Product lifecycle management concept in modern industry

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Abstract. The article is devoted to the automation of the production process at different stages of the product lifecycle. The economic prerequisites for the use of information technologies in production are identified. Stages of development of information technologies for various industries are defined. The possibility of automation of each stage of the life cycle from the preparation of technical specifications to the disposal of the product as integrated into a single information system. Difficulties of transition to the unified information system are designated.

1. Introduction

Industrialization entails the increase of production rates in all branches of economy. Industrialization process has special influence on the production sphere.

Modern production technologies are undergoing major changes. This is connected with facts such as market competition, tight time limits for development and manufacture of product, quality specifications, and also attractiveness of product design. Not only constructive technological possibilities but customer’s preferences have more and more influence on the product form. In a number of cases, it becomes necessary to talk about many modifications of the same product due to change of one or more characteristics. Thus, the production process may be considered as a complex task which is an aggregate of different knowledge, and as a consequence, an aggregate of cooperation of numerous specialists and/or organizations.

Traditional approach to organization of production requires performance of multi-criteria search of optimal solution from the point of view of construction and technological implementation of the product. Many risks appear at the stage of product designing. This is the consequence of the fact that the stage under consideration is the most labour-consuming. It is often neglected, which increases the probability of taking a non-optimal decision [1]. For purposes of increasing the competitive ability, each product requires warranty service, post-warranty repair etc. Thus, manufacture of products nowadays goes beyond the usual scope.

Besides the listed aspects, the modern economy forms special tendencies of production development, according to the IBM report:

- A customer is focused on ready products; the greater part of production is given suppliers’ buy back;
Design and configuration set are an author’s solution no more and are defined by demand;
Suppliers nowadays do not simply sell a product, but they also offer services on installation
and assembly of equipment;
Staff changes in supplying and manufacturing companies;
Possibility of using cloud technologies allows optimizing the enterprises’ risks;
Increase of production mobility for purposes of searching more profitable economic
conditions.

The mentioned tendencies stipulate such requirements for information technologies as providing
the integrity and high automation level, support of all stages of product lifecycle, organizing of joint
use of information about the product by greater number of business process participants which are
goingraphically distant from each other.

Automation systems [2] have great importance for production. Computer aided design systems
(CAD) have long ago become the engineers’ main instrument. As a rule, different CAD application
were used for those purposes, both 2D and 3D modeling. Parametric systems have become a more
complex version of the 3D modeling [3]. In a number of cases they contained information about
product. The array of instruments depended on manufacturing company’s activity sphere, and it had to
comply fully both with company’s needs and with requirements of the State Standard.
However, at the modern stage, it becomes necessary not to limit oneself to the product designing
stage, but to consider it during the whole lifecycle [4, 5].

2. Discussion
The notion of lifecycle is somewhat wider than the production cycle. It (the notion) includes the
following stages:

- Planning of product, making a technical assignment;
- Conceptual elaboration of product;
- Detailed elaboration of product;
- Engineering analysis and testing of pilot samples;
- Manufacture of products;
- Servicing and repair;
- Utilization.

The last three stages have not been considered in traditional approach to production before.
However, the modern economy requires their taking into consideration.
The main tasks of product lifecycle are:

- Engineering data management (PDM);
- Design management;
- Manufacture process management (MPM);
- Management of cooperation with external organizations, including subcontractors, joint
contractors, suppliers and other (SCM);
- Management of requirements and cooperation with customer (CRM, RqM);
- Work flow control automation.

Later, information systems of enterprise resource management (ERP), customer relations
management (CRM), and supplier cooperation management (SCM) were developed.
Thus, the described information systems are able to a considerable degree increase efficiency of
work in each sphere individually [6]. But that has a negative impact on the work of enterprise due to
absence of interconnection between them. Each system individually contains great amount of data, but
its use within one organization is limited. Thus, it was impossible to organize cooperation among manufacturer, supplier and consumer.

Conception of product lifecycle management (PLM) is a comprehensive solution on automation of different stages of design lifecycle, from taking engineering decisions to preparation for utilization in the unified information space.

This conception is based on using exact information at all stages of product lifecycle. Participants of project have access to the guaranteed exact and complete information for decision taking and for comparing with alternative options concerning expenses and other parameters [7, 8].

In a number of cases, PLM solution may provide high automation level which is supported by the RGD (Relational Generative Design) methodology. This solution suggests using the possibilities of parallel designing, accumulation and repeated use of corporate knowledge and standards, automation of performing the measurements at all stages of designing, various versions of visualization etc.

PLM conception includes the following components: basic standards and technologies (XML, means of visualization, cooperation and integration of applications); instruments of preparation of engineering information (CAD, CAE, CAM and other); auxiliary programs (data storing, information management, document circulation); functional applications (for management of configurations and versions) and corporate systems (ERP, CRM, SCM etc).

Actually, the PLM technology is a software which allows connecting between the described components. A setup diagram is shown in figure 1.

![PLM solutions flowchart](image-url)

**Figure 1.** PLM solutions flowchart.

Formation of the unified information space for work at all stages of product lifecycle is a technically complex process. It can be performed in several iterations [9]. Which makes the object-oriented approach the most preferable, and which allows increasing the system functionality due to the applications created [10]. For maximal convenience, such applications are often made multiple-user applications, or the remote work of users with access to the sharable database through Internet is organized [11].

As of today, several directions of PLM conception development can be outlined:

- Uniting many people for work on the same project.
- Providing more comprehensive information about product.
- Uniting more processes for work on the same project.
- Covering the whole lifecycle of product.

Extension of possibilities of PLM in each of those directions requires increase of informational responsibility from all participants of product lifecycle (customer, developer, consumer, and other). Thus, two groups of companies can be outlined: adequately equipped and inadequately equipped.

This prerequisite requires equipment compliance with data format. As of today, two groups of productions are outlined according to the means of processing the information:

- Uninterrupted productions – they are working with large data; enterprises of oil and gas, metallurgical, chemical, pharmaceutical, and food industries;
- Discrete productions – they are working with 3D models; enterprises of machine building, aerospace, ship building, construction and other branches.

The second type is noted as more preferable for work with PLM software [12,13].

Difficulties in implementation of concept are connected with the fact that the participants of production often have software already configured according to their needs. Thus, introduction of PLM technology in the industry requires conducting the following organizational stages:

1. Sufficient informational support of all production stages;
2. Creation of organization standard for development of design documentation;
3. Creation of the open format of data.

However, besides formation of the working technical model, the most difficult stage of PLM introduction at an enterprise is creation of business process model. It is often different from the model which is nowadays operated at an enterprise. At this stage, the analysis and formalization of the current condition is required for development of new criteria.

For describing the business processes, the UML (Unified Modeling Language) methodology can be used which allows building a model of subject domains by means of a set of special diagrams, i.e. which also implements the object-oriented approach. Instrumentally, it is based on diagrams building.

As of today, the market leader of PLM software products is the IBM/Dassault Systemes which offers as PLM solutions the CATIA, ENOVIA, DELMIA and SmarTeam systems [14]. At the market, there are also PLM solutions Autodesk, Siemens PLM Software etc.

3. Summary
Application of the PLM conception in the industry amid market economy can provide the following:

- acceleration of new products manufacture;
- strengthening of quality control;
- reduction of expenses by means of replacing the physical models by virtual models;
- economizing due to multiple use of design data;
- extension of possibilities of product optimization;
- economizing due to reduction of production wastes;
- reduction of expenses by means of complete integration of the engineering document circulation.

However, there are difficulties encountered while implementing this concept which are connected with the necessity of systematic analysis of the activities of an enterprise, detection of strong and weak points of the existing model. As a result, a new model of enterprise functioning can be built with consideration of the informational approach.

The evidence from practice shows that as of today, the development of PLM technologies is underway. In particular, that refers to the foreign market. The Russian industry at the moment is not
ready to accept the described concept to the full extent. This can be explained by difficulties in transition of an enterprise to the new functioning model.

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