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InfraBIM Open paradigm as the driver of informatization of the road sector in Russia

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Abstract. The status of development and implementation of road infrastructure information modeling in Russia is reviewed. The InfraBIM Open paradigm is the basis for formation of information modeling processes practiced in Russia. The paradigm also solves the issue of software hybrid replacement allowing the use of both domestic and imported software packages. The current state of normative documentation regulating information modeling in Russia is analyzed. The evaluation of three BIM pilot projects is given, also the list of software packages and their modules having capabilities for implementation of road information modeling processes is provided.

1. Introduction
The OpenBIM paradigm is formulated and supported by the International consortium BuildingSmart. The paradigm is a universal approach to collaborative design, construction and operation of buildings and structures based on usage of open standards and working processes [1]. Specialists engaged in informational support of the life cycle of transport infrastructure note that there are significant differences in the formation of models for industrial and civil construction objects and those for transport infrastructure. In this regard while sharing the general principles of the OpenBIM paradigm transport engineers formulate another InfraBIM Open paradigm.

The principles and mathematical apparatus of creating information models have long been developed and tested, but the question of supporting the interoperability of these models at all stages of their life cycle remains open. One of the most promising approaches to ensuring the interoperability of models is the support of the open exchange format IFC developed by the BuildingSmart consortium and proposed for the entire professional world community [2].

Support for the IFC format does not solve the whole complex of problems for the implementation of BIM methodology, as it affects all aspects of engineering practice: organizational, technical, technological and to some extent even ideological.

In Russia, the issue of BIM implementation at the state level had been discussing and resolving since March 2014 when this topic was first discussed at a meeting of the Presidium of the presidential Council for modernization and innovative development of the economy [3]. The meeting was dedicated to construction, and BIM implementation topic was designated as one of the goals of innovative development of the construction industry at the state level. Over the past 5 years, we have come a long way from theoretical discussions on BIM to the creation of the first regulatory documents [4], the development of the first pilot projects [5] and the evolution of the domestic software [6].
With regard to transport infrastructure, both experts of railway industry [7] and specialists in motor roads made certain steps in the development and implementation of InfraBIM Open whose achievements we will discuss next.

2. Normative documentation
At the initial stage of BIM development in the Russian Federation, foreign experience was studied including normative documents in the field of information modeling. In 2016 the state company "Avtodor" developed the first regulatory industry document in the field of BIM: standard of organization STO AVTODOR 8.6-2016 “Organizational and technological maintenance of road information modeling on all stages of road lifecycle”. This document made it possible to carry out the first pilot projects and to accumulate some experience for the further evolution of the road information modeling process.

In 2016-2017, on the instructions of the Federal road Agency (FDA) "Rosavtodor", a number of research works in the field of BIM were performed. As a result, we received road industry methodological document named ODM 218.3.105-2018. "Methodical recommendations on interaction of developers of design and working documentation on pilot projects for the construction, capital repair and reconstruction of roads with the application of BIM technologies", approved and put into effect by the decree of FDA "Rosavtodor" from 05.06.2018 No. 2084-r.

Development of Methodical recommendations pursued the following purposes:
• Improving the quality of project documentation and reducing the time of construction (reconstruction, repair) of roads through the implementation of the paradigm "Information modeling in the life cycle of roads".
• Improving the management system of the road network and improving the efficiency of capital investments at all stages of the life cycle of roads by introducing information modeling technology into engineering and management processes.
• Motivation of participants in the road construction process to the formation of the market of information modeling technologies and the creation of appropriate organizational, regulatory, technical and technological foundations.

The introduction of these Methodical recommendations will allow to conduct in 2019 a series of pilot projects at a new level of quality which, of course, should enrich the theory and practice of road information modeling at the stages of design and construction of roads.

Currently, also on the instructions of the FDA "Rosavtodor" there is developing two preliminary standards (PNST) to expand and detail the processes of roads information modeling. Preliminary standards should regulate the development of both the road information model and its individual components.

Development of industry-wide regulations and standards in the field of InfraBIM does not exclude the need to develop internal regulations (BIM-standards or STO), which should take into account the specifics of the work and human resources potential of a particular legal entity, as well as the application of international standards in the field of BIM [8–10].

3. Pilot projects
One of the first projects from the viewpoint of information modeling is the project "Feasibility study on the connecting road from M-4 "Don" to A-105, access to the airport "Domodedovo" (designer is "GorKapStroy" LLC). The purpose of this work is the formation of the road information model at the “Feasibility study” stage for the subsequent transfer of this model to the "Design" stage and, as a consequence, a significant time reduction for the development of project documentation.

For the first time, the mapping of geological data in the form of a 3D model was tested (Fig. 1) and cross-sections as part of the 3D-model of the road significantly increased the visibility of geological information in the road model.
Fig. 1. 3D model of the geological structure in the area of the right-of-way

In addition, the technology of detailed 3D study of overpasses, including spans, supports and foundations (pile grillage) was first tested at the feasibility study stage (Fig. 2).

In the development of the road information model the libraries of typical elements were used: reinforced concrete structures; metal structures; models of road signs (including pillars and foundations); fences; lighting, etc.

Fig. 2. 3D-display of overpasses, including the underground part of the structures

The prepared documentation of the feasibility study consisting of drawings, explanatory note and the road information model was transferred to the Customer for its subsequent detailing at the "Design" stage.

The processes of road information modeling were implemented with most completeness and depth in the project "Far Western bypass of Krasnodar" (Fig. 3).
This project carried out by the engineering group "Stroyproekt" can be considered unique due to two circumstances. First, several information models were consistently developed: Territorial planning, Engineering surveys, pre-Design model and Design model. Secondly, the domestic software package S-Info for life cycle management of transport infrastructure facilities has been tested.

4. Software products

Both domestic and foreign software products are used in the practice of road designing in the Russian Federation.

Following the principles of OpenBIM concept and solving the issue of hybrid substitution software allowing the use of both domestic and imported packages, we propose a hypothetical range of software implementing InfraBIM at the design stage of highways.

As you can see from the list, these are all fairly well known software products. The software package S-Info ("S-Info" LLC, Saint Petersburg, Russia) is the only new in this line, but its appearance makes the line of Russian software products relatively self-sufficient.

S-Info is the first domestic software package that allows you to assemble a consolidated road information model from the elements developed in various software modules. S-Info can be used to generate queries, transmit, coordinate, synchronize, and view assembled model data, serving as a common data environment (CDE), and to address application engineering and management tasks in the design, construction, and operation of highways.

- **Engineering survey**: CREDO software package (Credo Dialogue LLC, Belarus), TopoCAD (Adtollo AB, Sweden)…
- **Road design**: IndorCAD/Road (IndorSoft, Russia), Robur-Dorogi (Topomatik, Russia), Credo-Dorogi (Credo Dialogue, Belarus), Autodesk Civil (Autodesk, USA), …
- **Design of culverts and bridges**: IndorCulvert & IndorBridge modules (IndorSoft, Russia), Renga (Renga Software, Russia)+Revit (Autodesk, USA), …
- **Design and calculation of pavements**: IndorPavement, (IndorSoft, Russia), Robur-Dorozhnaya Odezhda (Topomatik, Russia), Credo-RADON (Credo Dialogue, Belarus), …
- **Estimate calculations**: ABC-4 (NPP ABC-N, Russia), 1C:Smeta (TsSP Erikos, Russia), 5D Smeta (NTC Gektor, Russia), …
- **BIM model assembly**: S-Info (S-Info, Russia), Autodesk Navisworks (Autodesk, USA), Tekla BIMsight (Tekla, Finland), …
- **Common Data Environment (CDE)**: S-Info (S-Info LLC, Russia), IndorBIM-Server (IndorSoft, Russia), ProjectWise (Bentley, USA), Pilot-ICE (Askon, Russia)…

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**Figure 3.** BIM-model of the Far Western bypass of Krasnodar
• **Scheduling:** S-Info (S-Info, Russia), Synchro (Bentley, USA), Microsoft Project (Microsoft Corp., USA), ...

As for the list of open exchange formats ensuring the interoperability of information models during their life cycle, here first it is necessary to talk about the support of the IFC format proposed by the buildingSMART consortium. However, the range of engineering and management tasks within InfraBIM is so wide and diverse that it requires support for other formats such as LandXML, CityGML and FBX.

5. **Conclusions**

The issue of road information modeling during their life cycle is solving at the practical level in Russia since 2016, including development of both regulatory documentation and domestic software products, implementation of pilot projects. Educating and professional development of engineers remain a weak point in this chain of information modeling implementation processes. The leading transport universities of the Russian Federation are engaged in solving this problem: Moscow automobile and road construction state technical university and the Russian university of transport.

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