

# *Self-learning systems as a new macro-regional level of the productive forces in the process of new industrialization*

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**Abstract** – The concepts of new industrialization based on the evolutionary model of the fourth industrial revolution are studied in the article; the term “new industrialization” is clarified, the innovative activity of Russian regions is analyzed; thus, based on the aspects above, the directions of structural reforms that will ensure the activation of new industrialization processes formation in the economic space of the Urals macro-region are highlighted. For this reason the authors consider the main development vectors formation of the new industrial sector to proceed according to the regional requirements of life standards. It involves the application of system approach principle, basing on the new industrialization concept as a social and economic category. It is also proved that enterprises should actively implement self-learning management systems based on artificial intellect, thereby increasing both financial and reputational management efficiency. An example of self-learning systems scheme that can dynamically manage their internal processes basing on a flexible assessment of their effectiveness is illustrated.

**Key words:** *new industrialization, region development, the fourth industrial revolution, Urals macro-region, the system of decision-making support.*

## I. INTRODUCTION

Currently, the Russian economy exists in conditions of instability associated with the acceleration of scientific and technological progress, generating spontaneous changes in market conditions, strengthening of globalization and innovation in the world economy. In this regard, the interest of domestic scientists to the problems of the industrial revolution and new industrialization, which is based on the achievements

of the third and fourth industrial revolutions, a powerful high-tech manufacturing sector, as well as the results of the fifth and sixth technological structures, is growing. According to the researchers [1], the main reason for this is the awareness of the need to develop a new social and economic strategy that allows the Russian economy to find a way out of the prolonged economic and social depression, in order to avoid the devastating effects of the country's functioning within the framework of the liberal monetary model. At the same time, the developed strategy should take into account that the goals and objectives of the new industrialization in Russia should correspond to the logic of global trends without violating national traditions meanwhile.

In the context of new industrialization model development it is necessary to take into account national / regional / urban specifics since the processes of new industrialization are characterized by significant originality and uniqueness depending not only on the time but also on the country / region / city in which they occur [2].

As noted by G. Granberg, the huge differences in natural, social, and demographic, economic, political, and some other resources of Russian regions frustrated the unified approaches to reforms, focused on some average conditions [3]. But despite this “numerous social and economic development strategies of the country and its regions suffering from a fundamental incompleteness — they do not include the spatial dimension of the productive forces organization in the foreseeable future”[4].

According to the authors the economic space of the Urals with its powerful production potential has the background and ideal conditions to initiate new industrialization processes

launch. It is the Urals macro-region that can create an impetus to the production renewal that will accelerate the movement of the national economy along the new industrialization vector. Thus, the article is aimed at analyzing the Urals development trends and features in terms of new industrialization processes formation.

## II. LITERATURE REVIEW

First, the term “new industrialization” is to be determined.

The move of the economy to a new level through the technological (industrial) revolutions is characterized by major technological changes. In the 17th century it was a move to machine labor instead of manual labor (the first industrial revolution). The 20th century (second industrial revolution) is characterized by electrification and the move to conveyor production and the 21st century (the third industrial revolution) is marked by availability of computers in production processes, the transition to renewable energy, automation, and digital production. For example, John Rifkin [5] in his works describes the important role of horizontal ties in the era of cooperation and property issues along the new society development conditions. This aspect continues to be discussed in the publications by P. Marsh and K. Andersen. It should be noted that, even though the above mentioned features of the third industrial revolution have not spread universally and completely, it is evolving into the fourth industrial revolution. Its megatrends include the development of 3D printing, unmanned vehicles, new materials, and robotic technology [6].

Table I provides the examples of development strategies programmes in different countries in terms of new industrialization.

TABLE I. THE PROGRAMS FOR THE FOURTH INDUSTRIAL REVOLUTION IMPLEMENTATION

Country	Programme/document
Germany	Platform Industrie 4.0
Netherlands	Smart Factory
France	Usine du Futur
Great Britain	High Value Manufacturing Catapult
Italy	Fabbrica del Futuro
Belgium	Made Different
China	Made in China
Japan	Monodzukuri
USA	Industrial Internet Consortium
Russia	New Industrial Initiative

Thus, the new industrialization is characterized by the “pervasive power of digital and information technologies”. This term is relatively a new one in Russian science and has

not been included in the vocabulary of all researchers and economists yet. Although in recent years a significant number of conferences devoted to the topic under consideration are held. First of all, the publications of “the Economist” covering the neo-industrial paradigm of modern development [7,8] should be mentioned.

V. Ryazanov, for example, believes that the new industrialization program of Russia is a major project for a period of 10 – 15 years [9]. It should be noted that due to significant amount of research done in this field (including the works by S.D. Bodrunov [10], S.Y. Glazyev [11], S.S. Gubanov [12], V.M. Kulkov [13], E.B. Lenchuk [14], M. I. Lvova [15], O.A. Romanova [16], V.T. Ryazanov [17], O.S. Sukharev [18], A.I. Tatarin [19]), there is a considerable spread in the following similar concepts definition: “neoindustrialization”, “reindustrialization”, “new industrialization”, and “super industrialization”.

The authors found the definition given by S.S. Gubanov important. He defines “new industrialization” as “a historically systematic process of productive forces development that takes place after the completion of the first industrialization phase meaning electrification. It represents the second industrialization phase, i.e. automation and computerization of production facilities” [20].

Other domestic scientific works describe “new industrialization” as the basis for economy modernization, allowing to create its scientific, technical, and high-tech basis, to provide a knowledge-intensive and innovative development type of the national economy [21], as a higher level of productive forces technological renewal with automation and computerization of all industries [22], as an actions network aimed at launching multiplying chains in the production sectors, setting the vector of resource allocation, focused on the real sector of economy and increasing productivity [23].

One more definition provided by a foreign author deserves special attention since the concept of “new industrialization” is analyzed as a process of synchronization of information and industrialization of economy as well as coordinated efforts and development strategy [24].

Due to the variety of definitions existed, as well as the lack of spatial dimension in their essence the authors clarify the concept of new industrialization as an output of macro-regional production forces to a new quantitative and qualitative level expressed in the development and identification of tactical and strategic measures of balanced technological, social and environmental development.

## III. RESEARCH

As noted above the essence of new industrialization consists in the process of development and diffusion of breakthrough technologies for new industries and existing industrial sectors (fig. 1).

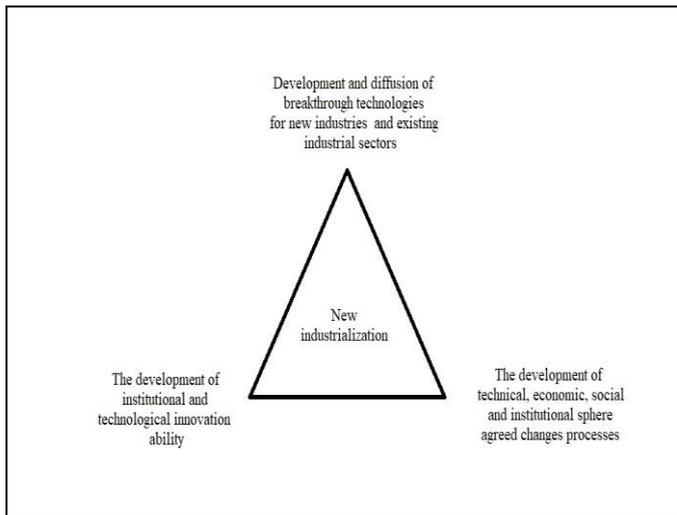


Fig. 1. The main characteristics of new industrialization

According to the authors the peculiarity of the new industrialization process should be the role of not only large companies with a strong infrastructure, finances, representing the connection with the state, but not least also the role of regional / urban companies, allowing to develop local communities and achieve the growth of the national economy due to their characteristics.

It can be noted that the development of new industrialization processes in the regions, in fact, is designed to provide a major structural changes in the country on the basis of specific innovative development factors.

According to the report "Global Innovation Index" (2018), prepared by Cornell University, the World Intellectual Property Organization (WIPO) and the INSEAD business school, Switzerland, the Netherlands, Sweden, the United Kingdom, and Singapore are at the top of leading innovators list. Russia ranks the 46th in the list [25]. According to the analysts, the low points of Russia can be explained by gaps in existing legislation and the traditions of its correct application. Another reason is the extreme energy intensity of the Russian economy (Russia ranks the last in the list on this indicator). On the other hand, Russia is in the Top 30 leaders by investments in science, technology, education (school and university levels), IT sector, the number of patents, and the number of people employed in non-manual spheres. It should be also noted that Russia ranks the first by the number of women with scientific degrees and those engaged in research. The Bloomberg agency puts Russia on the 25<sup>th</sup> place in the list of the most innovative countries – 2018 [26]. Due to the sanctions and the fall in oil prices, Russia fell by 14 positions and ranked the 26<sup>th</sup> in 2017. In

2018, the situation improved but still it ranked lower Iceland, New Zealand, Poland, and Canada.

As it was noted above, the authors consider the move to the new industrialization framework, economic growth, country plan development, and changes in society to be directly provided by the regional innovation-based development. Analyzing the regional innovation-based development, the authors determined the Urals Federal district

to be one of the most promising and rapidly developing innovative regions in the Russian Federation (table II).

TABLE II. INNOVATION PERFORMANCE METRICS OF THE RUSSIAN FEDERATION REGIONS

<b>Developed advanced production techniques of the Russian Federation regions, items</b>					
	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
Central Federal District	509	429	517	538	480
North-Western Federal District	301	298	235	239	206
South Federal District	29	38	63	76	79
North Caucasus Federal District	28	27	23	15	23
Volga Federal District	249	284	238	279	226
Urals Federal District	173	182	204	254	236
Kurgan Area	12	-	-	-	-
Sverdlovsk Area	71	59	90	99	85
Tumen Area	17	27	22	34	29
Chelyabinsk Area	73	96	92	121	122
Siberia Federal District	123	116	92	107	124
Far East Federal District	17	35	26	26	28
<b>Used developed advanced production techniques of the Russian Federation regions, items</b>					
	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
Central Federal District	60829	65591	69588	72648	77966
North-Western Federal District	18313	19478	20081	21653	22204
South Federal District	8290	9749	10850	12308	13264
North Caucasus Federal District	-	-	2338	2710	2911
Volga Federal District	57076	59643	64064	67118	64989
Urals Federal District	23746	22832	24161	26786	28588
Kurgan Area	995	1106	963	1727	1684
Sverdlovsk Area	9595	9050	9697	10379	10662
Tumen Area	7471	6785	7170	7680	8936
Chelyabinsk Area	5685	5891	6331	7000	7306
Siberia Federal District	16643	18063	19591	21792	22962
Far East Federal District	6801	6956	7345	7373	7170

Since a large number of high-tech industries are concentrated in the Urals Federal District, it is one of most high-tech regions of the Russian Federation. The wealth of the Soviet-era scientific and technological heritage allows the region to maintain its leading position in innovative development.

Since the spatial concentration of the industry in the Urals macro-region is almost four times higher than in the whole country, the cumulative effect of its development can undoubtedly become the driver of the development that it isn't only individual regional sectors, but also the entire national economy. The Urals Federal District, as an old industrial region, is much more flexible in adapting to structural adjustment processes than peripheral, lagging regions.

Thus, it is possible to mark the following areas of the structural transformations that will ensure the intensification of the new industrialization processes development in the economic space of the Urals macro-region.

1. The new industrial sector of the economy development.

Currently, the region has already developed the nanomaterials' production with predetermined properties, the nuclear industry, rocket and space technologies, TV and radio communications, as well as "smart products". The promising areas of the development are additive technologies, the production of the unique titanium fabric, high-performance LEDs, multilayer materials which change their properties in various environments, as well as the production of ultra-light and ultra-strong alloys, cyber steel, flexible cement, solar batteries, unmanned aerial vehicles, robots, sensors, etc.

2. Modernization of the traditional industries for the Urals Federal District.

The processes of the new industrialization are most noticeable in the metallurgy of the Urals region which is actively developing the production of nanostructured hard alloys, coatings and composite products of the exact form, high-strength weldable steel, etc. Thus, this trend will lead to an increase in labor productivity and will decrease the resource and energy intensity of the production.

3. The regional segment of the creative industries development.

This factor will contribute to the differentiation of the regional economy.

4. The development of dominant active formations in the spatial structure of the Urals Federal District.

The typical representatives of such formations are "nuclear cities" and urban agglomerations. The advantage of the Urals macro-region lies in the fact it includes five (out of ten in the country) towns of the "Rosatom" Corporation (Trehgorny, Ozersk, Snezhinsk, Novouralsk, Lesnoy) that promote high-tech innovative developments to the domestic and foreign markets. And also, it is the only macro-region with four million-plus cities (Ekaterinburg, Perm, Ufa, Chelyabinsk).

Thus, the research of the new industrialization in the regional economy leads to the conclusion that economic transformations in modern conditions acquire originality and identity depending on timing and regional specificity speeds up or slows down the processes of these transformations.

It should be noted that it was the Urals economic researchers who were among the first in the country to develop a theory of the reliance on the processes of the self-development at all levels of the regional and territorial social and economic systems that can ensure the most complete and effective use of their own internal spatial capabilities and resources for the implementation of the federal and regional targeted tasks [27].

In this regard, one of the main goals for the Urals Federal District enterprises in the move to industry 4.0, is that of full innovation cycles implementation. These are the cycles of:

- fundamental, exploratory, and applied research;
- innovative technologies and products creation;
- experimental design and technological works;
- commercialization and transfer of the intellectual property.

Since in the modern economy the most effective are brought by unique managerial decisions [28, 29], then to ensure the implementation of the structural changes identified by the authors, designed to activate the formation of new

industrialization processes in the economic space of the Urals, as well as to create additional competitive advantages for the national economy, the Ural enterprises need to improve their management system that is based on the practice of the introducing institutional innovations.

The following local practices of the institutional innovation can be distinguished as:

- the production programs adaptation to the needs of innovation economy and the processes of the new industrialization peculiarities;
- the introduction of transition subsidies to the enterprises modernization in particular under new industrialization features;
- the introduction of the independent certification qualifications mechanism meeting the needs of the new industrialization;
- the legal framework changes;
- the independent external assessment of knowledge and competencies;
- the expansion of the consulting services range;
- the creation of the educational programs realization conditions for the development prospects of technology and students attraction.

The infrastructure of the industrial sector, of course, is undergoing significant changes in the field of the network technologies that allows transforming all the processes of the enterprises, according to the requirements of the innovation economy reality. In this case the key element in the control loop must be decision makers (DM), as well as an information system linking knowledge within the enterprise into a single network. The introduction of intelligent decision support systems (IDSS), in particular, artificial intelligence technologies (IT), thus, it can significantly accelerate the transition to the launch of the new industrialization processes.

In this regard, it seems appropriate to use self-learning systems in the process of enterprises management of both the Urals Federal District and other strategically important regions; the systems above can control their internal processes dynamically, on the basis of flexible evaluations.

The system under consideration diagram is illustrated in fig. 2.

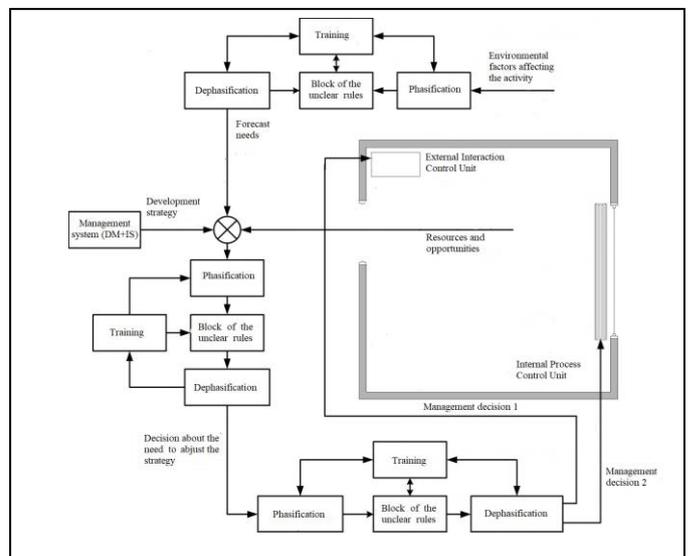


Fig. 2. Self-learning system-regulator of the management decision making

Since in the definition clarified by the authors, the new industrialization implies the output of the macro-regional production forces to the new quantitative and qualitative level expressed in the development and definition of the tactical and strategic measures of the balanced technological, social and environmental development, the phasification (fuzzification) in this case includes a correspondence between the values of the input variables of the fuzzy inference system for certain quantitative and qualitative characteristics, reflecting the efficiency of the enterprise to implement the processes of the new industrialization.

The processes of the phasification and dephasing will allow the self-learning system to analyze the quantitative parameters of the enterprise's activities in the processes of the new industrialization, but also the subjective characteristics of its image and reputational components. The system, offered by the authors, after its development will be a functionally complete device, which is based on automated process control systems that meet the requirements of the new industrialization. Since at this stage of the development, there are many internal processes and external interactions that need to be managed, which is based on the analysis of the large number of the both clear and fuzzy factors, decision makers cannot always cope with large amounts of the incoming information. Information systems (IS), self-adapting to the needs of the new industrial economy, quickly responding to changes in the factors of the internal environment, which will be able to solve this problem. In this case, the system regulator is designed to receive information about the needs of the main regional subjects, analyze the information received, build a forecast of the changes in requirements, which is based on accumulated experience (self-study) and develop a control action taking into account the existing Urals Federal District strategy and new enterprise development goals in the framework of new industrialization.

#### IV. CONCLUSIONS AND RESULTS

The given research has shown that the formation of the main development vectors of the new industrial sector should take into account the regional requirements of the life quality, which implies the application of the system approach principle, which based on the understanding of the new industrialization as a social and economic category.

Thus, the authors have the following results:

1. The content of the new industrialization as the output of the macro-regional production forces to a new quantitative and qualitative level, which expressed in the development and definition of the tactical and strategic measures of the balanced technological, social and environmental development, has been clarified.

2. The directions of the structural transformations that will ensure the activation of the formation of the processes of the new industrialization in the economic space of the Urals macro-region are formulated.

3. Local practices of the institutional innovations relevant to the Ural Federal District are highlighted.

4. An example of the self-learning system diagram, able to control the internal processes of the industrial enterprises dynamically, and based on a flexible assessment of their effectiveness, is offered.

Due to the formation of the modern industrial technologies spread widely in the world, Russia should not lag behind in this area.

As a result of the introduction into the processes of new industrialization, with sufficient potential of the Russian Federation, the country could expect its stable positioning in the global economy among the leading states. At the previous stage of the economic development before the advent of the information systems and decision support systems, all management processes were simple sequences of the interrelated actions to monitor and control parameters carried out by decision-makers based solely on personal knowledge and experience. At the present time there is a sharp increase in the number of the simultaneously controlled parameters and requirements for the speed of the reaction to the changes that occur; the cost of the mistake of the making the wrong management decision has multiplied. That's why the authors find area of further research in the development of the specific measures in the strategy of new industrialization of the national economy, based on the identification of new social and economic organizational forms emerging in the regions in the process of the new industrialization.

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