Куракина Наталья Владиславовна
студентка
Научный руководитель
Фомичева Татьяна Леонидовна
канд. экон. наук, доцент
ФГОБУ ВО «Финансовый университет
при Правительстве Российской Федерации»
г. Москва

DOI 10.31483/r-97255

ОБЗОР МЕЖСЕКТОРАЛЬНЫХ (СКВОЗНЫХ) ЦИФРОВЫХ ТЕХНОЛОГИЙ, ИСПОЛЬЗУЕМЫХ НА ЛИДИРУЮЩИХ ЗАВОДАХ СБОРНЫХ БЕТОННЫХ ИЗДЕЛИЙ РОССИИ И ЕС

Аннотация*: в статье рассматривается ряд основных и перспективных видов «сквозных» цифровых технологий класса «новые производственные технологии», реализуемых на современных передовых предприятиях по производству сборных железобетонных конструкций в России и Европе, для промышленного и жилого строительства, таких как САПР и BIM. В эпоху цифровой трансформации рынков компаниям важно переосмыслить все элементы своей бизнес-модели – от разработки и производства продукции до взаимоотношений с клиентами. Опыт ведущих международных и российских компаний в отрасли сборного железобетона показывает эффективность внедрения цифровых технологий.*

Ключевые слова*: сквозные технологии, цифровая экономика, производственные технологии, интеллектуальное производство, цифровизация производства сборного железобетона, информационное моделирование зданий, автоматизированное проектирование.*

Natalia V. Kurakina
student
Scientific adviser

Tatyana L. Fomicheva
candidate of economic sciences, associate professor
FGOBU VO "Finansovyi universitet pri Pravitel'stve Rossiiskoi Federatsii"
Moscow

A REVIEW OF CROSS-CUTTING (END-TO-END) DIGITAL TECHNOLOGIES USED AT LEADING PRECAST CONCRETE FACTORIES IN RUSSIA AND EU

Abstract*: the article discusses a number of basic and prospective types of «end-to-end» digital technologies in the «New production technologies» class, which are being implemented at modern advanced enterprises for the production of precast concrete structures in Russia and Europe, for industrial and residential construction, such as CAD and BIM. In an era of markets digital transformation, it is important for companies to rethink all elements of their own business model, from product development and production to customer relationships. The experience of leading international and Russian companies in the precast industry shows the effectiveness of the intro-duction of digital technologies.*

Keywords*: «end-to-end» technologies, digital economy, production technologies, smart manufacturing, digitalization of precast concrete production, Building Information Modelling, Computer-Aided Design.*

Introduction.

The next global technological revolution is under way. New digital technologies are rapidly developing and spreading, which penetrate all areas of human life, covering almost all sectors of the economy around the world. A new generation of «digital economy» based on «smart» data is actively being formed. The «Strategy for the Development of the Information Society of the Russian Federation for 2017–2030»approved by the President of the Russian Federation provides the following definition of the digital economy: «The digital economy is an economic activity in which the key factor of production is data in digital form, processing large volumes and using the results of analysis of which, in comparison with traditional forms of management, can

significantly increase the efficiency of various types of production, technologies, equipment, storage, sale, delivery of goods and services».

The foundation of the Russian economy is high-tech industrial production, which must meet the high requirements of international competitiveness, efficiency and labor productivity. At the moment, to meet these requirements, the material and digital (virtual) worlds are being combined, end-to-end digitalization, industrial intellectualization and automation are rapidly developing, and the transition to cyber-physical systems is underway. The topic of digital transformation has become a major strategic challenge for most companies in Russia, especially in the context of the coronavirus pandemic, as it is a prerequisite for the sustainable development of the organization. In addition, it allows companies to be successful and flexible in the face of constant acceleration of processes and constant unexpected changes.

Under the influence of the new technological cycle, more and more companies are launching programs of deep internal change, restructuring of business models and processes. Along the way, many executives are faced with new issues. How do you start and manage the digital transformation process effectively? What technological solutions will help change the business correctly?

1. «End-to-end» digital technology. Definition and list of technologies.

Within the framework of the National Technology Initiative (NTI is an association of business representatives and expert communities for the development of promising technology markets and industries in Russia, that can become the basis of the world economy) «end-to-end» technologies were identified as key scientific and technical areas that have the most significant impact on the development of national and global markets. In fact, end-to-end technologies include those that simultaneously cover several markets, trends and industries.

The new national program «Digital Economy of the Russian Federation» approved at the end of 2018, the list of end-to-end technologies is not given (it is envisaged to change the list of such technologies as new technologies are introduced and developed), but within the framework of the federal project «Digital Technologies» «road maps» on nine «end-to-end» technologies have developed: artificial intelligence,

robotics, Big Data, distributed registry systems, quantum technologies, industrial Internet, new manufacturing technologies, wireless communications, virtual and augmented realities.

One of the main objectives of the national program «Digital Economy of the Russian Federation» is to transform and improve the efficiency of the main sectors of the economy through the introduction of new digital technologies.

2. New Manufacturing Technologies.

New production technologies are a set of new, high-potential, demonstrating rapid development, but still not widely spread, innovative approaches, materials, methods and processes that are used for the design and production of competitive and well-consumed products on the world market.

Based on the analysis of hundreds of sources («Road maps», «Technet», Science Technology Initiative, «Atlas of End-to-End Technologies of the Digital Economy of Russia», Manufacturing USA, Industrie 4.0 (Germany), Made in China 2025, Horizon 2020 (EU)), the following most relevant sub-technology blocks for strategic development are identified:

1) digital design, mathematical modeling and product lifecycle management (Smart Design);

2) smart Manufacturing / Smart Production;

3) manipulators and manipulation technologies.

The quality criteria to distinguish sub-technology from a large number of modern technological solutions are:

1) Digital Design, Mathematical Modeling and Smart Design: includes technologies that deliver the concept of advanced digital design; the driver of this process is «Digital Twin» development technology. It is important to note that among the many advanced technologies, the «Digital Twin» is a technology integrator of almost all «end-to-end» technologies and sub-technologies, acts as a technology-driver, provides technological breakthroughs and allows high-tech companies to move to a new level of technological and sustainable development on the way to industrial leadership in global markets.

This block of sub-technologies includes:

– CAD – Computer-Aided Design;

– CAE – Computer-Aided Engineering and HPC – High Performance Computing;

– CAO – Computer-Aided Optimization – multi-parametric, multi-critical, multidisciplinary, topological, topographical, optimization of sizes and shapes, etc.;

– CAM – Computer-Aided Manufacturing, CAAM – Computer-Aided Additive Manufacturing;

– PDM – Product Data Management and PLM – Product Lifecycle Management), including a service that provides access to the digital profile and status of the product, ensuring traceability of products during the development, production, logistics, installation and operation stages;

– Platform solutions for operational monitoring, product maintenance, predictive analytics and repairs;

2) Smart Manufacturing includes technologies that implement the concept of «smart» production with minimal human participation; Solutions for operational management of processes, manufacturing, enterprise; solutions that provide high production flexibility, rapid reconfiguration and scaling based on flexible, reconfigurable and modular machines, equipment and robotics for the production of customized products of a wide range (on individual orders); platform solutions for manufacturing, industrial Internet and logistics, including the following sub-technology:

– Smart production lines;

– CNC – Computer Numerical Control;

– Mobile digital devices equipped with wireless modules to receive and transmit data;

– ERP – Enterprise Resource Planning;

– Automated MES – Manufacturing Execution System – production processes, equipment management systems;

– Systems of RFID – Radio Frequency Identification (including barcodes, zR codes);

– IIoT – Industrial Internet of Things – a significant integrated technology direction that connects different IT systems, equipment and sensors in a single chain;

– Platform solutions for logistics;

– Systems of BPM – Business Process Management;

– Flexible, reconfigurable and modular machines, equipment and robotics systems;

– Precision technology, precision measurement sensors;

– Machine nodes and aggregates that affect executive accuracy;

3) manipulators and manipulation technologies include mathematical modeling techniques of robotic systems as spatial mechanical systems with holonomic and non-holonomic connections, methods of direct dynamic modeling of non-linear spatial mechanical systems with contact interactions; development of software for the management of robotic manipulators; software and hardware tools interacting with the environment and objects.

3. Effects from the introduction of «New Manufacturing Technologies».

Positive effects from digitization in the precast concrete industry.

According to Precast Software Engineering (one of the leading developers of building information modeling technologies, a provider of specialized software for precast concrete manufacturers), published in 2019, the following results were noted among more than 380 precast concrete production enterprises:

– Improving internal business processes;

– Increased production capacity;

– Reducing production, planning and storage costs;

– Reducing defects;

– Better distribution of information in the company;

– Ensuring compliance with BIM data-sharing requirements (e.g. in government projects);

– Ensuring the quality of models and data;

– Increased customer satisfaction;

– Dissatisfaction with the existing solution (about 2–3% of cases);

– Increase in sales.

Expectations of Russian CEOs from digital transformation.

According to research surveys of the Russian company KMDA, published in the analytical report of KMDA in the current 2020, among more than 700 representatives of Russian companies from 27industries, from the oil and gas industry, engineering and education to IT and banking, the following expectations of companies from the digitalization of the business were recorded:

– Increase in capitalization – 89%;

– Increase in product and service margins – 84%;

– Competitiveness – 78%;

– Cost reduction – 76%;

– New business models – 75%;

– Productivity boost – 70%;

– Increase in speed of adaptation to external changes – 63%;

– Improving the efficiency of business processes – 59%;

– Reducing labor costs – 54%.

Overall effects from digital transformation.

According to the same report, reducing labor costs and improving the efficiency of processes are the main effects already achieved in the companies of respondents:

– Labor reduction – 34%;

– Improving process efficiency – 30%;

– Productivity boost – 25%;

– Increase in speed of adaptation to external changes – 25%;

– Creating new business models – 24%;

– Cost reduction – 23%;

– Competitiveness – 22%;

– Increase in product and service margins – 16%;

– Increase in capitalization – 11%;

– No effect – 25%.

In general, the even distribution of responses shows that holistic and qualitative work on the implementation of the digital transformation strategy allows to achieve results in several areas at the same time.

The exceptions are the increase in product margins and the increase in capitalization achieved in 16% and 11% of cases. This is logical, as these positions are the ultimate goal of digitalization for most companies. Also 25% of respondents did not note any positive effect of digital transformation. This may be due to the lack or poor quality of the transformation strategy, problems in its implementation, or the fact that the transformation is at an early stage and the effects have not yet been achieved.

4. New production technologies used at precast concrete plants in the Russian Federation and the EU.

– CAD (Automated parametric design systems with 3D models);

– ERP (Enterprise resource planning system, such as 1CC: ERP);

– Automated MES – production processes management;

– Automation/Robotization (Pallet circulation Lines, mesh welding machines);

– Special BIM Solutions;

– Mobile applications;

– Smart Factory.

5. Examples of the introduction of «New production technologies» at precast concrete plants in the Russian Federation and the EU.

5.1. Building Information Modeling technologies.

Precast Software Engineering is a supplier of BIM components for precast concrete plants such as:

PLANBAR PRECAST – is an automated design system – digital design of precast concrete products in a three-dimensional format in the form of 3D-models. This is the main component, the basic «end-to-end» technology.

TIM is a platform solution for managing data about products and their status, providing integration with other systems (ERP, MES, open BIM, etc.); digitalization, visualization and integration of basic business processes based on 3D models

(customer service, design, production preparation, production planning, logistics, installation, accounting).

mTIM is a mobile application for TIM that provides mobile remote access to information data on all project products, as well as documentation of the installation progress of products. Factory customers who have access through the mTIM app can monitor the status of their orders in real time, tracking which products have already been designed, which are manufactured or when they will be produced, which are already in the finished product warehouse and are waiting for shipment, how many are shipped, on the way or already installed.

Motivation of the Austrian company Oberndorfer Betonwerke, which has implemented Precast Software Engineering technologies as part of the adopted business digitalization strategy:

– Continuous visualization of the current state of the project (up to the level of precast concrete elements);

– Continuous availability of current up-to-date data for all employees;

– The aim is to be a pioneer in digitalization;

– The future is in working with a 3D model;

– The most successful companies of the future will be those who work entirely on the basis of a 3D model.

5.2. Smart paperless production – digital visualization of production drawings.

The «SMART Production: Visualization of Digital Production Drawings» technology, which was recently developed and tested in 2018, opens up new opportunities for PCP manufacturers.

Christoph Mostler, Director of precast concrete plant the MABA Fertigteilindustrie GmbH in Gerasdorf, Austria, in an interview talks about the increasing product requirements and the complexity of the product, therefore, there is an abundance of information that is increasingly difficult to work with. Nowadays it is hardly possible to display all these products on paper and see them, if so, then only with a lot of extra effort.

Precast Software Engineering and RIB SAA Software Engineering are now offering a new way to solve this problem with their Smart Production- Paperless Manufacturing software.

With the introduction of this product, new technologies become accessible and tangible to customers, production processes are optimized, and the speed of adaptation to changes that occur on the client side or in the production process increases. Smart Station allows to facilitate the production process by providing employees with touch screens. Thus, when changing pallets on the pallet circulation line (a type of conveyor), the screens will display the latest information about the new pallet and the products formed on it, it is possible to consider in more detail the necessary embedded parts, precast, study the drawing layers, view the list of necessary materials.

Together with two leading Austrian companies producing precast concrete, Oberndorfer Betonwerke and MABA Fertigteilindustrie, two reference projects have been successfully commissioned and put into operation.

Christoph Mostler confirms the effectiveness of this system, due to its ability to regulate data in a timely manner. Wolfgang Gigelleitner, head of engineering and CAD / CAM at Franz Oberndorfer GmbH & Co KG, explains that the essence of the new technology is the ability to use a drawing on a one-to-one scale, which is not possible when using a paper drawing. In addition to easy management, digitized visualization of drawings offers many additional advantages over classic paper ones. For example, modifications made as soon as possible by the technical Department can be immediately sent to production.

Currently, RIB SAA Software Engineering GmbH receives requests for either new plants or conversion of existing plants almost monthly. This shows a clear trend towards paperless factories.

5.3. CONCRETE PRO Laser Projection System – Digital Laser Tempalte for the Production of precast concrete products.

The development of the German company LAP GmbH CONCRETE PRO is a laser system for projecting the contours and outlines of manufactured precast concrete elements on the molding surfaces of tables, stands, pallets of the circulation line or on

the molded multilayer products themselves. Projected laser lines are based on production drawings prepared digitally in the CAD system. The contours are reproduced on the work surface on a 1:1 scale. CONCRETE PRO optimizes the manufacturing process and ensures the quality of the finished product. Production of precast concrete structures, regardless of their appearance, becomes faster, more flexible and more accurate than with mechanical templates, color plotters or other measuring and positioning auxiliary devices. In fact, this technology is a digital laser pattern that works «at the speed of light» – instead of a long and time-consuming reconciliation using a tape measure, squares, ruler and calculations.

Unlike pallet markings using plotters, where all the work steps are simultaneously applied and depicted on pallets using CONCRETE PRO, you can, through remote control, gradually call the projected data and then work with them. LAP Multicolour allows you to display different or particularly important production stages in different colors. For example, you can project the outline of an object on a pallet in green, and then you can project the outline of this object in red to control it. After completing the production of precast concrete products, no longer need to clean the tray from paint, because lasers do not leave any traces.

Conclusion.

End-to-end digital technologies offer the widest possible opportunities for all market players, including the industry of precast concrete products. The constant strategic agenda of modern enterprises should be the continuous search for new technological solutions based on the application of the NCT NTC, which will help to eliminate existing problems. The production of precast concrete products should become adaptable and more flexible, and interaction with customers should become easier and more convenient for them.

Timely study of domestic and foreign success stories, the ability to learn from them and take into account their features to implement the most effective solutions in their enterprises will increase the chances of companies in the competition.

References

1. Decree of the Government of the Russian Federation No. 16–32R of July 28, 2017 on approval of the program «Digital economy of the Russian Federation». URL: http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M0.pdf

2. Decree of the President of the Russian Federation of May 9, 2017 No. 203 «On the Strategy for the Development of the Information Society in the Russian Federation for 2017–2030». URL: https://www.garant.ru/products/ipo/prime/doc/71570570/

3. Osochenko E.A. Atlas of end-to-end technologies of the digital economy of Russia. – Moscow: project office «Digital economy of the Russian Federation» «Rosatom», 2019. – 372 p.