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## TRENDS AND PROBLEMS IN THE PRODUCTION OF MODERN ELECTRONIC DEVICES IN THE CONTEXT OF IMPORT SUBSTITUTION

Y. A. Kazlouskaya, S. A. Slassi Mutabir

*Belarusian National Technical University, Minsk*

*The study analyzes trends and challenges in Belarus's electronics manufacturing under import substitution policy. The goal is to identify specific challenges and prospects for the domestic industry. Methodology includes data analysis from the Ministry of Industry, the National Academy of Sciences, and local enterprises. The key trends identified are the development of microelectronics based on JSC "Integral", localization of component production and creation of telecommunications equipment. The main challenges include: technological lag in chip manufacturing, dependence on imported components, personnel shortage, and the need to adapt to international requirements. The conclusion emphasizes the need for enhanced cooperation with friendly countries and accelerated development of domestic research capabilities.*

**Keywords:** electronics industry, import substitution, microelectronics, localization, technological sovereignty, personnel potential.

## ТЕНДЕНЦИИ И ПРОБЛЕМЫ ПРОИЗВОДСТВА СОВРЕМЕННЫХ ЭЛЕКТРОННЫХ УСТРОЙСТВ В УСЛОВИЯХ ИМПОРТОЗАМЕЩЕНИЯ

Ю. А. Козловская, С. А. Сласси Мутабир

*Белорусский национальный технический университет, г. Минск*

*Исследование анализирует тенденции и вызовы в производстве электроники в Беларуси в условиях политики импортозамещения. Цель – определить специфические трудности и перспективы для отечественной отрасли. Методология включает анализ данных Министерства промышленности, Национальной академии наук и местных предприятий. Основными выявленными тенденциями стали: развитие микроэлектроники на базе ОАО «Интеграл», локализация производства компонентов и создание телекоммуникационного оборудования. Ключевые проблемы включают: технологическое отставание в производстве чипов, зависимость от импорта комплектующих, кадровый дефицит и необходимость адаптации к международным требованиям. В заключение подчеркивается необходимость усиления сотрудничества с дружественными странами и ускоренного развития собственных научно-исследовательских компетенций.*

**Ключевые слова:** электронная промышленность, импортозамещение, микроэлектроника, локализация, технологический суверенитет, кадровый потенциал.

The electronics industry is a strategically important sector for ensuring the technological sovereignty and national security of the Republic of Belarus. In the context of global geopolitical changes and competition pressure, the issues of import substitution and the development of our own production base have become of paramount importance. Do-

mestic enterprises in the electronics industry, such as OJSC Integral, OJSC MTZ, RUE Minsk Wheel Tractor Plant and others, have faced the need to quickly adapt to new realities.

The purpose of this study is to analyze current development trends and systematize key issues that hinder the production of modern electronic devices in Belarus.

The study was conducted using the following methods:

1. Analysis of official data includes examination of reports and development programs of the Ministry of Industry of the Republic of Belarus and the State Military-Industrial Committee.

2. Expert analysis is based on summarizing materials from scientific publications by scientists from the National Academy of Sciences of Belarus, in particular from the B. I. Stepanov Institute of Physics and the Joint Institute of Mechanical Engineering.

3. Case study reflects the analysis of the experience of specific Belarusian enterprises (OJSC Integral, OJSC Peleng) in localizing production and developing new products.

The following results were obtained and followed by discussion.

1. Key trends in the Belarusian electronics industry.

Based on the analysis, the following priority areas for development were identified:

Development of microelectronics based on OJSC Integral. The company is the flagship of the domestic electronics industry and focuses on the production of integrated circuits, semiconductor devices, and microwave components. As part of the state program “Innovative Development”, production is being modernized to meet design standards of 90-130 nm, which will allow for the production of more competitive products for industry and the defense sector [1].

Localization of the production of components and accessories. In the context of import restrictions, work has intensified to create domestic analogues of electronic components. This applies to both passive components and specialized microcircuits for automotive electronics and agricultural machinery control systems manufactured at MTZ and Gomselmash [2].

Creation of telecommunications equipment and security systems. Belarusian companies (e.g., NP LLC Exiton) develop and manufacture video surveillance, communication and access control systems for the domestic market and for supply to EAEU countries.

2. Current production issues.

Despite positive initiatives, the industry faces a number of systemic problems:

Technological lag in chip production. Modern world leaders have mastered 3-5 nm technical processes, while Belarusian industry is only striving to reach 90 nm levels. This creates an objective gap in the performance and energy efficiency of products which is critical for consumer electronics.

Dependence on imports of critical components. Even with in-house microchip development, the production of end devices (televisions, machine tools) often depends on imports of processors, displays, and specialized sensors, whose supply chains have been disrupted.

Staff shortages and brain drain. Training highly qualified electronic engineers, technologists, and designers takes time. There is competition for personnel with the IT sector, as well as the risk of specialist migration, which undermines the long-term potential of the industry [3].

Limited funding and the need for a quick return on investment. Setting up a modern microelectronics production facility requires billions in investment, and the market is limited. This makes such projects high-risk for private investors and requires direct government involvement and support.

The study showed that the Belarusian electronics industry is undergoing a difficult transformation phase determined both by internal needs for technological sovereignty and

external constraints. Positive trends include active work on localizing and adapting production based on leading enterprises. However, overcoming key problems – technological backwardness, import dependence, and staff shortages – requires the implementation of coordinated state policy. Prospects lie in deepening cooperation within the EAEU and SCO for joint development and the creation of new production chains as well as in targeted support for domestic research centers and educational programs that train specialists for the real sector of the economy.

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### **РОБОТИЗАЦИЯ ПРОЦЕССА ТРАНСПОРТИРОВАНИЯ ЗАГОТОВОК, ДЕТАЛЕЙ, ИНСТРУМЕНТА И ДРУГОГО ВСПОМОГАТЕЛЬНОГО ОБОРУДОВАНИЯ С ИСПОЛЬЗОВАНИЕМ ДЕКАРТОВОГО РОБОТА**

**И. С. Марченко<sup>1</sup>, А. И. Голяк<sup>1</sup>, Р. В. Ковалевский<sup>1</sup>, Ю. Н. Матрунчик<sup>2</sup>**

<sup>1</sup>*Белорусский национальный технический университет, г. Минск*

<sup>2</sup>*Национальный детский технопарк, г. Минск, Республика Беларусь*

*Представлена разработка роботизированной системы транспортировки на базе декартового робота. Разработанная система может быть использована для различных операций транспортирования заготовок, деталей и готовых изделий на промышленных предприятиях. Данная тематика актуальна в большом спектре отраслей производства, таких как машиностроение, приборостроение, пищевая и легкая промышленность.*

**Ключевые слова:** система транспортирования деталей, декартов робот, электропривод, серводвигатель, образование.

### **ROBOTIC TRANSPORTATION OF WORKPIECES, PARTS, TOOLS AND OTHER AUXILIARY EQUIPMENT USING A CARTESIAN ROBOT**

**I. S. Marchenko, A. I. Golyak, R. V. Kovalevskiy, Yu. N. Matrunchik**

*Belarusian National Technical University, Minsk*

*National Children's Technopark, Minsk, Republic of Belarus*

*This paper presents the development of a robotic transportation system based on a Cartesian robot. The developed system can be used for various transportation operations of workpieces, parts, and finished products in industrial enterprises. This topic is relevant across a wide range of industries, such as mechanical engineering, instrument making, food processing, and light industry.*

**Keywords:** parts transportation system, Cartesian robot, electric drive, servomotor, education.