Organization of a virtual enterprise in information systems

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Abstract. To date, the current issue in the global economy is its digital transformation. Modern digital technology in the process and product activities of the company implies the introduction of CALS-technologies, PLM, MES, ERP systems, and the interaction between agents opens the possibility of creating a virtual enterprise. The main difficulties are in the non-digital culture of enterprises, in the conservatism of people, their desire to preserve the status quo. The task of creating optimal organizational structures and a CALS system can only be solved under the conditions of a specific virtual enterprise.

1. Introduction
To date, the current issue in the global economy is its digital transformation. According to the Decree of the Government of the Russian Federation dated March 2, 2019 No. 234 "On the management system of the implementation of the national program" Digital Economy of the Russian Federation", responsibility was assigned for the implementation of the national program" Digital Economy of the Russian Federation "to the Ministry of Digital Development, Communications and Mass Communications, the Ministry of Economic Development In turn, they issued recommendations on the introduction of digital transformation (Chief Digital Officer, CDO) in enterprises with state participation [1].

One of the main tasks of CDO is the development of projects and documents of strategic planning in the field of digital transformation of the company, including the development and implementation of new business models, the introduction of modern digital technologies in the process and product activities of the company, the transition to managing the company and production processes based on data (data-driven decision management - DDDM).

The transition to company management based on DDDM opens the possibility of creating a virtual enterprise (VE), thereby increasing the speed and quality of order fulfillment by combining the resources of various partners into a single system.

The VE requires the development of a unified technological policy, primarily in terms of processing and managing shared information [2]. The organization of VE and digital transformation in the process and product activities of the company implies the introduction of CALS-technologies (Continuous Acquisition and Lifecycle Support - continuous information support for supplies and product life cycle) [3-7]:

- PLM systems (product lifecycle management system) - a system, including application software, for managing the life cycle of products;
MES systems (from the English. Manufacturing execution system, production process control system) - specialized application software designed to solve problems of synchronization, coordination, analysis and optimization of production in any production;

ERP systems (Enterprise Resource Planning), an organizational strategy for the integration of production and operations, human resource management, financial management and asset management, focused on continuous balancing and optimization of enterprise resources through a specialized integrated application software package that provides a common data model and processes for all fields of activity.

To implement the digital transformation uses a variety of software.

2. Digital Transformation System Overview

2.1. Production management system "ALFA ims"

"ALFA ims" system is one of the information systems for production management. Manages the stages of creating a digital production model, synchronizing all processes and controlling them in real time (MES, manufacturing execution system), also includes an enterprise resource management system (ERP, Enterprise Resource Planning), human resources management (HRM), fixed assets and repairs (EAM, Enterprise Asset Management), and Logistics Management (SCM, Supply Chain Management). It allows you to synchronously manage at all levels: from inter-factory cooperation to workshops and sites. Unified coordinated planning of technological preparation of production, production itself, R & D, equipment repairs, supplies, cost of products, loading of personnel. Gives prompt feedback and fast end-to-end rescheduling.

The system integrates all the processes of value creation, allowing you to concentrate on the main thing: on what allows an enterprise to earn money, make them as quickly as possible, instantly react to changes, making decisions in real time. The capabilities of the "ALFA ims" system are presented in Figure 1.

![Figure 1. Online production "ALFA ims".](image)

2.2. System "Galaxy"

The "Galaxy" system is an ERP system, an integral part of a complex of business solutions. Digitalization platform for large enterprises, holdings and public corporations and business applications for planning and managing production, production assets and reliability.

This system allows you to remotely manage your own production (Figure 2):

- Production management at the level of factories and production sites.
- Production management at the level of technological conversion.
- Intra-shop operational management of production operations.
- Operational control of the assembly of complex assembly plants in real time.
- Management of logistics and supply synchronization with the needs of production in real time.
- Product quality management at all stages of production.
- Cost and cost management.

**Virtual Enterprise Management:**
- Formation of network schedules of production and supply of products.
- Assessment of the consolidated resource needs of enterprises - members of a network of agents by type of resources.
- Formation of alternative scenarios for the implementation of contracts.
- Unified integration environment of interaction with information systems of enterprises participating in the agent network.
- Monitoring the execution of servicing and production procedures in real time.

2.3. "SAP" System

The "SAP" system is a multi-component system that allows you to combine the business processes of production, procurement and marketing of enterprise products. Corporate information system based on the methodology of ERP (enterprise resource planning) and aimed at achieving optimal business process. For large state-owned industrial giants, stable execution of the state order is required within strictly specified periods; for private industrial enterprises, profit and equipment recoupment are more important. Projects implemented with the help of "SAP" help both state and private structures to optimize costs and achieve their goals at each stage of the production cycle (Figure 3).
2.4. "MFG / PRO ERP" system
"MFG / PRO ERP" is a system for large and medium-sized enterprises with a discrete type of production. 5,200 completed implementations in the world, 8 in Russia. Fully localized. According to various experts, the system is one of the most powerful solutions for discrete manufacturing (engineering, light industry, automotive, electronics, etc.) (Figure 4).

- Used to manage the production activities of the enterprise in accordance with various types of production processes and consists of modules:
  - Composition / Specifications / Formulations;
  - Operations / Work Centers;
  - Formula / Technological process;
  - Maintaining outfit - production orders;
  - Operational control of working time;
  - Line production;
  - Global quality management.

The main functions of "MFG / PRO ERP" are not only support the optimal functioning of the production processes in the enterprise, but also optimize information flows between consumers, the company and suppliers. The "MFG / PRO ERP" system is designed to automate the process of managing the production and economic activities of large industrial enterprises, ensuring a complete logistic production cycle (marketing, supply and supply, processing, and marketing) in various industries.

![Figure 4. "MFG / PRO ERP" in mechanical engineering.](image-url)

2.5. "Oracle" system
Oracle Manufacturing module (Oracle Manufacturing) allows you to optimize production processes from raw materials to final products. Supporting both discrete and continuous production processes, the Oracle Production module contributes to their continuous improvement, cost reduction, and also ensures the conformity of manufactured products to the requirements of standards and legislation.

This subsystem includes the following modules (Figure 5):
- "Inventory Management" (Inventory Management);
- "Specifications" (Bills of Material);
- "Engineering" (Engineering);
- "Work in progress" (Work in Process);
- "Quality Control" (Quality);
- "Production Planning" (Planning);
- "Planning of material flows" (Supply Chain Planning);
• "Shop Planning" (Manufacturing Scheduling);
• "Cost Management" (Cost Management);
• "Mobile applications for production" (Mobile Supply Chain Applications);
• "Management Information System (Production)" (Manufacturing Intelligence).

Figure 5. Oracle Manufacturing.

All of the above systems allow you to build VE with the optimal organizational structures and CALS-systems. But for their implementation there are a number of problems.

3. Problems of implementation of systems in Russia and the world
In 2019, Panorama Consulting [8] announced the data of another comparison of ERP-projects implemented on key platforms - SAP, Oracle and Microsoft.

According to the submitted implementation data, from May 2017 to September 2018, the largest share in the global market of ERP systems continued to be maintained by SAP, occupying 26%, Oracle ranked second (17%), then the Tier II vendor group (14%) , Microsoft Dynamics (11%) and a group of vendors Tier III and others. In Russia, the system "Galaxy" ranked fourth in the market for ERP systems with a share of 7% in 2018.

According to the survey results, there is a tendency for an increase in the demand for ERP among small and medium-sized businesses with annual revenues of less than $ 300 million. From March 2017 to February 2018, their share among all implementation projects increased to 59%. Due to the increase in the number of enterprises with a small budget, the average level of costs for ERP projects has increased: from 5.9% of the company's annual budget in the 2017 report to 6.5% in the 2018 report.

A common reason for the introduction of ERP-systems is the desire of enterprises to simplify the work of employees and to establish effective interaction between distant units (Figure 6).

Figure 6. Reasons for introducing ERP.

The implementation period strongly depends on the chosen functionality and the scale of the enterprise. For example, the implementation of 100 jobs at OAO "Russky Product" took about one and a half years.
The Ministry of Industry and Trade: 60% of Russian factories have begun a digital transformation [9-14].

The main difficulties of implementation are in the non-digital culture of the enterprise, in the conservatism of people, their desire to maintain the status quo. A very important role is played by the rules and regulations that have been established for many decades, and the fulfillment of their requirements cannot be translated simply. But it is possible to do digitalization to the maximum. And this is not just automation, but the creation of new business processes that are impossible to implement without the "numbers". Many Russian enterprises stage "Industry 3.0", that is, production automation, not only that they did not pass, but have not even started yet. If there is no PLM, ERP, MES, then introducing virtual reality or artificial intelligence is premature. Digitalization itself is only the last stage of a long and difficult journey, and we should start with an honest assessment of our readiness for transformation. The enterprises spend a lot of effort to make such an assessment, but in return they have the opportunity to build a transformation plan and ensure its connection with the strategy. There is a gradual set of maturity, there is a gradual mastering of the methodology for managing the life cycle of products in conjunction with the integrated management of resources and regulatory information. Another obvious trend is the gradual import substitution of software in those technological niches where there are competitive Russian products. But this process is not fast, there are hardware limitations caused by an objective technological lag in this area, the same applies to operating systems and DBMS with enough functionality to be deployed at the corporate level. The main difficulty in the assessment is the laboriousness of collecting statistical information, especially when it is necessary to take into account transactions or documents that are not implemented in digital form, without using an electronic document management system.

The overall level of digital maturity in Russia is about 20%. But at the same time, the costs of 55% of Russian industrial enterprises for digitalization and the development of IT infrastructure do not exceed 1% of their budget, and only 6% of enterprises have expenses that exceed 5% of the budget. Only about 14% of the factories in Russia have reached a high stage of readiness for digital transformation - the share of CNC machines accounts for more than 50% of the installed equipment. 20% of respondents could not confirm the existence of ERP-systems. MES-systems are implemented in 20% of organizations, but at the same time lead systems of their own design. So the CALS-system solves the problem of its "soft", organic embedding in the VE and the enterprises in its composition, ensuring the loyalty of functional units and the stability of its operation.

4. Conclusion

The problem of forming the best organizational structures and CALS-technologies can be resolved only in the circumstances of a specific VE. It is important to understand the essence of the problem. As the international and Russian experience shows, the formation of "correct" design and production systems based on the principles of CALS from scratch is essentially impossible [15]. For this reason, the pace of CALS implementation and many of the know-how in this area will not be determined by the capabilities of new IT tools and supporting CALS tools, but by methods and techniques for changing the existing management and informational mechanisms both from within each VE member and in the EaP whole VE is considered an innovative form of business. Its economic potential is irrefutable. To date, developed and successfully used in practice a variety of concepts of the organization of the VE and the corresponding information systems to support the processes of coordination and communication. The main problem on the way to forming an VE is the degree of "transparency" of business and the confidence of enterprises in the virtual network being created. Tangible problems for small and medium-sized businesses are considered to be fairly high conditions for information equipment and the introduction of certain technologies. However, the formation of an VE is an objective trend, the proper degree of development of modern markets and related technological changes.
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