Applicability of information technology in the design and operation of water supply and wastewater systems in Russia: a review

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Abstract. The article examines the role of information technology in the design and operation of water supply and wastewater systems. Noted that the history of the water supply development in Russia went back many centuries. At the same time, the first urban water supply projects were developed jointly by architects and engineers over several years; today, project development takes much less time, since in the modern world information technology has become an integral part of various industries, significantly improving the efficiency and quality of processes. The Renga functional was analyzed, algorithm for adding a new category of engineering equipment is proposed.

1 Introduction

The history of the water supply development in Russia went back many centuries, so during excavations carried out on the territory of Veliky Novgorod, water supply systems were discovered, divided into a gravity water supply network and channels for drainage and drainage (approximately IX-XII centuries), and by the XV century water supply systems were provided some crafts. At that time, there were wooden water pipes, for the regulation of which wooden valves were used. At the end of this century, water supply system appeared in Moscow, and the first pressure water supply system in Russia already appeared in the 17th century. Later, all royal palaces were equipped with water pipes that used both lead and copper pipes. And only at the beginning of the 19th century in Russia a city water supply system appeared for the townspeople; its length was 16 km; it ran from ancient Mytishchi to Moscow. More than 149 cities received centralized water supply to residential buildings by 1910, and by 1980, 1000 cities of the USSR had centralized water supply systems.

Today, new materials and technologies are actively used to save water resources and improve the quality of service to water consumers, and the issue of competent design of water supply and sanitation systems is becoming important. The first urban water supply projects were developed jointly by architects and engineers over several years; today, project development takes much less time, since in the modern world, information

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technology (IT) has become an integral part of various industries, significantly improving the efficiency and quality of processes. In the field of design and operation of water supply and wastewater systems, where high accuracy, reliability and efficiency are required, the introduction of information modelling technology (IMT) contributes to the digital transformation of the construction industry.

The use of information systems (IS) in this area provides an integrated approach to data and process management at all stages of the project life cycle. Thanks to this, a high level of coordination and synchronization of work is achieved, which reduces the likelihood of conflicts and errors.

If we consider the domestic experience in developing the applicability of information technology in the design and operation of water supply and sanitation systems, it should be noted that since 2016, a course has been taken towards import substitution of software, which is confirmed by regulations.

The most used programs at present are such programs as nanoCAD BIM VK, which is used for the design and calculation of models of internal water supply, sewerage and fire extinguishing systems, and Renga software.

Within the framework of the presented article, an analysis and assessment of the applicability of Renga software for the design and operation of these systems was carried out.

2 Materials and methods

As part of the presented study, Renga software was used, which focused on solving the problems of an architect, designer and engineer in internal systems using information modeling technologies. The software provides users with a solution with the necessary functionality, an intuitive interface, and an affordable price.

The system is based on the Russian mathematical cross-platform kernel C3D (C3D Labs). The solution has powerful tools for modeling 3D bodies of almost any shape and complexity, calculating characteristics, constructing triangulation for visualization, and exchanging data with other systems [1]. As part of the analysis of the system, an assessment was made of its applicability in terms of designing water supply and sanitation systems, laying routes, and arranging equipment, filling the information model, ensuring automation of calculations and specifications, ensuring collaboration of specialists, and preparing documentation.

3 Results

The functionality of the Renga system involves the creation of an information model of internal water supply and sanitation systems of buildings and structures for various purposes. Software tools are used to automate most of an engineer's tasks, in processes such as laying water and sewer lines, populating models with engineering data for relevant areas, and obtaining drawing documentation [2].

The design process of internal water supply and sanitation systems in Renga can be organized according to two scenarios:

1. Creating an information model based on 2D drawings, filling the 3D model with utility network objects.

2. Modeling of engineering systems in a three-dimensional model, which ensures the parallel work of several specialists.

The Automatic Routing tool allows to create complex pipelines, which provides the construction of routes for internal water supply and sewerage networks. In this case, the sequence of connecting objects, as well as the offset from the level of the floor and walls, are set in a special "System Designer" mode, which automatically creates a pipeline route, determining the optimal location of pipes, elbows, fittings and other elements, taking into account parameters such as height, slope, pipe diameter, etc.

Equipment placement in software can also be carried out according to several scenarios. Let's look at the main ones.

1. In the first scenario, parametric equipment styles are provided to create various types of equipment. The program implements a universal tool "Styles", which allows to create all the necessary types of equipment from any manufacturer. Renga provides parametric equipment styles, which can be found in the main panel in the "Manage Styles" tab.

In more recent versions, Renga STDL, a domain-specific style template description language, has become available, which includes built-in Lua functions for creating style templates and allows the use of the JSON format to define object style parameters [3-5]. In this case, the algorithm for adding a new category of engineering equipment can be represented as a process shown in Fig. 1.

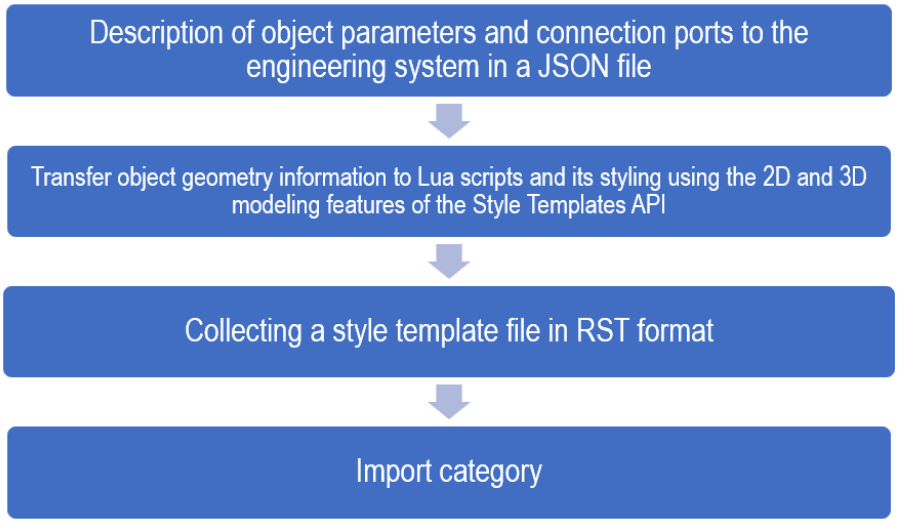

Fig.1. Algorithm for adding a new category of engineering equipment.

2. In the second scenario, you can use the assembly tool, with which you can independently create equipment that is not presented in catalogues or templates based on exact dimensions. Network tracing will be carried out from the connection point specified by the specialist.

3. In another scenario, you can use ready-made catalogues of manufacturers presented on the developer's website.

4. As part of the final scenario, you can use IFC format files; for such a model you need to add trace points and connect to the utility network.

The program provides functionality for entering the information model the required data for each element of the model for subsequent use by all project participants. Using this tool, the user can quickly obtain the necessary information about the purpose and dimensions of premises, the position of shafts for utilities, the location of technological equipment, etc.

In addition, the program can perform engineering calculations of water supply systems, including calculations of water consumption and drainage, hydraulic calculations, calculation of heat losses using the program for calculating internal water supply and sewerage systems of buildings - “Smart Water” [6].

The company offers a tool called "Specifications" that allows you to accurately calculate all aspects of internal water supply and sewerage networks. The mechanism automatically collects information from model objects and generates the table required by the designer according to the standards in force in the country, without resorting to manual calculations. Specifications are associated with the 3D model and are automatically recalculated when changes are made to the model.

The program allows you to create documentation on internal water supply and sanitation systems that meet current standards of the Russian Federation.

To ensure the collaboration of specialists, Renga Collaboration Server [7] is provided, where project participants can leave comments, ask questions, and discuss changes with other participants. Each of them can view and edit a 3D model of the building, add and change structural elements, as well as create and change internal utility networks. All changes made by each participant are automatically saved and become available to other project participants. This allows you to effectively coordinate the work of various specialists and ensure high quality of the project.

To simplify the organization of a common information data environment, a comprehensive solution from ASCON Pilot-BIM is proposed [8]. It allows you to combine BIM models created in different systems into a consolidated IM using the IFC format for data exchange. The solution also allows you to coordinate and exchange tasks between project participants, both within the group and with colleagues working in other BIM systems. For information exchange, it is also possible to use drawings in DWG/DXF formats with CAD systems.

However, the program under consideration is currently limited only to the design of buildings and structures, but in this software, it is possible to simulate water supply and sanitation systems that can be used for analysis, for example, to calculate pressure loss or the volume of water required for the operation of the system.

Conclusions

The article examines the role of information technology in the design and operation of water supply and wastewater systems, focusing on the Renga system. An examination of Renga's design and operational capabilities reveals its significant advantages as a BIM system. Even though the use of Renga is currently limited to the design of buildings and structures, this approach is fully justified by the fact that the company does not aim to overload users with a variety of functionality, preferring to delegate this to partners and related programs. This approach contributes to faster development of the system and ensures its stability and functionality. Thus, the Renga system stands out from other solutions, demonstrating the optimal combination of ease of use and high efficiency in the design and operation of water supply and wastewater systems.

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