

ІНДУСТРІЯ 5.0 ТА КОЛАБОРАТИВНІ РОБОТИ: ПЕРСПЕКТИВИ ТА ВИКЛИКИ

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Анотація: в тезах розглядаються ключові аспекти переходу від Індустрії 4.0 до Індустрії 5.0, зосереджуючи увагу на ролі колаборативних роботів (коботів) у сучасному виробництві. Основний акцент зроблено на питаннях безпеки, термінології та адаптації технологій до людиноцентричного підходу. Проведено аналіз відмінностей між Індустрією 4.0 та 5.0, а також охарактеризовано можливі шляхи впровадження нових методів співпраці між людиною і машиною. Представлені рекомендації щодо підвищення ефективності та безпечного використання коботів у виробничих процесах.

Ключові слова: колаборативні роботи, кобот, Індустрія 4.0, Індустрії 5.0.

INDUSTRY 5.0 AND COLLABORATIVE WORK: PROSPECTS AND CHALLENGES

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Annotation: The abstracts examine key aspects of the transition from Industry 4.0 to Industry 5.0, focusing on the role of collaborative robots (cobots) in modern production. The main emphasis is on issues of safety, terminology, and adaptation of technologies to a human-centric approach. The differences between Industry 4.0 and 5.0 are analyzed, and possible ways of implementing new methods of cooperation between man and machine are described. Recommendations are presented for increasing the efficiency and safe use of cobots in production processes.

Keywords: collaborative robots, cobot, Industry 4.0, Industry 5.0

Over the past decades, the global economy has undergone numerous changes due to rapid technological progress. Industry, which was based on mechanization and automation a few decades ago, today integrates intelligent systems and robotics into production processes. The concept of "Industry 5.0" arose as a response to the growing need for product individualization, harmonization of human-machine interaction, as well as consideration of environmental and social requirements. One of the key elements of this transformation is the introduction of collaborative robots (cobots), which allow creating a safe working environment and optimizing production processes. This article analyzes the main principles of Industry 5.0, the role of cobots, the prospects for their implementation, and the challenges that arise along the way.

The transition from Industry 4.0 to Industry 5.0 is accompanied by significant changes. Where the focus was previously on digitalization, automation and network technologies, Industry 5.0 emphasizes the humanization of technology, product individualization and sustainable development. Table 1 shows the main differences between these two approaches.

Table 1 – Main differences between the two approaches.

Aspect	Industry 4.0	Industry 5.0
Focus	Automation and digitalization	Harmony of human-machine interaction

Continuation of the table 1

Aspect	Industry 4.0	Industry 5.0
Product	Mass production	Customized production
Security	Separate production areas for robots	Secure collaboration in a single space
Socio-economic aspect	Production optimization	Improving the quality of work and sustainable development
Technologies	IT systems integration	Intelligent systems with high adaptability

This table demonstrates how shifts in the manufacturing paradigm are focused not only on technological advancements, but also on creating conditions for safe and innovative human-robot collaboration.

Collaborative robots (cobots) are becoming an integral part of Industry 5.0 due to their ability to adapt to changes in production processes and to safely interact with humans. However, their implementation comes with both benefits and challenges. Key aspects are presented in Table 2.

Table 2 – Key aspects.

Advantages	Challenges
Flexibility and adaptability to change	Integration into existing production systems
Improving the safety of the work environment	Ensuring high reliability and security
Reducing physical activity	The need for constant maintenance
Optimization of production processes	Risk of resistance to change among staff

This analysis helps to understand that to fully realize the potential of collaborative robots, it is necessary to take into account both technical and socio-economic factors.

The implementation of Industry 5.0 technologies and cobots is associated with a number of challenges, including technical aspects (system compatibility, security, interoperability) and socio-economic problems (the need for retraining personnel, resistance to change, high investment costs). To ensure successful integration, strategic approaches are being developed that include innovative management models, government support, and partnerships between science, business, and government agencies. The main challenges and possible solutions are presented in Table 3.

Table 3 – Key challenges and possible solutions.

Challenges	Possible solutions
Technical compatibility	Modernization of existing systems, development of standards
Safety and reliability	Improving sensor technologies and algorithms
Interoperability	Development of universal protocols
The problem of retraining personnel	Integrated training programs, trainings
Resistance to change among staff	Support programs, communication policy
High investment costs	Government subsidies, soft loans, partnership

This table clearly shows that a comprehensive approach and cooperation between all stakeholders are key to overcoming existing barriers.

The implementation of Industry 5.0 opens up new opportunities for optimizing production processes, improving product quality, and creating a safer and more comfortable working

environment. Collaborative work helps expand opportunities for creativity and innovation, allowing employees to focus on analytical and creative tasks, and delegate routine operations to robots. Thanks to this, enterprises are able not only to reduce costs and increase efficiency, but also to ensure sustainable development, taking into account environmental and social aspects. Table 4 shows the impact of the implementation of Industry 5.0 on production processes.

Table 4 – Impact of Industry 5.0 implementation on production processes.

Implementation aspect	Expected impact on production
Innovations	Improving product quality, reducing costs
Security	Reducing occupational injuries, improving working conditions
Environmental friendliness	Optimizing energy consumption, reducing waste
Social aspect	Staff training, staff adaptation
Flexibility	Rapid adaptation to changing market conditions

This analysis allows us to form an idea of the multifaceted impact of Industry 5.0 and collaborative robots on the future of production, where technological progress is harmoniously combined with the development of human potential.

CONCLUSION. Industry 5.0 and collaborative work open up new horizons for production, aimed at individualizing products, improving working conditions and harmonious coexistence of technology and man. Despite numerous prospects, the implementation of these technologies is accompanied by a number of challenges, including technical integration, socio-economic adaptation and high investment costs. Overcoming these barriers is possible through the implementation of innovative management models, state support and partnership between scientific institutions, business and state structures.

In conclusion, Industry 5.0 has the potential to become a catalyst for economic growth and social change, contributing to the creation of safe, flexible and innovative production processes. The analysis of key aspects presented in the tables allows us to clearly outline both the benefits and challenges of this process, which is extremely important for the further adaptation of future technologies.

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