Investigation of the general concept of the implementation of automation and digitalization tasks for production processes using innovative high-level solutions

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Abstract: *The main issues are considered in this topic: the main problems of the design and implementation of high-level systems for the automation of production processes are considered. As part of the digitalization of production, there is a need for the operational management of all enterprise processes at all levels of the system. The work highlights several recommendations for the development of integration of such systems. The research describes the interoperability of various systems of resource management, processes, laboratory, planning for obtaining quality products.*
***KEYWORDS**: DIGITALIZATION, MES, LIMS, ERP, AUTOMATED SYSTEMS, PRODUCTION PROCESSES*

1. Introduction

Due to the development of microcontrollers and microprocessors, modern production, industry is very different from what it was 50-100 years ago. This is a natural process of replacing manual human labor with automated production, in which a person is no longer standing at the machine tool or with a plow in the field, and for the most part the role of a person in it is assigned to controlling and replacing faulty blocks. This makes it possible for a modern person to develop as a creator, to pay more attention to the qualitative development of himself.

2. Problem discussion

Information technology today has become an integral part of systems automation. The fast pace, the lightning speed of change and updating of information technology introduces tangible adjustments to the automation of systems and processes in general. As part of the "Industry 4.0", it's time to talk about the automation of production processes, when the control object is considered not only processes, but also the labor, financial and commodity flows and resources. When the level of digitalization of production allows for the operational management of all tasks at all levels of production, to plan all processes and tasks for effective management and control. To solve the problems of operational control of production processes, such a concept as MES (manufacturing execution system) systems appeared. Many enterprises faced a number of problems that arose during the transition to a system of automation of production processes, since there are no ready-made solutions, or clear guidelines, structures, algorithms for the implementation of such complex systems.

3. Objective and research methodologies

The main purpose of this work is the research of the general concept of realization of automation tasks and digitalization of production processes using innovative high-level decisions. The work reflects a study of the authorization problem using a solution in the field of building systems in terms of innovative software products and industrial network systems.
The work presents recommendations for building a network structure using the example of a testing laboratory. The Testing Laboratory provides measurement data on product quality, including in real time, collected from the production level, ensuring proper quality control and focusing on critical points. Laboratory can propose actions to correct the situation at this point based on the analysis of correlation dependencies and statistical data on cause-effect relationships of controlled events. All processes are automated using the LIMS (Laboratory Information Management System) package. The LIMS system is designed to optimize the processes of the testing laboratory, improve the quality of information processing, with an integrated analytical analysis package.
Upon receipt of an order for a new batch of products, a task for sampling arrives. A sample entering the laboratory is marked with a QR code or NFC labels and an identifier for entering a common sample base. All data is synchronized with the subsystems of the production process control system for optimized, continuous management, control and planning. The full production process, taking into account quality control of products and raw materials, is shown in Figure 1.

***Figure 1.** Structure manufacturing process*

The structure of the interaction of devices for working in the LIMS system is shown in Figure 2. A simple system includes one server with a database and a web server, and several clients.
Clients can be stationary computers, PDAs or smartphones, a prerequisite is access to a local network or a WI-FI network. An employee, for example, having a smartphone or tablet connecting to a local network, enters data, performs various operations with test samples, analyzes the data received, accesses the web application of an automated laboratory. All test results, or quality control of products and raw materials, are automatically entered into a report, which is subsequently sent to MES. MES accepts the results and forms a series of tasks for further production.
If necessary, a data center is possible, which will include a database server and a web server, such a structure is shown in Figure 3. All clients are connected to a web server. Storage, collection and processing of information is carried out using databases as the system exchanges a huge stream of information data.

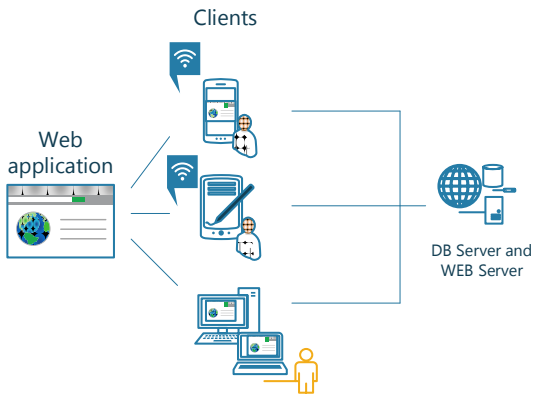

***Figure 2.** Structure of the interaction of devices for working in the LIMS system*

Clients having access to a web browser after passing certain procedures to protect security (entering a password, login, having passed authentication levels), depending on their access level, can carry out various procedures and operations. For security purposes, the enterprise has its own internal local area network without access to the global network; all information may be available for other systems, production subsystems, such as ERP (Enterprise

Resource Planning), MES, operational planning systems, automated technological process control systems ATPCS [1].

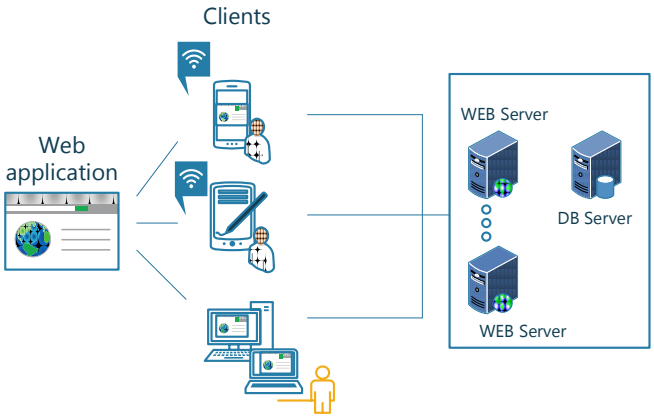

Figure 3. *Complex structure of the interaction of devices for working in the LIMS system*

LIMS interacts with various systems for data exchange, and continuous, operational management of all production processes. Quality control of raw materials and finished products is an integral part of any production, the efficiency, and most importantly the image of the company, and therefore the income and profits of the enterprise, depend on this. The structure of the LIMS interaction with other systems is shown in Figure 4. The ERP system exchanges data on resources, raw materials, the amount of material resources, and also contains information about suppliers and orders. The MES system performs operational control of all production tasks, forming a task list for all systems, tracking the status of all processes from receipt of an order to shipment of finished products to the customer. LIMS sends a report on the results of sample tests, or research of new formulations, on the basis of which MES forms production tasks. The operational planning system creates a schedule for all tasks, taking into account restrictions. The status of equipment, its readiness for the process, the timing of repairs, or inactivity in the event of a breakdown, the status of labor resources, taking into account the number of employees, shifts, and their qualifications, the status of processes, and standards for their implementation, etc. The process control system already carries out all the tasks taking into account the report on product quality control at various stages.

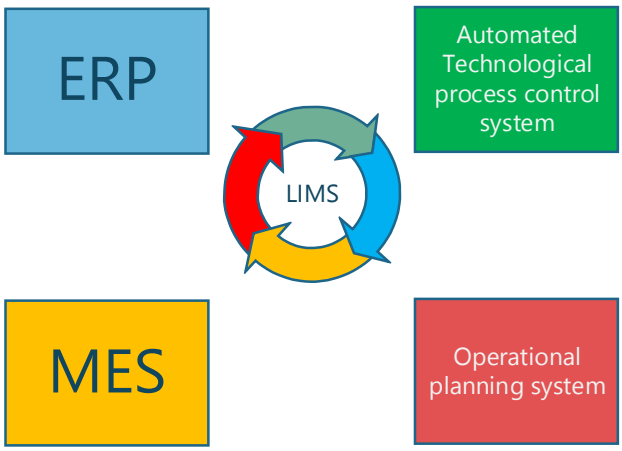

Figure 4. *Structure of the LIMS interaction with other systems*

For the interaction of all systems, a number of services are required that will integrate the current, necessary information into various systems without data loss and using data transfer standards understood by all production participants. The system needs to speak the same language so that the rest of the participants correctly understand and express their thoughts. In the framework of production, making everyone speak the same language is quite problematic, since a huge number of devices, types of interfaces, networks, taking into account the huge data stream that must be translated into an understandable language for the rest.

One solution to this problem is the use of services such as Uniconnect Agent, Uniconnect and Unilink, namely the transfer of XML files in which information is generated in the form of tags, with an identifier of all the necessary data.

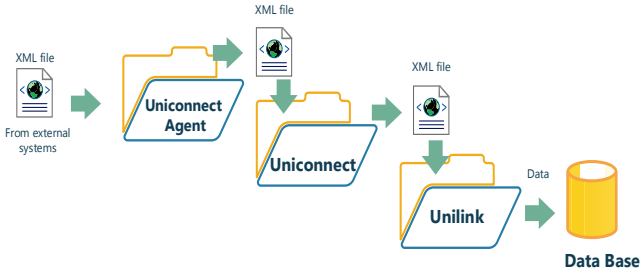

Figure 5. *Data transfer process*

Figure 5 shows the process of transferring data from external systems to the LIMS system. A file is generated that is sent to the exchange folder, then the Uniconnect Agent polls the folder for the presence of the file, and sends the file to Uniconnect. Uniconnect parses incoming files and converts the file to Unilink-friendly syntax. Unilink stores data in a database. All data stored in the database is available to the user and further processing and analysis.

In the printers, the same principle of communication via XML files is applied, or using customization of the Web application, prescribing the relationship with devices integrated in the application, but this option requires programming skills case of establishing communication with laboratory equipment, various analyzers, electronic scales, C #, HTML 5, CSS3 , Java Script. The data exchange process between laboratory equipment and the database is shown in Figure 6.

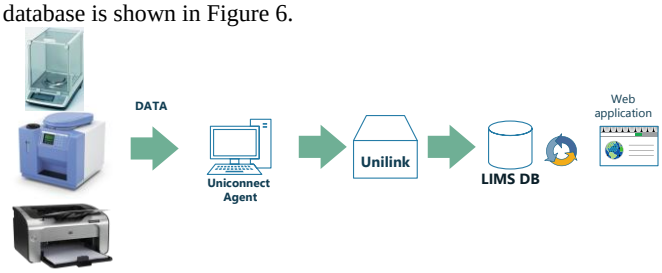

Figure 6. *Data from laboratory equipment*

4. Conclusion

This work highlights the problems encountered in the design and implementation of automated systems for production processes. When the task is to efficiently and effectively manage the production process from the receipt of the order and raw materials, after production, and the receipt of finished products, shipment to the customer and complete quality control at all stages of production. The complexity of introducing such systems to manage and plan the full production cycle lies in the lack of ready-made algorithms or recommendations for implementation, construction and integration into an existing production without possible losses. This study shows one of the solutions for the integration of such systems, allowing production facilities to step closer to the digitalization of production.

5. Literature

1 Kopesbaeva A.A., Kim Y.S. Research and implementation of robust controllers for controlling objects with an unknown or incomplete mathematical model. “Vestnik AUES” of the Almaty University of Power Energy and Telecommunications, No. 2-25, 2014 p. 32-37.