers, a project seems to be unconceivable without implementation of automated design systems.

Implementation of automated design systems allows to increase performance of structural and technology engineer in 2-3 times, to boost efficiency of interaction between different units and departments, to raise level and quality of structural and technology project works, to reduce the term of technical preproduction, to avoid non-productive activity of engineers, to extend possibilities of design process and to create uniform structural and technological data base.

Idea of direct design has appeared as a result of virtual technology application analysis as an instrument of visualization of design solutions for management and construction technology. It is based on engineer's full immersion into design environment. The engineer is placed into designed space, he defies the way of transformations and implements those transformations in interactive mode, moving forms in virtual space. Idea of direct design is supported by many of researchers in field of virtual reality. The example of such kind of "full immersion" is shown in figure 1.



**Figure 1. Virtual model of building master plan**

Partial translation of basic vector graphics is the most commonly used way of 3D modeling nowadays. The principle is that any of 3D models (from which virtual space consists of) is presented as some number of intersected surfaces. As a result we have 2D polygons which are placed in 3D coordinate system.

3D models were given a texture to increase level of realism.

One of the most popular tendencies of computer graphics development is modeling of physically accurate light distribution in different medium.

To estimate quality of realization of virtual reality functions using software tools there is suggested to consider the following indexes:

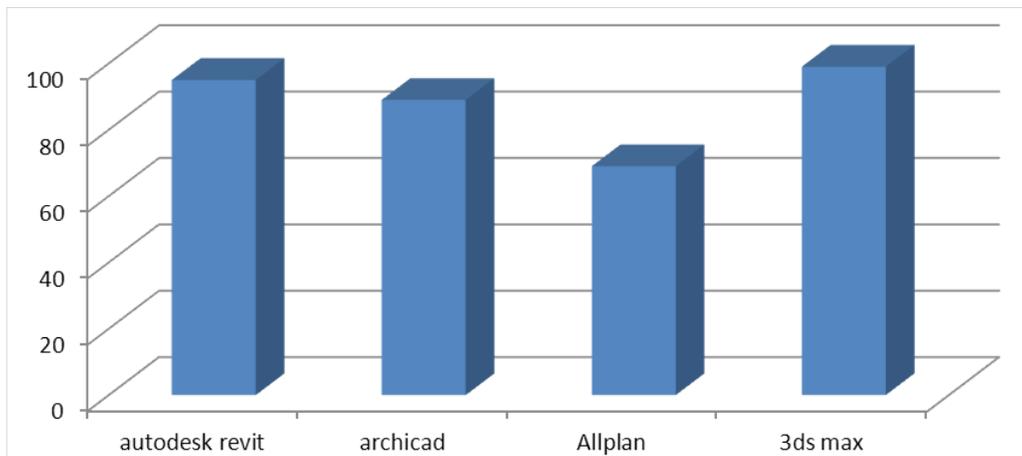
- Functionality (this index shows the completeness of possibility realization of function under consider, for example for differentiate function it is the order of derivative)
- Sustainability of operation (the ability to provide continuation of program execution after technical failures, input data errors and maintenance runtime errors)
- Working efficiency (the ability of program to execute within the required mode and extent of the information in accordance with program documents without technical devices failure)
- Clarity (index of simplicity and representation of initial modules of software in the most easy to perceive way, relevant documents of software description)
- Usability (index of representation of software documents and modules in a clear and simple way for further understanding of software operation logic in whole or in part)

- Automation level (index of automation level of data processing within the operating software structure rationality in the context of interoperability between the user and the usage of computing sources)
- Temporary efficiency (the ability of software to execute required actions in a particular time interval)
- Universality (index that characterizes ability of software to adapt to further requirements, that may appear as a result of application field changeover or other conditions of software operation)
- Flexibility (ability to implement software for different purposes in different fields)
- Mobility (possibility of software implementation without sufficient additional efforts at similar PS class)
- Modifiability (simplicity of amending and tweaking of software during the operational process)

Software complexes to analyze are represented in table 1. According to expert opinion, software performance assessment score may vary from 5 to 10 points, score distribution can be seen below.

**Table 1.**

Index name	Autodesk Revit	GraphisoftArchica d	Nemetc hekAllplan	Autodesk 3DS Max
Functionality	9	9	7	10
Sustainability of Operation	9	8	5	9
Working efficiency	10	10	6	10
Clarity	10	7	7	9
Usability	8	7	9	6
Automation level	9	8	6	9
Temporary	8	7	5	8
Universality	9	8	6	10
Flexibility	7	9	7	10
Mobility	8	9	6	8
Modifiability	8	7	5	10



**Figure 2. Integral estimation of software performance**

In accordance to total score it is found that Autodesk 3DS Max is the most suitable for creation of virtual reality model of building master plan.

Numerous high-quality architectural and designer's projects that were created with Autodesk 3DS Max have become ingrained in our everyday life and have taken an outstanding position.

As is well-known, working plan and plan for organization of construction both contain building master plan that is represented by construction site plan, that shows location of constant buildings, temporary service buildings and structures, constant and temporary railways, roads, engineering networks, warehouses, cranes and machinery, production facilities, existing buildings and clearance area.

Modern software complexes "Gektor-Stroytel", NanoCAD, "Stroytel" and others allow to improve designing process of some parts of building master plan:

- Crane selection within bearing and elevation properties, crane location within marking crane operation area and automatic definition of danger zone, crane section view drawing with crane bearing property insert
- Multivariate calculation of requirements, sanitary facilities and administrative buildings selection, drawing generation
- Calculation and automated selection of lightning equipment for construction area illuminating
- Energy requirements specification for power, technology and domestic need, area and passage illumination
- Water piping calculation, multivariate water consumption calculation and specification of pipe diameter

- Set of lines and schemes of construction solutions for temporary fencing within automated calculation of material requirements
- Routing of construction site temporary roads
- Warehouse area calculation with building code requirements
- Set of technology schemes of construction processes (AutoCAD drawing) with specification of type of work (MS Word text file)
- Ground work plan, calculation of ground excavation volume, freeform generation of the section view and plan view of excavation, selection of the efficient earthmoving equipment within working conditions
- Calculation of dewatering of excavations and trenches using light wellpoints for cases when artesian water movements can appear
- Selection of slinging equipment with slinging schemes, cargo mass table, list of slinging equipment

Complex of methods and technical devices should be tools of improvement, based on computerization, usage of peripheral devices, reprographics, that allow to combine technology process and generation of documents into one single system.

The main conditions of rationalization are:

- Implementation of surface modeling and document blanks
- Implementation of electrographic devices for originals production
- Microfilm with enlarged document copy
- Aperture card that provides copying automation and document storage

This technology is one of the first steps of improvement of building master plan design. The technology can be used for virtual education.

**Creating 3D model of construction site.** Usually modeling takes from 50% to 80% of total working process. It is very important to understand that modeling time depends on difficulty of situation at construction site, building or structure, but not dimensions (or value). Model texturing time depends on material difficulty and its variety.

Visualization presupposes illumination adjustment, material and surrounding selection. From this moment model becomes more realistic and presentable, it is possible define image quality. It can take from 10% to 50% of total working process. Visualization quality directly depends on skills and experience of designer.

The first step of visualization is working out 3d modeling method. It is very helpful when it is needed to estimate total amount of work, and it is

possible to define time limits. High-quality assignment reduces designing mistakes.

Building master plan contains all required attributes. At the stage of “2d drawing extruding” should be specified angle and its number. This component has effect on time limits and quality of displaying **virtual reality**.

Architectural and construction visualization, as a part of 3d graphics, allows to estimate with a high-quality level of authenticity how future building or another architectural form will fit in existing construction site. 3D model can be edited at any moment of visualization process, which will save time and money in the future.

3D visualization is an important tool of investment attracting into a construction project, because investor can see not only “cold hard” facts and drawings, but a vivid image of future building. Sometimes it is very hard to present the project conception using only traditional tools such as drawings, sketches of photo shots of analogues.

Civil engineers haven't fully valued possibilities of 3D modeling. But it is absolutely remarkable that every year 3D visualization becomes more popular among companies which work in field of civil engineering design and construction. It is necessary at every stage of project realization, from the first ideas to project sale. Additionally 3D visualization is a tool for investment attracting into a project, because investor sometimes can't get at the meaning of technical drawings. 3D modeling is more clear and easy to understand. Engineers, who work in construction field, often export AutoCAD models into 3Ds Max. 3Ds Max is considered one of the best tools for photorealistic models.

Working with AutoCAD only could simplify in a great measure project modification process with parallel visualization of intermediary results. Continuously tracking light pattern, we can find the best ergonomic, aesthetic and insolation solution for building location.

For automatic performance of realistic visualization of building model in AutoCAD environment there was developed an application. The application is based on Visual Basic for Applications (VBA) programming language. VBA editor (AutoCAD built-in) or Visual Studio editor may be application development framework. This application can be stand-alone product or can be used directly in current drawing in AutoCAD environment framework.

## REFERENCES

- [1] Kolesnikova E.B., Sinenko S.A. Virtual reality technology in representation of building master plan during the project construction // Civil Engineering [Promyshlennoe i grazhdanskoestroitel'stvo] 2012. №11. p. 60.
- [2] Lebedeva I.M., Sinenko S.A. Algorithm of visualization application for design solutions in AutoCAD environment framework // Technology and Organization of Construction [Tehnologija i organizacijastroitel'nogoproizvodstva] №1(1) 2012 p.43