Integration of BIM Technology in Polytechnic Education for Hydraulic Engineers

Yu E Ezhov[1], P A Garibin[1] and E O Ol'khovik[1]

[1]Admiral Makarov State University of Maritime and Inland Shipping, Dvinskaya Str., 5/7, 198035, St. Petersburg, Russia

E-mail: olhovikeo@gumrf.ru

Abstract. The work is devoted to the introduction of building information modeling (BIM) technologies in the field of hydraulic engineering. Prospects of transition to digital technologies of design, management of process of construction and operation are given. A number of factors complicating the transition to work within BIM have been identified. The importance of personnel training for building information modeling is noted. The problems of joint work of several generations of specialists in one team, various experience and professional skills that are used in the design and operation of building structures are considered. With timely improvement of software, development of the regulatory framework and appropriate personnel's training, the transition to the BIM technologies will provide the necessary development of the hydrotechnical industry. The development of the system of graduate's competencies taking into account the training of BIM technologies is offered. The options for implementing the building information modeling concept into the educational process of builders-hydraulic engineers are discussed.

1. Introduction

The Russian Concept of Continuing Education states that an increase in the average duration of adult education by one year in the long term perspective leads to an increase in economic growth by 3.7%, and per capita income by 6%.

Currently, the building industry of the Russian Federation is undergoing a process of active introducing the BIM (Building Information Modeling) technologies, which, in fact, are part of the digital economy [1] within the concept of Industry 4.0.

The BIM distinguishing feature is the fact that the project throughout the life cycle (PLM) represents not a set of segmental files, but a complete database [2]. Another BIM important feature is dualism, which is manifested in the fact that, on the one hand, BIM is a model, and, on the other hand, it is a technology. If the BIM is considered as a tool, then it is a dynamic database, if as a technology, then this is the management of the created database.

A key factor in the success of such innovation processes as the BIM technologies introduction in Russia is personnel support for all its stages. Therefore, the advanced personnel's training is necessary for the BIM technologies transfer.

2. Materials and method

Unlike work in traditional CAD systems, work in the BIM-oriented complexes allows you to simulate not only building objects, but also to control their characteristics and their changes over time [3, 4].

One of the basic principles of information modeling is the aspiration to combine all stages of a construction life cycle and all sections of design in one model (one database) [2].

However, to combine the entire project in one model is not yet possible. The technology allows reducing the number of data sources on a project, but it does not allow reducing their number to one. Hence a whole class of tasks (and software class) for supporting the BIM projects is being appeared [6]. New specializations are emerging. Thus, the improvement of software packages allowing us to realize the information modeling of a building life cycle is aimed at adding subprograms expanding the functionalities.

For example, the introduction of actual state monitoring systems at the facility operation stage requires new competencies from the staff. At the conference "Future Professions in IT and IoT", the following professions had been highlighted as the professions of the "future": Automated Industrial Diagnostics Specialist; Equipment failure Prognosticator; Team "Repairman 2.0" [7]. The technological enterprises have already begun to independently train the quality specialists, who should be engaged in planning maintenance and repair, depending on the equipment actual condition based on large databases.

A large number of publications are devoted to the development and implementation of information modeling technology in industrial and civil construction into the industry and the educational process. The work of Z. Pezeshki and S. A. S. Ivari [8] provides a classification and analysis of the literature from 2000 to 2016 devoted to the information modeling of buildings, the genesis of the development of the BIM methodology during this period is examined. The authors formulated the main directions of the information modeling methodology development, as well as related research and development. The orientation of BIM methods to correspond the expertise needs, the ability to constantly change and learn, that is the driving force of the BIM methodologies, is noted.

The review [9] focuses on the development trends of the design process of building objects, taking into account information modeling technologies. It is noted that currently the BIM technologies use is being actively implemented both in the construction industry and in the academic environment. The study shows the benefits of BIM, such as a systemacy of modeling process, a powerful platform for interactive visualization, and standardized data exchange.

Hydrotechnics is a special branch of constructional production - almost every construction is unique here. In this regard, the developed standard building databases do not supply the required amount of information. The situation is also complicated by the fact that, at the stage of the life cycle of operation, methods for assessing the operational reliability of the facilities are insufficiently developed; this especially refers to the transport hydraulic structures - port berthing facilities, gateways, etc.

3. Discussion

As with the advent of any new technology, and with the advent of BIM, difficulties arise with its implementation. To work with a large-scale project within a single information model, heavy-duty computer engineering is required. This leads either to the need to acquire a powerful server, or to the transition to cloud technologies. However, these are almost always the foreign services, which necessitates the information protection.

Another important point is the organization of teamwork. Participants in BIM projects must create, modify, store model objects according to the established rules. Such rules are usually regulated by the "BIM-standard", which is currently under development for hydraulic structures. The creation of a hydraulic structure information model is based on the use of already existing reference books - databases of its individual elements. All objects existing there are visualized, and also contain the information about material, cost, strength characteristics, service life, etc. Using objects already existing in the database significantly speeds up and automates the working process. It should be noted that the creation of such reference books in full for transport hydraulic structures is the issue of the near future. The priority of the external databases (libraries, catalogs) development should be behind manufacturers of products - individual structural elements.

The ways to solve these problems are to conduct training and exchange of experience among construction companies and the teaching staff of universities. Certainly, the software developers should be involved in these events, as well as their communication with each other should be established in order to reduce conflicts between different software packages and different software versions.

The need to use the BIM-technologies poses a serious task of personnel training [10–12]. At present, its solution has become a real necessity for construction universities to prepare a graduate who would be competent in the information modeling issues. For example, in St. Petersburg State University of Architecture and Civil Engineering, the information modeling is taught as part of a course and diploma project for architects, builders, network engineers, and IT specialists. [6].

The information modeling is being actively implemented in the field of hydraulic engineering and related fields [8, 13, 14]. Now most of the problems associated with their implementation, already have solutions. The process of BIM introduction will be gradual: from the implementation of one or two sections of the project within the information model, to the implementation of the entire project. In some construction universities and transport institutes, 3D modeling is taught highly fragmentary, and preference is given to 2D models. In some cases, the software does not work correctly - its different versions conflict with each other, and the software often has a high price.

There is an acute shortage of specialists. Population aging forces the entire education system to change. Adults are harder to adapt to technological innovations, so continuous lifelong learning is of particular importance. UNESCO divides continuing education into:

- formal education that a person receives in public educational institutions,
- non-formal education (including corporate education) – in the form of mentoring, internships, briefing, training,
- informal education – self-education.

The problem of teamwork up to 5 generations of people in one team is generally recognized [15]. BIM does not make unclaimed the “old generation” of specialists. Obviously, any generation sooner or later becomes “old”, but experience and professional skills are needed in any business, especially at designing and operating the technologies of hydraulic structures information modeling.

Information models can be created by working in the style familiar to the specialists who had been formed in the “classical” era, but just a lot of new are added to them. Another thing is that the former specialists will have to make some efforts in the mastering these new tools and the transition to a new technology.

It should be noted that the most organic process of transition occurs during the polytechnization of the process of classical education. The tasks of polytechnic education for students in the specialty of hydraulic engineering are discussed in detail in the work [16]. The methodology of organizing the polytechnic education and combining it with the introduction of BIM technologies are described in the works [17–19].

The efficiency of polytechnic education in modern conditions is confirmed by the results of research [20, 21] of the impact of the polytechnic education reform in Finland in the 1990s, which made it possible to significantly improve the quality of education in vocational colleges, bringing them closer to universities; this further increased the mobility of graduates, both of high schools and colleges. As a result, the polytechnic reform in Finland had been giving the results for more than a decade, with an increasing rate of 1-2% every year.

4. Conclusion

The introduction of the “Industry 4.0” concept and, above all, IoT (Internet of Things) technology, is possible with well-established processes for receiving and analyzing data, as well as the exchange between them. The development of technologies for working with information models is the near prospect of the construction industry in Russia. With timely improvement of software, development of the regulatory framework and appropriate personnel's training, the transition to the BIM technologies will provide the necessary development of the Russian hydrotechnical industry. Solving the tasks of developing a digital economy in hydraulic engineering is possible only with the integration of BIM-technologies into the educational process. According to leading foreign experts, Russian Polytechnic Education has the best prospects for adapting to the implementation of the Industry 5.0 concept, which is being developed now.

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