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Strategizing of forming a platform operating model to increase the level of digital maturity of industrial systems

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Abstract. The authors of the article suggest the strategy of forming a platform operating model to increase the level of digital maturity of industrial systems in the changing conditions of reality. They have analyzed the current situation on adapting industrial systems to the changing conditions of reality of 2022: the sanctions restrictions and the COVID-19 pandemic crisis. In analogy with the bionics companies concept the authors introduce the term of "bionic industrial systems" as the aggregate of economic entities which form the closed cycle of producing artificial products by machine and combine new technology with human ability of transforming operations on the basis of digital strategizing, develop the experience, customer relationships and more effective performance, increase the pace of innovation significantly. There is a conclusion that bionic industrial systems are characterized by the presence of digital strategies, high level of digital maturity which should be evaluated according to the index of digital acceleration. The authors suggest four strategies allowing transformation of industrial systems into bionic ones and maximize their value on the basis of digital strategizing. The use of platform operating model is considered to be the key distinctive feature of the bionic industrial systems. The article presents the strategy of forming a platform operating model of bionic industrial systems based on the model of digital transformation of the transactions of *the* Deloitte company. This is the structure describing the digital path on the basis of defining 10 evolution stages taking into account cybersecurity and digital culture. The digital industrial platform ZIIoT by the Russian IT-company "Tsifra" (Digit) has been studied as the best experience, and the authors present practical cases of its implementation in Gasprom, Lukoil, Novolipetsk Metallurgical Plant. The implementation of the strategy of forming a platform operating model in industrial systems is expected to result in reducing costs due to accelerated implementation of digital scenarios, additional income and opportunities of diversification through digital strategizing, etc. The authors introduce the concept of forming a platform operating model to increase the level of digital maturity of industrial systems.

Keywords: industrial systems, strategizing, digital strategizing, platform concept, platform operating model, digital industrial platform, digital maturity, digitalization, bionic company, bionic industrial system

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Стратегирование формирования платформенной операционной модели для повышения уровня цифровой зрелости промышленных систем

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Аннотация. В статье предложена стратегия формирования платформенной операционной модели для повышения уровня цифровой зрелости промышленных систем в изменяющихся условиях реальности. Проанализирована текущая ситуация по адаптации промышленных систем к условиям реальности 2022 года: к санкционным ограничениям и кризису, связанному с пандемией COVID-19. По аналогии с концепцией бионических компаний BCG введено понятие «бионических промышленных систем», под которыми понимается совокупность экономических субъектов, формирующих замкнутый цикл производства искусственных продуктов машинным способом на основе цифрового стратегирования, сочетающих и объединяющих новые технологии с человеческими возможностями для преобразования операций, развивающих опыт, клиентские отношения и более продуктивную работу, значительно увеличивающих темпы инноваций. Сделан вывод, что бионические промышленные системы характеризуются наличием цифровых стратегий, высоким уровнем цифровой зрелости, которую предложено оценивать на основе индекса цифровой акселерации. Предложены четыре стратегии, позволяющие осуществить трансформацию промышленных систем в бионические и максимизировать их ценность на основе цифрового стратегирования. Ключевым отличием бионических промышленных систем признано использование платформенной операционной модели. Предложена стратегия формирования платформенной операционной модели бионических промышленных систем, в основу которой положена модель цифровой трансформации операций компании Deloitte – структура, описывающая цифровой путь на основе выделения десяти эволюционных этапов с учетом кибербезопасности и цифровой культуры. В качестве лучшего опыта рассмотрена цифровая индустриальная платформа ZIIoT российской IT-компании «Цифра» и приведены практические кейсы ее внедрения в «Газпром нефти», «Лукойле» и Новолипецком металлургическом комбинате. Результатами реализации стратегии формирования платформенной операционной модели в промышленных системах должны стать: снижение затрат за счет ускоренной реализации цифровых сценариев, дополнительная прибыль и возможности диверсификации через цифровое стратегирование и др. Предложена концепция формирования платформенной операционной модели для повышения уровня цифровой зрелости промышленных систем.

Ключевые слова: промышленные системы, стратегирование, цифровое стратегирование, платформенная концепция, платформенная операционная модель, цифровая индустриальная платформа, цифровая зрелость, цифровизация, бионическая компания, бионическая промышленная система

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构建平台运营模式以提高工业系统数字化成熟度的战略

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摘要：本文提出了在不断变化的现实条件下构建平台运营模式以提高工业系统数字化成熟度的战略。分析了工业系统适应2022年不断变化的现实条件（制裁限制和COVID-19大流行引发的危机）的现状。通过类比仿生公司的概念，引入了 «仿生工业系统 «概念，将其理解为一组经济实体，在数字化战略规划的基础上，通过机器生产人工产品形成闭合循环，将新技术与人类能力相结合并加以整合，以转变运营方式，发展经验、客户关系和更富有成效的工作，显著提高创新速度。得出的结论是，仿生工业系统的特点是存在数字化战略，数字化成熟度高，建议根据数字化加速指数来评估。提出了将工业系统向仿生系统转变，并通过数字化战略实现其价值最大化的四项战略。仿生工业系统的主要区别是使用平台运营模式。提出了仿生工业系统的平台运营模式战略，该战略基于德勤的企业运营数字化转型模型——一种描述基于十个演进阶段的识别并考虑到网络安全和数字文化的数字化路经的架构。俄罗斯IT公司Zyfra的ZIIoT数字化工业平台被视为最佳实践，介绍了ZIIoT平台在俄罗斯天然气工业股份公司（Gazprom Neft）、卢克石油公司（Lukoil）和新利佩茨克钢铁公司（NLMK）实施的实际案例。构建工业系统平台运营模式的战略的实施结果应该是数字化方案加速落地带来的成本降低，数字化战略带来额外的利润和多元化机会等。提出了构建平台运营模式以提高工业系统数字化成熟度的概念。

关键词：工业系统、战略规划、数字化战略规划、平台概念、平台运营模式、数字化平台、数字化成熟度、数字化、仿生公司、仿生工业系统

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Introduction

From the perspective of the leaders of the industrial sector of the economy of Russia [1, 2], in the context of adapting to the changing reality, digital strategizing, the development and implementation of digital strategies, and investment in digital technology along with increasing digital maturity and the level of digitalization of the industrial systems, improving the digital skills of industrial undertakings, assets, both in terms of working with advanced technologies and in terms of transformation management, constitute priority tasks for the economic systems [3, 4].

Digitalization contributes to higher resilience in times of crisis, increased quality and speed of decision-making, and better financial performance. The objects of digital strategizing are complex economic systems, which can be industrial complexes and undertakings, scientific organizations, Universities 4.0, industrial clusters, complexes of science, industry, and education, industries, megalopolises, and regions, all within a hierarchical multi-level structure. The authors consider industrial systems as an economic system for the purposes of this article.

Russia is striving for technological sovereignty and independence in line with the trends of import

substitution, technological parity, and technological superiority. In a short period of 10-20 years, the domestic high-tech industrial sector needs to form the so-called diamond fund from at least a few dozen technologies that belong only to Russia [3]. Digital strategizing involving the use of artificial intelligence and the industrial Internet of things provides not just tools for optimizing the work of industrial undertakings but also helps to maintain economic resilience and production stability in terms of changing reality.

Despite the challenges of the external environment, the country has all the necessary competencies, technologies, and solutions for a successful transition to Industry 4.0 and subsequent Industry 5.0, subject to productive interaction and joint efforts of industrial undertakings, IT suppliers, universities to prepare relevant personnel [5, 6]. Such interaction may occur on the basis of an open innovation strategy, the triple helix innovation framework [7] (which comprises the academic community, including universities, industry, and government as its main elements), the quadruple helix innovation framework [8] (science, industry, government, and society), and the quintuple innovation helix framework [9] (science, industry, government, society, environment).

The purpose of this study is to strategize the creation of a platform operating model to increase the level of digital maturity of industrial systems and its further development based on digital twin technologies.

The object of the study is industrial complexes and systems that link together interconnected undertakings of industrial activities operating under the pressure of sanctions and the need for post-pandemic recovery.

The current situation in adapting industrial systems to changing reality are restrictive measures (sanctions) and the COVID-19 crisis

In Q1 2022, the industry of the Eurasian Economic Union (EAEU) showed high industrial production growth rates – by 5.6 % overall compared to the same period in 2021. In Russia, the industrial volume increased by 5.9 % (**Fig. 1**) [10].

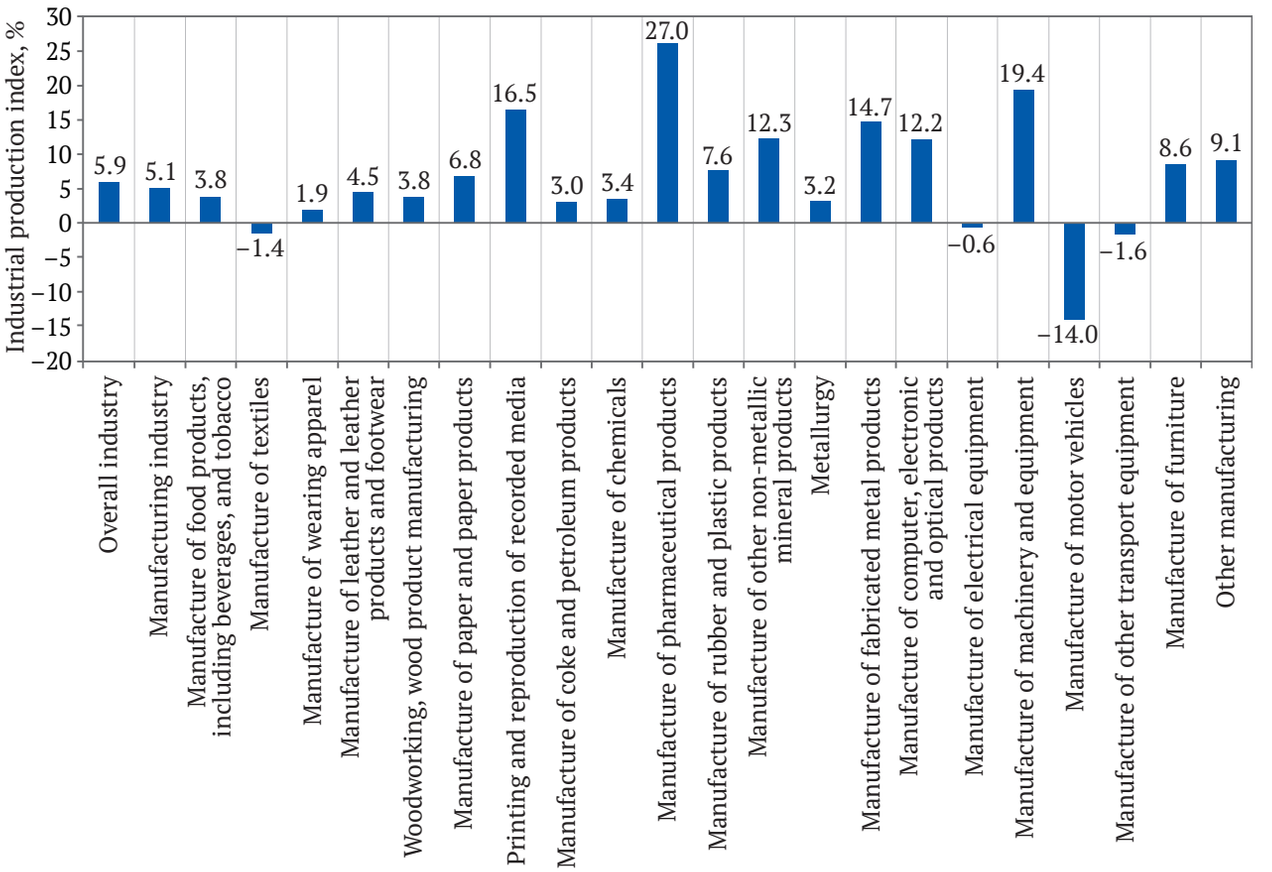

Fig. 1. Growth/decline rates of the industrial production index in Russia in Q1 2022 versus the corresponding period of the previous year [10]

Despite the new sanctions in Q2 2022, there is also a positive trend in the industrial sector. The industry of the EAEU countries in January-May 2022 showed an increase in production by 2.6 % compared to the same period in 2021.

Industrial undertakings managed to adapt quite flexibly to changing reality. A key role in this process was played, on the one hand, by an increase and ramp-up in production and, on the other hand, by intensive preparation for the harsh times of recession, which, according to economic forecasts, may soon happen. However, the state of the market is currently showing disruption in supply chains and increased difficulty in procurement. At present, it is important to understand what solutions will help to achieve economic effects faster, including through digital strategizing, digital transformation, and digitalization of processes [1].

Bionic Industrial Systems – Leaders in Digital Strategizing

The need for technological parity and technological superiority opens the era of bionic industrial systems. The adjective "bionic", from the point of view of terminology, means "one with regular biological capabilities or characteristics enhanced by electronic or electromechanical devices". In other words, "bionic" means "the one that uses the principles of organization, properties, functions, and structures of animate nature in technical devices and systems" [11].

In this study, we will consider *bionic industrial systems* a set of economic agents that form closed-loop manufacturing of artificial products with the use of machines, based on digital strategizing, that combine and link new technologies with human capabilities to transform operations that develop experience, customer relationships, and more productive work, significantly increasing the pace of innovation (**Fig. 2**).

Bionic industrial systems are characterized by a strong "sense" of purpose and the use of digital strategies [12, 13]. Currently, digital strategies are in the greatest need of strategic wisdom, which is considered by the author a mandatory priority of the concept of strategizing [14, 15]. These postulates are also the basis for the concept of creating a platform operating model to increase the level of digital maturity of industrial systems.

Bionic industrial systems combine digital flow technologies with flexibility, adaptability, and comprehensive human experience to reach their full potential. In bionic industrial systems, digital transformation is taking place by abandoning a traditional thinking and making a transition to a more collaborative, experimental approach. Such new approaches to working open up new solutions that, in turn, can improve the customer experience, motivate innovation of employees, and spur company growth at a fundamental level.

Strategy for the Transformation of Industrial Systems into Bionic Ones

It has been empirically proven that bionic industrial systems are characterized by their digital strategies that allow them to achieve a high level of digital maturity. The level of digital maturity

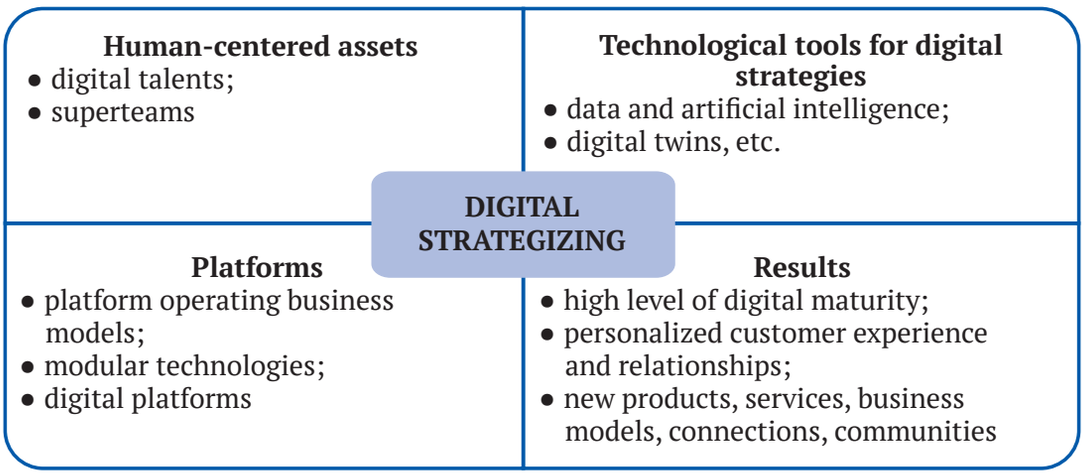

Fig. 2. Bionic industrial systems as a convergence of technology and human capabilities based on digital strategizing

can be assessed using a number of indices, for example, based on the Digital Acceleration Index (DAI) [16] or based on the index proposed by the authors in their previous works [17–19]. According to the BCG classification of bionic companies [20], companies with a DAI score from 67 to 100 points qualify as bionic companies, those with a score from 44 to 66 are building digital proficiency, and those with a score of 43 or lower are categorized as digital laggards.

The business value of bionic companies increases more than two-fold every year. Moreover, bionic companies with digital strategies and high digital maturity have proven to be much more resilient before, during, and after the COVID-19 crisis. After the market value of these companies plummeted at the beginning of the pandemic, they quickly rebounded. Within six months, their value was on average 23 % higher than before the crisis, while the least digitally developed companies grew on average only by 7 % (**Fig. 3**) [20].

Bionic companies, characterized by digital strategies and a high level of digital maturity, outperformed their competitors in nine metrics, and were particularly strong in areas such as revenue growth, enterprise value, and return on investment (ROI) of the digital projects. From 2017 to 2020, 40 % of the most digitally mature (bionic) companies increased revenue by more than 10 %, while among the least digitally mature companies (digital laggards) this result was achieved only by 19 %. Likewise, 33 % of bionic companies increased total enterprise value by more than 10 %, while only 15 % of lagging digital companies reported the same. Regarding the return on investment of digital projects, 66 % of bionic companies reported a return of 10 % or more, while only 36 % of lagging digital companies achieved such return. In six other metrics – cost reduction, share price growth, market share growth, and three impacts on earnings before interest and taxes EBIT (total impact, digital technologies and AI impact) – bionic companies achieved a 10 % threshold 50 % often than lagging digital companies [20].

Regardless of the level of digital maturity of an industrial system, the following four strategies allow for maximizing the value of digital initiatives and implementing a vital transformation in turning an industrial system into a bionic one based on digital strategizing [21]:

– a strategy of significant investment in technology, data, and human potential;

– a strategy for laying artificial intelligence at the core of digital transformation;

– a strategy for implementing a platform operating model;

– a strategy of convergence of technologies and human capabilities.

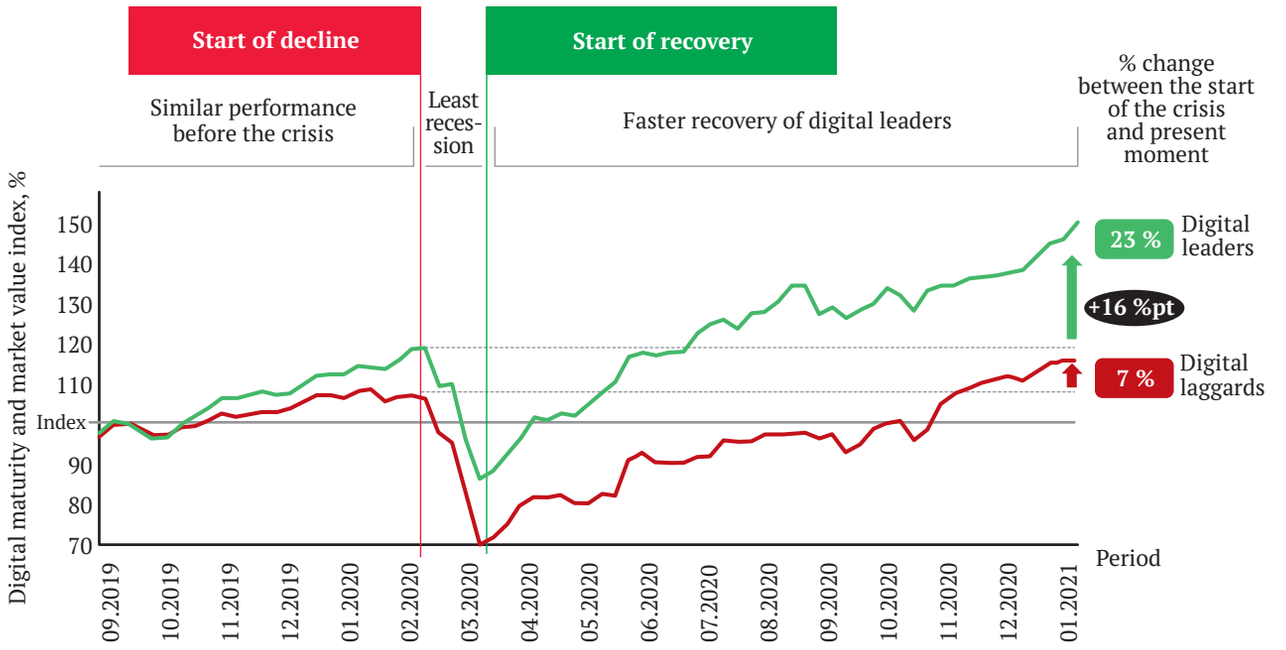

Fig. 3. Digital Maturity and Market Value Index for 193 companies from 38 countries [21]

Thus, the key difference between bionic industrial systems is the use of a platform operating model based on digital strategizing that allows for increasing the level of digital maturity of an industrial system [20].

Platform Operating Model in Bionic Industrial Systems

In the view of a number of reputable consulting companies, such as BCG, Deloitte, and Accenture, the path of the industry to the digital future lies through platforms. Digital platforms allow companies to avoid spending their resources on in-house development of industrial applications from scratch, taking the necessary basic part for them from the market. Digital industrial platforms already contain the necessary services for working with industrial data and tools for developing industrial applications. Companies can use the platform to create their own services that replace the functionality of solutions from foreign vendors, and subsequently, share them with colleagues in the market through the platform ecosystem [22].

About 20 % of the bionic companies in the BCG study [20] operate entirely on a platform model, while 60 % use a hybrid model. In a hybrid approach, some digital initiatives are managed by product teams that bring their solutions to business units and functions, while other digital initiatives are centrally managed by headquarters, business units, or functions. To put that into perspective, about 65 % of digital lagging companies still use an isolated operating model that is driven by business units.

The strategy for creating a platform operating model in bionic industrial systems is based on the Deloitte Digital Operations Transformation (DOT) model – a framework that describes a digital journey based on the identification of ten milestones, taking into account cybersecurity and digital culture to determine the future value of the industrial system (**Fig. 4**) [23, 24].

In 2021, the Russian IT company Cifra presented the Zyfra Industrial IoT (ZIIoT) Platform, a digital industrial platform for managing continuous production, which is used in the O&G and mining industries (**Fig. 5**).

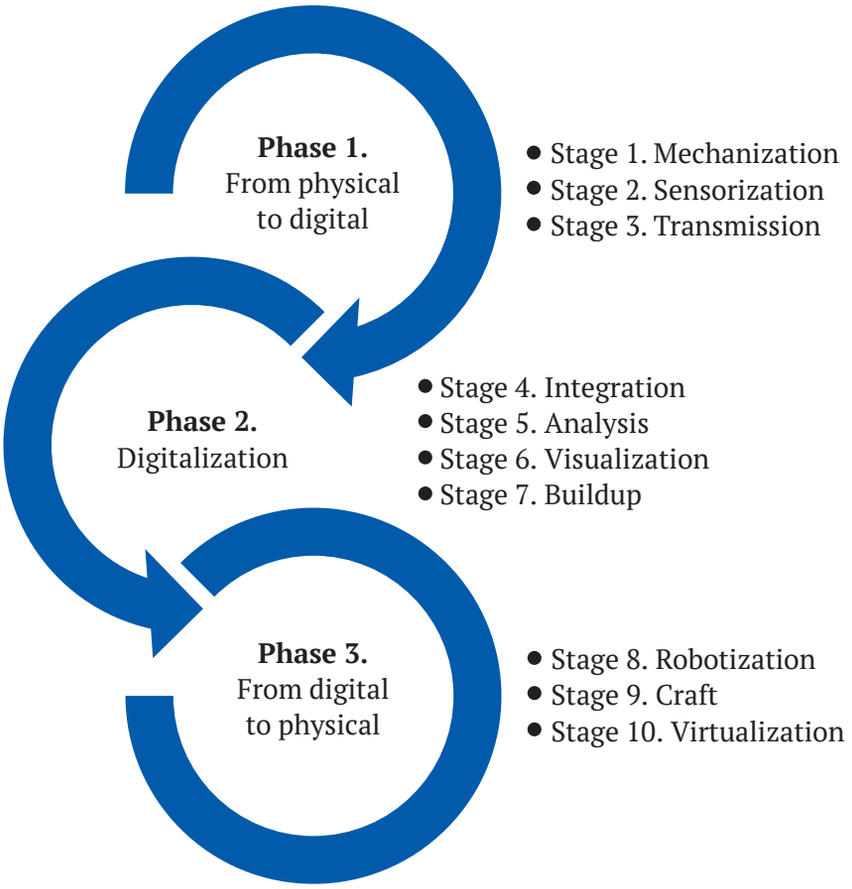

Fig. 4. Deloitte's Digital Operations Transformation

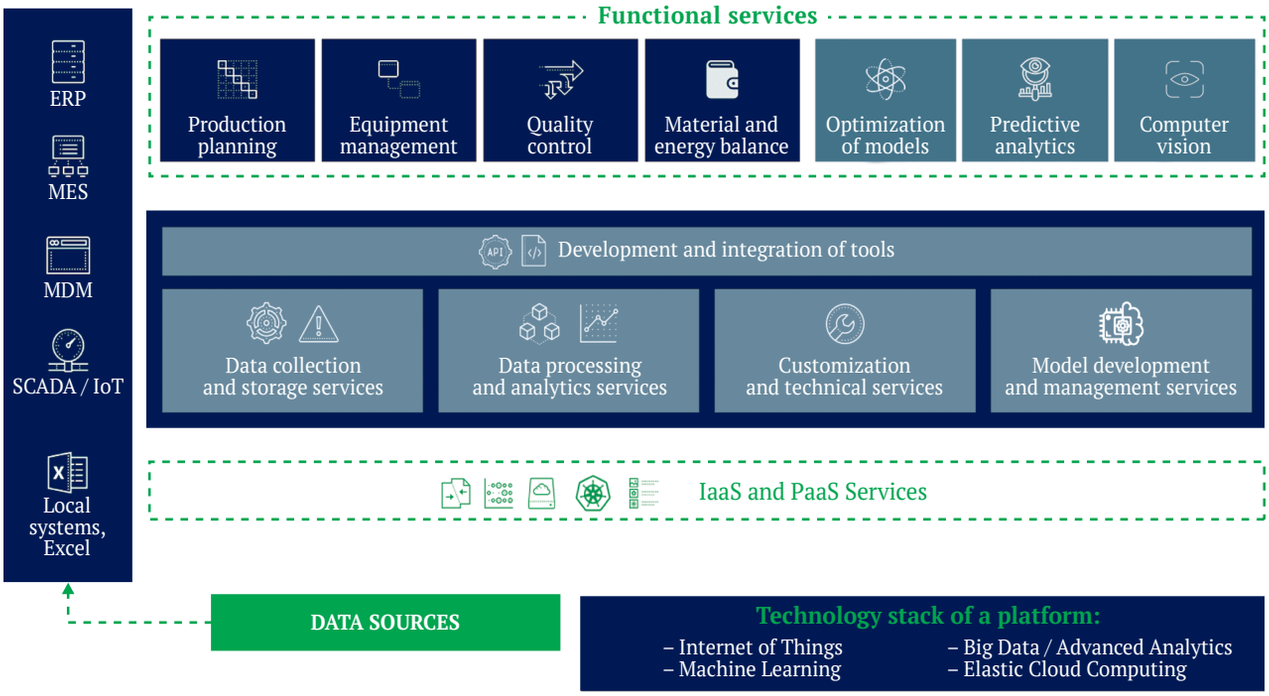

Fig. 5. Zyfra Industrial IoT (ZIIoT) Platform [25]

The platform includes all the necessary set of components for the creation and implementation of MES and AI digital solutions in the undertaking. ZIIoT allows building a ready-made environment for innovation with a set of basic digital components for creating and implementing advanced technological solutions in an industrial system.

Let us consider the practical cases of implementing the ZIIoT platform at the companies Gazprom Neft, Lukoil, and the Novolipetsk Metallurgical Plant (NLMK) group, a major international manufacturer of high-quality steel products.

The corporate digital platform of Gazprom Neft allows to [26]:

– support innovative and organizational changes in the business processes of operational production management: projects of the Production Control Center (PCC), the Performance Management Center (PMC);

– implement IaaS, PaaS, Microservice Architecture, embedded development environment;

– deplete the corporate center, Omsk and Moscow refineries (refinery), the production facilities;

– carry out import substitution for Windows, Oracle, OSIsoft, etc.;

– ensure information security.

The unified digital platform of Lukoil is a tool for creating new business applications for production automation and digital initiatives. It allows to [26]:

– create microservice architecture, embedded development environment, databases, auto-documentation of development;

– deplete AZURE, corporate center, Perm Oil Refinery

– carry out import substitution for Windows, Oracle, OSIsoft, etc.;

– implement a program to transfer the local information system (LIS), to corporate information system (CIS) to a single digital platform.

NLMKa's unified digital platform allows to [26]:

– carry out the transfer of MES systems (80 systems) of our own development on Oracle to a single digital platform;

– create an ecosystem of partners for the development and implementation of standard MES systems for the energy production of Mining and Processing Plants (GOK), sintering and blast furnace production, a corporate center (CC), steel production, a single dispatch company;

– deploy a unified digital platform at NLMK Lipetsk site in the technology, business, and corporate segments;

– use only an open source component in the unified digital platform;

– reduce the dependence of software on vendors.

The following are the expected effects from the use of the ZIIoT platform in the specific industrial systems [25]: reduction of defects in production – 15 %, reduction of unfinished production – 20 %, reduction in losses of air separation products – 1 %, reduction in consumption of purchased gas – 1.5 %, reduction of electricity consumption – 1 %, reduction of the gap (losses) between the technological and commodity balance – 1.5 %, increase of the efficiency of related systems – 20 %, reduction of the influence of the human factor on the quality and objectivity of the collected production information – 80 %, reduction of the leak detection time – 3–12 h, reduction of emergency response time – 30–50 %, reduction of false alarms – 20 %, reduction of FTE control of gas pollution – 90 % [25].

Digital Twins as a Further Development of the Platform Model Strategy in Bionic Industrial Systems

Though the introduction of a platform operating model in bionic industrial systems is the milestone, it is just a halfway to digital twins [27].

In 2021, Accenture [28] placed digital twins in the top 5 strategic technology trends. An unprecedent development is currently forecasted for the technology, which is believed to have its origins in NASA's Apollo simulators since the Apollo program: 65 % of the world's top business executives surveyed by Accenture expect a significant increase of investment in digital twins in the next two to three years. Already last year, 18 % of companies reported using digital twins in their processes, another 24 % were testing the technology [25].

The global digital twin market was valued at 7.48 billion USD in 2021 and is projected to grow at a compound annual growth rate (CAGR) of 39.1 % from 2022 to 2030. Production shutdowns and supply chain disruptions during the COVID-19 pandemic have resulted in the suspension of a number of other value chain activities in industries such as aerospace, manufacturing, and automotive. This affected the market in the first half of the pandemic in 2020. However, as the number of COVID-19 cases began to decline and restrictions were lifted, the market began to recover strongly, as a number of industries began to move towards automation and virtualization of both products and processes [29].

The integration of digital twin technology with technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and cloud computing is expected to drive further market growth. Industrial systems are implementing IoT and AI technologies to collect and analyze behavioral data from existing IoT devices and connected products, which can then be applied to a digital twin model to replicate the operation and use of an existing device. This helps engineers and designers observe the performance of the product and identify any issues, as well as predict future iterations of common issues. The implementation of these technologies also helps companies to improve the efficiency of operations and system performance, thereby increasing the overall performance of the product [29].

In Russia, the concept of a digital twin based on a platform approach is still under development. In particular, a digital twin based on the ZIIoT platform was implemented for the United Engine Corporation. It allows simulating engine testing in a virtual environment, therefore, much less physical testing is required [27].

Digital twin technology is difficult to scale and adapt to different industries. Digital twins are industry- and even company-specific. The digital platform for the oil and gas industry and oil refining – ZIIoT Oil&Gas – was originally created taking into account industry specifics and can be used to implement both digital twins and a whole range of applied solutions for production management in the oil and gas industry [27].

The Concept of Creating a Platform Operating Model to Increase the Level of Digital Maturity of Industrial Systems

Bionic industrial systems, considered by the authors as a convergence of technologies and human capabilities based on digital strategizing, the platform operating model in bionic industrial systems, strategies for transforming industrial systems into bionic ones, practical cases of implementing the ZIIoT platform at Gazprom Neft, Lukoil and NLMK companies, and digital twins as a further development of the platform model strategy in bionic industrial systems allowed to propose the concept of creating a platform operating model to increase the level of digital maturity of the industrial systems.

The concept of creating such a model is based on the development of an integral interconnected theory, tools and practical applications (strategies, development programs, methods, road maps, block diagrams, draft regulatory documents, etc.) for the implementation of strategic management of the digital potential of complex economic systems based on a platform concept under the conditions of digital transformation of the economy using a multi-level matrix approach and management of the digital potential of economic systems, taking into account the integration of the scientific, technological, educational, and business sectors of the economy based on digital strategizing, development and implementation of digital strategies, and creation of a digital platform. Here, the socioeconomic performance of economic systems, including bionic industrial systems, as the criteria for the effectiveness of the developed strategy, should be based on the parameters for assessing digital maturity. This paper proposes an original approach to the concept of bionic industrial systems, a methodology for assessing digital maturity based on the digital acceleration index, and a strategy for the creation of a platform operating model of bionic industrial systems based on a model of digital transformation of operations.

The following digital behaviors must be integrated into the platform operating model for an industrial system to successfully implement digital strategizing, complete its digital transformation, become bionic, and increase its digital maturity to the maximum level [21]: promoting interdisciplinary and inter-system workflow; approval of standardization while maintaining competitive advantages; implementation of systemic changes in work teams and the formation of digital culture; maintaining speed between digital and traditional technologies; gaining momentum from experimentation to ensure scale; a long-term approach to the digital strategy. About 30 % of bionic companies that have reached digital maturity have a planning horizon of five or more years [30].

Conclusion

The transition to digital technologies and platform operating models has already become a matter-of-course for some companies, however, for domestic industrial systems, it is advisable to use the proposed strategy and the concept of creation of a platform operating model to increase the level of digital maturity, especially under current conditions, to achieve economic effects, including through digital platform solutions and digital behaviors.

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