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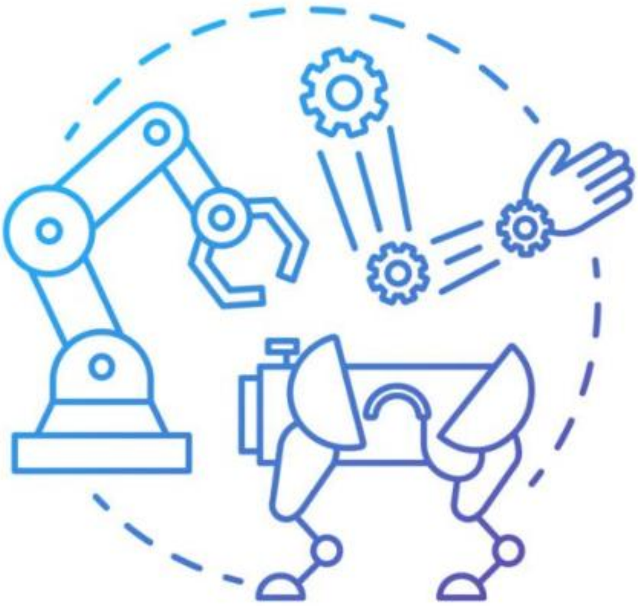

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«Комп’ютерно-інтегрованих технологій, автоматизації та робототехніки»
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У збірник включені тези доповідей, які присвячені сучасним автоматизованим технологіям Industry 4.0 та їх впровадження; інформаційні управляючі системи технологічного призначення; математичні методи в системах автоматизації; розробка та програмування в робототехніці; штучний інтелект та машинне навчання в автоматизації; інтеграція технологій у виробництві та промисловості; сенсорні технології та взаємодія людини з роботами в Industry 5.0; ефективність використання роботизованих систем у виробництві; етика та правові аспекти в робототехніці; Інтернет речей та Інтегровані системи в комп'ютерно-інтегрованих технологіях, автоматизації та робототехніки; технологічні виклики та інновації у світі робототехніки.

Computer-integrated technologies, automation and robotics 2026: Proceedings of III st All-Ukrainian Conference, Kharkiv, May 14-15, 2026: Thesises of Reports / [Ed. I.Sh. Nevlyudov (chief editor).] .-Kharkiv .: [electronic version], 2026. - 97 p.

The collection includes abstracts devoted to modern automated technologies of Industry 4.0 and their implementation; information control systems for technological purposes; mathematical methods in automation systems; development and programming in robotics; artificial intelligence and machine learning in automation; integration of technologies in production and industry; sensor technologies and human interaction with robots in Industry 5.0; efficiency of using robotic systems in production; ethics and legal aspects in robotics; Internet of Things.

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THE DEVELOPMENT OF INFORMATION CONTROL SYSTEMS FOR TECHNOLOGICAL PURPOSES

V.I. Ievtushenko, S.V. Sotnik
Kharkiv National University of Radio Electronics
Ukraine, 61166, Kharkiv, Nauky av., 14
E-mail: vitalii.ievtushenko@nure.ua

Annotation: The work is devoted to the significance and evolution of information management systems for technological purposes. A review of the transformation of MES systems from monitoring tools to predictive analytics platforms is conducted. The evolution of SCADA system architectures from centralized models to cloud-based and web-oriented solutions is analyzed. Mechanisms of compatibility and integration of PLM and ERP systems within a unified information space of an enterprise are also considered. The research results can be used in the design and modernization of integrated information environments for modern industrial enterprises.

***Keywords*:** predictive analytics, industrial automation, PLM, ERP, information control systems.

РОЗВИТОК ІНФОРМАЦІЙНИХ УПРАВЛЯЮЧИХ СИСТЕМ ТЕХНОЛОГІЧНОГО ПРИЗНАЧЕННЯ

В. І. Євтушенко, С. В. Сотник
Харківський національний університет радіоелектроніки
Україна, 61166, Харків, пр. Науки 14
E-mail: vitalii.ievtushenko@nure.ua

***Анотація*:** Робота присвячена значенню та еволюції інформаційних управляючих систем технологічного призначення. Проведено огляд трансформації MES-систем від засобів моніторингу до платформ прогнозної аналітики. Проаналізовано еволюцію архітектур SCADA-систем від централізованих моделей до хмарних та веб-орієнтованих рішень. Також розглянуто механізми сумісності та інтеграції PLM- та ERP-систем у єдиному інформаційному просторі підприємства. Результати дослідження можуть бути використані при проектуванні та модернізації інтегрованих інформаційних середовищ сучасних промислових підприємств.

***Ключові слова*:** прогнозна аналітика, промислова автоматика, PLM, ERP, інформаційні управляючі системи.

The rapid development of automation technologies complicates the process of managing production systems, making the automation of component selection and implementation critically important [1-10]. A modern enterprise operates under conditions of high market dynamics, which requires the implementation of integrated information systems capable of ensuring process transparency from the product design stage to serial production [11, 12].

The growing complexity of production processes and the need for rapid response to changes in technological chains determine the relevance of developing information management systems capable of integrating heterogeneous data and enabling real-time decision-making.

MATERIALS AND RESEARCH RESULTS. Among information management systems for technological purposes, a special place is occupied by manufacturing operations management systems, specifically Manufacturing Execution Systems (MES), whose evolution most clearly reflects the general trends in the industry's development. The evolution of MES: from monitoring to predictive analytics.

Manufacturing Execution Systems have undergone a complex transformation journey. Initially, their functionality was limited to data collection, equipment utilization control, and production output reporting. Modern MES systems integrate with IIoT sensors, enabling real-time data acquisition.

The implementation of neural networks allows systems not only to record downtime but also to analyze the vibration, temperature, and electrical characteristics of equipment to predict critical failures (Predictive Maintenance).

An integral component of the information infrastructure of modern manufacturing, alongside MES systems, is SCADA platforms, the architecture of which has also undergone significant transformation under the influence of the demands of digital manufacturing.

Traditional SCADA (Supervisory Control and Data Acquisition) systems were based on a rigid hierarchical architecture, which limited their mobility.

Centralized models required dedicated server rooms and local operator stations, which significantly increased capital expenditures and complicated adaptation to changes in the production environment. The response to these limitations was the migration to cloud platforms, which allows scaling the system without significant investments in proprietary infrastructure.

In parallel, the use of web technologies (HTML5, REST API) provides access to process control via mobile devices, which is critically important for organizing remote monitoring in geographically distributed production environments [14-16].

If SCADA systems provide supervisory control at the level of technological processes, then strategic management of the product and enterprise resources is implemented through the integration of Product Lifecycle Management (PLM) and ERP systems, the interaction of which forms the digital ecosystem of modern manufacturing. This work presents a comparative analysis of the integration of PLM and ERP systems (Table 1). The interaction between Product Lifecycle Management (PLM) systems and Enterprise Resource Planning (ERP) systems forms the foundation of the digital ecosystem.

Table 1 – Comparative analysis of PLM and ERP system characteristics

Criterion	PLM	ERP
Main goal	Intellectual property management: from concept to utilization (eBOM)	Enterprise business process and resource management (mBOM)
Management object	Product (design, composition, manufacturing technology)	Business (finance, personnel, logistics, orders)
Data dynamics	Great at the R&D stage (changes in drawings and specifications)	Great at the execution stage (transactions, balances, payments)
Type of information	Technical documentation, 3D models, simulation results	Financial statements, orders, delivery schedules
Planning horizon	Strategic (full product life cycle)	Operational and tactical (day, month, quarter, year)
Key modules	CAD/CAM/CAE integration, PDM (Product Data Management)	MRP/MRP II, CRM (customers), SCM (supply), HR
Integration point	Transfer of the product's engineering bill of materials (eBOM) for production planning	Creating a purchase order based on the manufacturing bill of materials (mBOM)
Standards	ISO 10303 (STEP), ISO 10007 (Config Mgmt)	ISO 9001, IFRS, ISO/IEC 12207
Integration maturity level	One-way eBOM→mBOM transfer	Two-way real-time data synchronization

Note: eBOM (Engineering Bill of Materials) is the engineering composition of a product, formed at the design stage; mBOM (Manufacturing Bill of Materials) is the manufacturing composition of a product, used directly in production planning. The key integration point between PLM and ERP is the transformation of eBOM into mBOM, which ensures consistency between engineering documentation and production planning. A comprehensive architecture of this interaction, covering all management levels from design to supervisory control, is shown in Fig. 1.

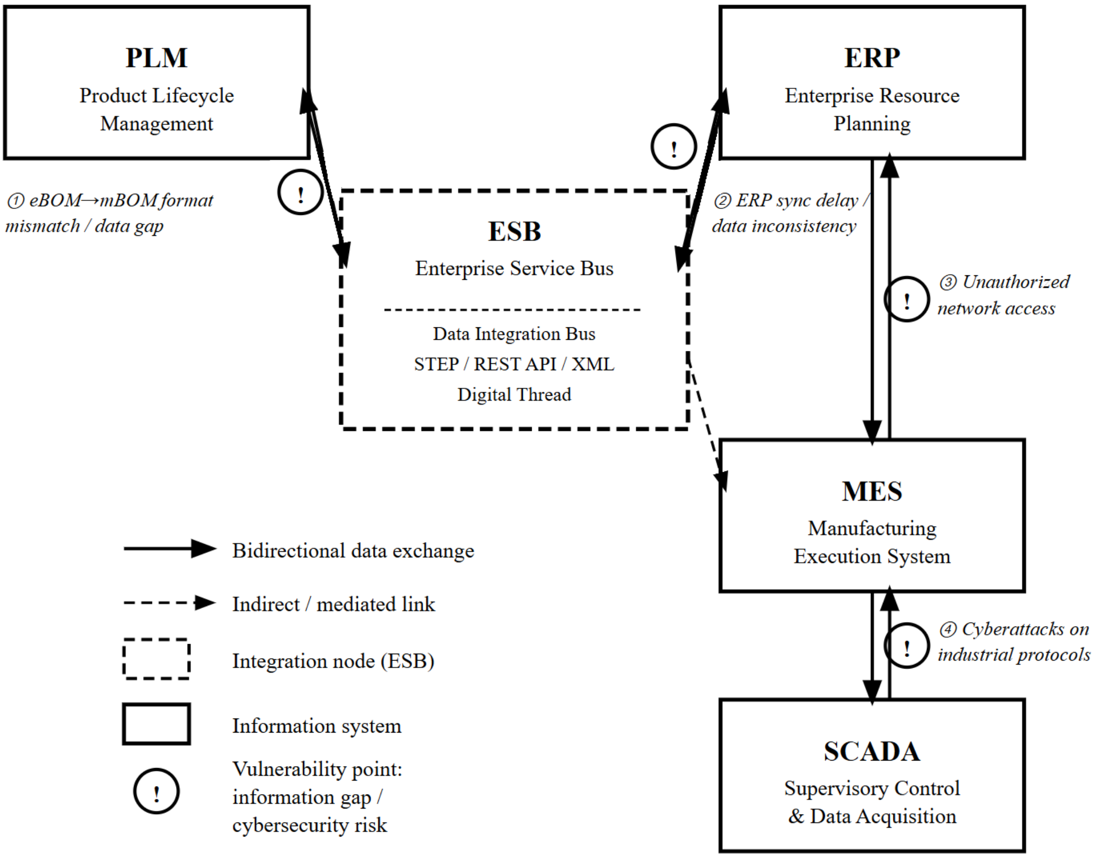

Figure 1 – Architectural diagram of the integration of PLM, ESB, ERP, MES, and SCADA, with the designation of vulnerability points

However, achieving full-fledged PLM and ERP integration in practice encounters significant technical barriers. The main difficulty is the mismatch of data formats ('information gaps') that occur when transferring design documentation to production.

To overcome these barriers, modern approaches utilize Enterprise Service Bus (ESB) data buses and exchange standards such as STEP to ensure a continuous flow of data (Digital Thread).

Despite the technological maturity of these solutions, the practical implementation of integrated information systems is accompanied by several challenges that require separate consideration:

1. Cybersecurity, because the increase in the number of entry points through cloud SCADA and networked MES requires strengthening the protection of industrial networks.

2. Human Factor, because the high complexity of the systems necessitates continuous improvement of the engineering personnel's qualifications to work with specific software.

CONCLUSIONS. An analysis of information management systems for technological purposes indicates a deep integration of all production levels – from product design to the supervisory control of technological processes. The paper reviews the evolution of MES-systems, demonstrating a transition from passive data collection to intelligent predictive analytics based on neural networks and IIoT infrastructure. The transformation of SCADA-system architectures from rigid centralized models to flexible cloud-based and web-oriented solutions that enable remote monitoring of geographically distributed productions is analyzed. A comparative analysis of PLM and ERP systems was performed, which allowed for the formalization of key differences between them across nine criteria and the identification of an integration point through the eBOM to mBOM transformation mechanism. An architectural scheme for the integration of PLM, ESB, ERP, MES, and SCADA was developed, indicating vulnerability points, which illustrate information gaps and cybersecurity risks at each level of system interaction. The obtained results confirm that the seamless integration of these systems is a necessary condition for increasing the efficiency of automated production, minimizing management decision-making time, and reducing equipment maintenance costs. A promising direction for further research is the development of self-tuning control systems capable of real-time adaptation in a dynamic production environment.

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