Recent trends on BIM in architectural design in Russia

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Abstract. This paper presents an overview of the relevant normative framework related to BIM in architectural design in Russia. It focuses on the use of Russian software for BIM architectural design (in particular, it views Renga and NanoCAD) for education in architecture and architecture practice. It analyses several case studies for low-rise cottage, public buildings, school and museum buildings. The features of working with digital information models at various stages, project management are shown. Examples of the application of domestic software are considered. Together with other creative methods for architectural design, creating and working with digital building information models provides a wide range of opportunities for architectural education.

1 Introduction. Normative framework related to BIM in Russia

In Russia, building information modeling (BIM) technologies are actively used in architectural design and construction, which is related with the aims of digitalization (a program "Digital Economy of Russian Federation") and the development of the construction industry, expanding the use of BIM at all stages of the life cycle of construction projects.

The development of BIM technologies in Russia has reached a high level, and research papers and existing literature are devoted to various aspects of these technologies. For instance, Talapov (2022) describes the history of design, outlines the features of the transition and implementation of BIM in Russia and provides an overview of examples from world practice [1].

During recent decades a regulatory and normative framework related to BIM has been established in Russia. Let's briefly define the main terms and definitions related to BIM technologies used in our country.

Information model of a capital construction object - a set of interrelated information, documents and materials about a capital construction object, produced electronically at the stages of engineering surveys, architectural and construction design, construction, reconstruction, repair, maintenance and (or) demolition capital construction object [2].

Building Information Modeling technology is a process of collective creation and use of numerical information about buildings and structures, which makes it possible to form the basis for all decisions throughout the life cycle of an object and to coordinate various

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components and systems of a future building, as well as to check in advance their viability, functional suitability, performance [3].

A Digital information model is an object-oriented parametric three-dimensional model that digitally represents the physical, functional and other characteristics of an object (or its parts) in the form of a set of information-rich elements [4].

A digital twin is a virtual model of an object that accurately reproduces a shape of an object and is synchronized with it. The digital twin is developed and applied at all stages of the product life cycle, changing at each stage. The content and functionality of a digital twin depends on the stage of the product life cycle. [5]. Thus, the basis of a digital twin of a building is a BIM model of a building, to which information about the current state of a building is added - at the construction stage, at the stage of building maintenance [6].

Making digital twins nowadays in a relevant idea around the world, and this concept can be applied to buildings and to the city as a whole. According to the article Ivanov (2022) [7], digital twins are linked into a single system that allows using the generated data. Examples may include a digital twin of city infrastructure, digital twin of transportation network, digital twin of urban ecology, and other systems. The digital twin of the city will allow to monitor the current state of the urban environment, to respond to emergencies, to analyze the city considering historical data, and many more.

Digital twins have already been created for several cities around the world - for example, Antwerp (Belgium), Rotterdam (Netherlands), Newcastle (Great Britain), Boston (USA) and others. These models are used to solve various problems - from analyzing the level of noise and air pollution to analyzing scenarios of people's behavior at city public events and festivals and improving public safety [8].

Overall, Urban Planning Code of Russia and other documents set the normative framework related with BIM technologies. In addition, recent document (SP 333.1325800.2020 Information modeling in construction) presents a BIM-regulation.

The normative framework, together with the relevant software, is the basis for the introduction of digital technologies in the economy, architecture and construction, and social domains in Russia. In the field of architecture and building construction, digital technologies are primarily represented by BIM architectural design, project management, project expertise and are important for all participants of the process.

Therefore, this article is focused on analyzing the use of Russian software for BIM architectural design (in particular, it views Renga and NanoCAD) for education in architecture and architecture practice.

2 Methods

The following research methods are used: analysis of existing literature and analysis of actual normative framework for BIM-regulation in Russia. This article analyses the opportunities to use Russian software on the example of Renga and NanoCAD based on around ten case studies from architectural practice. It aims to analyse the opportunities of the above-mentioned software for architectural education.

3 Renga in architectural education and in practice

3.1 Renga software and case studies of its use for architectural practice

The Renga software includes the following basic software products - Renga Architecture (for the development of architectural solutions for buildings), Renga Structure (for the development of a structural part) and Renga MEP (for the design of engineering systems).
These components are combined into a single Renga information system. [9] The Russian company Renga Software was founded by Ascon and 1C in 2016. The features and benefits of the software are the following: it has convenient settings for producing design documentation for SPDS and ISO, it is possible to import and export to the IFC file exchange format, as well as to DWG format, which allows Renga to be used in combination with another CAD software. In addition, the building information model in Renga can be used at all stages of the life cycle of a building using the 1C platform (cost estimates, calendar and investment planning, property management, etc.).

Renga software is designed in accordance to Russian standards and norms. An overview of case studies for architectural projects performed by architectural companies and studios in Renga is presented in Table 1 (6 case studies are presented in the table).

**Table 1.** Case studies of using Renga in architectural practice.

The article [10] notes that during the project, Renga Software specialists interacted with the state expertise, and the requirements for the building information model and the requirements for the content of digital information models were formulated. According to the article, this provides a faster transition to BIM architectural design in the industry.

In the article [16] advantages and disadvantages of using programs are shown. For example, difficulty of creating non-standard shapes and geometry in Renga is compensated by an opportunity to import 3D objects from other programs. Advantages in Renga include a simple interface, presence of domestic libraries of elements and equipment, and integration with 1C.

Renga implements an OpenBIM approach, which makes it possible to combine projects and their parts, as well as various elements created in different BIM products [11]. It is implemented with import and export in .IFC file format.

In general, Renga is a comprehensive system for BIM architectural design, which allows to solve the architecture and engineering tasks.

3.2 Renga software use for architectural education

Let's view some features of working process in Renga. The software opens with a 3D view, in which you can start designing with the placement of building axes (Symbols - the symbol type "axis"), and then by using wall, column tools, etc. The base level is set by default to 0.000 level. To create floors, it is necessary to copy base level to the required level.

Navigation in the project comes from the Project Explorer tab, where you can set up drawing sheets (drawing stamps are pre-installed in Renga according to GOST), open views, plans, create a specification of rooms or equipment in the project. The project browser has the ability to create specifications and by default there are specifications (for example, a list of finishing materials, a specification of equipment, products and materials, a specification of doors and windows). Besides, in the project browser there is the ability to create tables and a default table.

Elevations and sections can be created based on a 3D model by selecting the Symbols icon in the Tools, and then selecting the appropriate symbol types (Elevation or Section) and placing them on a 3D model or a floor plan.

Renga allows to select different styles of windows, create your own or use ready-made ones from other projects, just like with doors and any interior or entourage objects.

The Project Explorer includes sections for piping systems, duct systems, and electrical systems for engineering documentation of a project.

Fig. 1. shows a student architectural project, a 3D model of low-rise cottage, made in educational process at NRU MGSU.

Table 2 shows examples of student work of various public buildings in the Renga, created in the process of studying at NRU MGSU (materials are given by A.S. Pavlyuk).

Fig. 1. Student work, cottage building, Vadim Egorov, IAG 3-41 (2022)
Table 2. Case studies of using Renga in architectural education

<table>
<thead>
<tr>
<th>Student work, Lyceum with in-depth study of natural and technical disciplines, Merkulova Margarita, NRU MGSU, IAG 4-52 (2022)</th>
<th>Student work, preschool institution, Dyakina Dana, NRU MGSU, IAG 4-52 (2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student work, preschool institution, Maria Gavrilina, NRU MGSU, IAG 4-52 (2022)</td>
<td>Student work, theater and film school, Lyubinskaya Maria, NRU MGSU, IAG 4-52 (2022)</td>
</tr>
</tbody>
</table>

The building information model created in the software can be further exported to other programs for different purposes: for 3D visualization in other programs, for physical and technical calculations, for VR presentation and 3D printing (by exporting to appropriate formats).

3.3 Other features of Renga

In general, many specialists are often simultaneously involved in the design of a building or a complex of buildings at different stages. And coordination of different parts of documentation is required. Therefore, collaboration is very important in today's dynamic design process. This requires project management and joint work on the project.

Pilot-BIM is a shared data environment for BIM projects for automatic generation and collaboration with consolidated models. It allows to assemble a consolidated BIM model from parts created in various CAD systems.

The capabilities of the Pilot-BIM program are a formation of the electronic structure of the project, a storage of all information on the project, management of the progress of work on the project (issuance and control of tasks), the coordination of documentation, for creation of reports, as well as joint work with customers, contractors and other stakeholders.

4 NanoCAD in architectural education and in practice

NanoCAD software allows to create drawings in accordance with Russian standards for the design documentation for construction, SPDS [17]. The advantage of the program is the
ability to create design documentation for the general technical requirements of regulatory documents and ESKD.

On the nanoCAD platform, BIM solutions for structures and other related parts of the project are implemented. Applications to the nanoCAD platform include programs for solving specialized tasks, for example, nanoCAD metal structures, nanoCAD construction site, and nanoCAD GeoniCS.

Let's consider some features of the nanoCAD, in particular, those related to the use of domestic standards and norms. Using the drawing standards, sets of common properties of drawing elements are defined, such as layers, text styles, dimension styles, line types. This is useful for working in an organization or when multiple authors are working on a same project. After creating a standard, checking for compliance with standards can be carried out both manually and automatically. To validate a drawing with standards, you can attach a DWS standards file to it.

Reference and regulatory system NormaCS is designed to find the necessary information. It can be used when working in NanoCAD program. For example, the "Search in NormaCS" command is available from the context menu when text is selected.

The software provides the possibility of integration with the NormaCS Specification digital platform, which includes the current regulatory and technical base of documents used in the Russian Federation. The main task is the selection of the requirements of regulatory documents for the objects of the information model imported from the IFC format. The search can be carried out both in the entire model and in its individual elements [18].

5 Conclusion and discussion

Overall, normative framework for BIM technologies in Russia and Russian software (in particular, Renga and NanoCAD) are considered. The features of work with digital information models at various stages, project management are viewed. Practical examples of the application of software (on the example of Renga) in practice and in the architectural educational process are shown. Around ten case studies of using Renga software for architectural practice are analysed. This article gives the example of using Renga for architectural education on the example of student’s projects.

It seems important that computer software and digital methods are a tool that can be used to implement the architect's creative concept. The creativity of an architect is a complex process that includes both creative intuition and working with tools, combining art and engineering into one to create architectural projects for the benefit of individuals and society.

In conclusion, it seems important that together with other creative methods for architectural design, creating and working with digital building information models provides a wide range of opportunities for architectural education.

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