The strategy for the development of the fusion of customized production as the basis for reset of the Industry 5.0

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Abstract. The authors of the article propose new conceptual foundations for the organization of a network fusion of customized production of automobile vehicles based on"microfactories","automobile ateliers", and service centers. At the same time, a key role is assigned to the head center for digital car design. The relevance of the topic is due to the need to move from the export-raw material model of the Russian economy to a neo-industrial one based on the widespread use of digital industrial technologies. Attention is paid to the third and fourth industrial revolutions with an emphasis on electric transport as the most environmentally friendly mode of transport, which at this stage is a priority task for the development of the automotive industry. The article analyzes new challenges of deglobalization and decarbonization of the global economy for the automotive industry. The topic of digitalization for the automotive industry is certainly relevant, as it is one of the most innovative industries. Examples of the introduction of end-to-end digital technologies, digital twins and other programs in the production process at automotive enterprises are considered. Attention is drawn to the premiere of the new Russian electric car "KAMA-1", created by specialists of the St. Petersburg Polytechnic University with the support of PJSC "KAMAZ". Conclusions are drawn about the possible implementation of the project for the development of fusion customized production in the real sector of the economy and possible participants are indicated. Keywords: neoindustrialization of the economy, digital economy, automotive industry, Industry 5.0, fusion customized production, electric vehicles, self-driving transport, transformer

1 Introduction

One of the main elements of the fourth Industrial Revolution is the German Industry 4.0 program. It was first presented at the Hanover Fair in 2011 by H. Kagerman, W. Lukas, W.
Wallster, the German scientists and politicians. The digital economy in industry is implemented within the framework of this concept.

The subject of digitalization for the automotive industry is certainly relevant, as it is one of the most innovative and high-tech industries, which at the present stage is one of the leading drivers of the development of the digital economy.

The over-punctuality of the topic is certainly associated with the challenges of deglobalization and decarbonization. Already, car production is being suspended around the world due to a shortage of automotive components, which include electronic chips. Such phenomena will only increase, as the automotive industry is very globalized. The problem of decarbonization of enterprises is added to this. Many factories have announced redevelopments to get rid of "dirty" technologies and the "carbon footprint". There is a shortage of automotive components. Most manufacturers will not be able to withstand such competition. The task of quickly and timely reorientation to the "right" suppliers is solved by fusion customized production based on deep digitalization, where high-tech platform solutions allow you to recalculate the input parameters of new automotive components, perform hundreds of necessary virtual tests and get vehicle validation.

The aim of our work is to study the conceptual foundations of the organization of network fusion of customized production with a focus on electric vehicles and unmanned vehicles, taking into account the challenges of deglobalization and decarbonization in the global economy. Such a complex task can be solved only on the basis of deep digitalization of the production process in the context of the use of digital twins, BigData, artificial intelligence, other "end-to-end" digital technologies and high-tech platform solutions.

## 2 Methods

Large-scale and grandiose technological shifts are called technological or industrial revolutions. We will cover topics related to the third and fourth industrial revolutions and focus on the digitalization of the automotive industry, with a focus on electric transport as the most eco-friendly mode of transport.

Jeremy Rifkin, the American economist, has identified five principles or pillars on which the third Industrial revolution is based: 1) the transition to renewable energy sources; 2) the conversion of all of the buildings on each continent in mini power plants, producing electricity at the place of its consumption; 3) the use of hydrogen and other technologies in every building for storage of periodically generated energy; 4) using Internet technology to transform the power grid of every continent into an intelligent power grid, providing energy distribution similar to the distribution of information on the Internet (millions of buildings are generating a small amount of energy, can you give the surplus to the grid and share them with other continental consumers); 5) translation of car fleet to electric vehicles with charging from the mains or fuel cell vehicles that can obtain energy from continental intellectual power and to give the excess to the network [1].

Jeremy Rifkin also attaches great importance to horizontal ties, the era of cooperation and ownership issues in the new living environment. The concept of network fusion of customized production is based on horizontal connections and the "era of cooperation".

Despite the fact that the realities of the third revolution are still far from spreading around the world, it is developing into the fourth industrial revolution. The fourth Industrial Revolution, characterized, according to Klaus Schwab, the chairman of the World Economic Forum, by a combination of technologies that blur the boundaries between the physical, digital and biological spheres and focus on such areas as artificial intelligence, robotics, the Internet of Things, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing, self-driving cars [2]. If the third industrial revolution was
about electric vehicles, the fourth revolution for the automotive industry is characterized by self-driving cars or, as they are also called, self-driving cars.

In the Industry 5.0 version, value-oriented and human-oriented projects impose technological transformations within the framework of the Industry 4.0 concept to create a closer relationship between people and machines. The model of the Industry 5.0 concept allows you to combine the capabilities of Industry 4.0 technologies with the human-oriented approach of Industry 5.0 (the concept of the Brent Kedzerski) with collective intelligence based on the combination of human and machine intelligence (the concept of Ozdchan Saritas)[3].

The topic of digitalization is certainly relevant, multifaceted and timely at this stage of development. It is reflected in many modern publications [4-10]. For fusion customized production, the theme of digitalization is the main base. This is the foundation on which the entire structure rests. Fusion customized manufacturing, like the entire automotive industry, is the leading driver of the digital economy. The emergence of new complex problems associated with the challenges of deglobalization and decarbonization can be solved only on the basis of deep digitalization of the production process using digital twins, BigData, artificial intelligence and other" end-to-end " digital technologies.

Digital technologies of BigData, digital doubles and other programs are being implemented in production. They have shown their special effectiveness in design developments. When designing a car, the parameters of a multi-level matrix are set, which consists of more than one hundred thousand requirements for the product as a whole and its components. These figures are taken because a modern car consists of about ten thousand parts, maybe a little less, depending on the brand of car. Accordingly, each part has the same parameters. The mathematical model works with trillions of different input and output data, which allows you to reduce the number of natural tests of cars tenfold. Now they have even abandoned track testing of commercial vehicles, everything takes place in the shop on special stands.

Digitalization is being implemented in all technological chains of production. Electronic circulation of technical documentation and mathematical models of car parts has been introduced. There are programs that allow you to track the execution of orders and orders. We can say that, to some extent, artificial intelligence helps to manage enterprises. There are also a lot of programs for warehouse management, accounting and other areas of production. Digitalization is being implemented on a large scale in the production process, and this helps factories to stay afloat, despite the quantitative decline in car production. Structural changes, although with various difficulties and contradictions, still occur in the technological process, management and other areas of the enterprise's activity.

3 Results and discussion

The global automotive industry is on the verge of drastic changes. They are associated with the onset of the sixth mode of the technological cycle. We see two main ways of developing the automotive industry. These are electric cars and cars with a hydrogen engine. These trends were discussed in detail in our articles [11-13]. But for Russia, as always, a third road is also visible, this is gas. GAZ does not require any new design solutions, everything already exists. Older platforms are great for this. The costs are only needed for small changes in the design of the car and the creation of an extensive structure of gas stations.

But the focus is now shifting towards decarbonization. And it seems that this powerful trend will affect the entire global economy. Decarbonization means restricting the import of "dirty" goods, tracking the" carbon footprint "of imported products and other strict measures that will limit financial injections into the"carbon economy". The development of the electric vehicle industry in terms of consumption and production will make a significant contribution
to decarbonization and will serve to improve the quality of life of people in large cities of the country. In 2019, the document "Strategy for the development of the automotive Industry of the Russian Federation for the period up to 2025" was adopted, according to which by 2025 the number of electric vehicles under the minimum scenario should reach 129 thousand units.

In December 2020, the premiere of a new Russian passenger electric car based on the modular platform of the KAMA-1 car took place. It was fully designed by specialists of the Computer Engineering Center of St. Petersburg Polytechnic University with the support of KAMAZ PJSC. For its development, digital twin technologies and unique CML - platform solutions were used, which are a system of digital models of electric vehicles and technological processes that are interconnected and balanced on a single platform in a multi-level matrix of requirements, targets and resource constraints. The "smart" digital twin of the KAMA-1 electric car has passed more than 800 virtual tests.

Now let's touch on the problem of deglobalization and what it means for the automotive industry as a whole. Previously, interdependence was considered the main postulate for the stable development of the industry. In fact, we buy most of the automotive components abroad. S. D. Bodrunov pointed out this problem. In his article "State and trends in the development of mechanical engineering in Russia", he writes: "A high dependence on the import of components is observed in all branches of mechanical engineering. The problems of "screwdriver" assembly of imported automotive components in the automotive industry are widely known" [14]. And this largely applies to the passenger car industry. It is no secret that most of the auto parts come from abroad, and in the future the car is assembled on the territory of Russia.

In the context of deglobalization and regionalization, supply chains will be disrupted. Already, car production is being suspended around the world due to a shortage of automotive components, which include electronic chips. Such phenomena will only increase, as the automotive industry is very globalized. In total, in the automotive industry, it is customary to distinguish between four levels of suppliers that permeate the entire chain in industry and related industries. The problem of decarbonization of enterprises is added to this. Many factories have announced redevelopments to get rid of dirty "technologies and the "carbon footprint". There is a shortage of automotive components. Most manufacturers will not be able to withstand such competition.

Network fusion customized production based on deep digitalization of the production process will allow you to quickly reorient production to the necessary suppliers.

The English word fusion (from the English fusion - alloy) is characterized as "a combination of incongruous", a mixture of various elements. As applied to the automotive industry, we interpret this word as a combination of elements from different brands and platforms of the car. The term customization (from the English to customize — customize, change) means the individualization of products for the orders of specific consumers. Such production allows the consumer to participate in the design of the car of their dreams. Digital technologies and high-tech platform solutions are designed to smooth out the client's incompetence, which will tell you which parameters and auto components need to be improved as a result of, for example, increasing the engine power of the car. Electronics can limit the speed of movement if the customer's car body is not designed for high-speed driving. Virtual tests will show the future owner why certain restrictions have been introduced.

Let's consider the principles of functioning of fusion customized production. The customer comes with their ideas to one of the divisions: "microfactory", "auto studio", service center or refers to the website of the head center for digital design of cars. Gets an action plan, explanations for adjusting your ideas based on virtual tests, and an estimated cost of work. After agreeing on the volume and drawing up the contract, the client expects the production of his "dream car". The role of the head center for car design can be assumed by the "Center for Computer Engineering" of St. Petersburg Polytechnic University, which has
experience in designing the first Russian electric car "KAMA-1", developed on the basis of digital twin technology. The role of "microfactory" can initially be performed by the structure of PJSC "KAMAZ", which is engaged in pilot production, and they can be joined by a network structure consisting of customer-centric automobile ateliers and service centers.

We propose a new strategy for the development of the automotive industry based on transformer platforms for unmanned vehicles[15]. The KAMAZ-3373 cableless truck named "Shuttle", created by PJSC "KAMAZ", is the basic component of a transformational vehicle for unmanned vehicles. The "Shuttle" should become the platform base for the lower part of the transformer. Various types of special equipment can act as the upper module. Thus, a diverse variability of the vehicle is achieved. The first sample of the "Shuttle"has already been created and road tests are underway. This is an autonomous battery electric vehicle with an on-board platform.

Now a lot of efforts of developers of new technology are aimed at creating replaceable passenger capsules. They should be used for such a project as Hyperloop, a vacuum train, with the further possibility of reinstalling on aircraft and ground unmanned taxis. This concept of vehicles is easily integrated into our system of transformer cars in the class of passenger transport in the subclass of passenger capsules (Figure 1). It will be possible to produce transformers at "microfactories" created specifically for the needs of customers.

![Classification of transformational transport](image.png)

4 Summary

The paper considers new conceptual foundations for organizing a network fusion of customized production of automobile vehicles based on microfactories, automobile ateliers, and service centers. At the same time, a key role is assigned to the head center for digital car design. Such an organization of production can open up the next, more grandiose stage in the development of the automotive industry, based on transformer platforms for unmanned vehicles. Creating a line of fusion customized cars, electric vehicles-transformers will "reboot" the Russian automotive industry of a full cycle and make a significant contribution to the development of the Russian economy.
The custom production fusion project aims to solve four main tasks. For the traditional automotive industry - on environmental friendliness, decarbonization and achieving carbon neutrality of transport, which is achieved by quickly changing "dirty" suppliers. As a customer-centric project, it is aimed at meeting the needs of citizens and is able to produce the "dream car" of the consumer. The characteristics of the car are set by the consumer himself, who is corrected by artificial intelligence and other digital high-tech platform solutions. The project is capable of cost-effectively organizing production and increasing the production of electric vehicles based on new principles of production organization. It also allows you to start the next stage of development of the automotive industry, based on transformer platforms for unmanned vehicles. The paper considered a new strategy for the development of the automotive industry based on transformer platforms for unmanned vehicles, which is able to give a new impetus and reboot the Industry 5.0. The classification of the proposed branch of unmanned vehicles is given.

5 Conclusions

Modern industrial technologies are widely used in the world, and Russia should not lag behind in this area. The focus on the development of network fusion of customized production with a focus on electric vehicles and unmanned vehicles simultaneously with other breakthrough technologies for Russia can become an entrance ticket to the sixth technological order of the fourth industrial revolution.

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