Organization of functional interaction of corporate information systems

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Abstract. In this article the methods of specialized software systems integration are analyzed and the concept of seamless integration of production decisions is offered. In view of this concept developed structural and functional schemes of the specialized software are shown. The proposed schemes and models are improved for a machine-building enterprise.

1. Introduction

Quite often it happens when that a lot of different software products are used by an industrial plant. This may be caused by integration of companies using different software, or simply by historical factors of development.

There are several reasons for the simultaneous application of a variety of specialized software systems:

- high complexity of today's products;
- manufacturers are transformed into transnational corporations, and for the organization of their operation data replication is required;
- assimilation of existing software infrastructures to maintain data integrity in mergers and take-over.

In this regard, analysis and integration of data from different software systems, and creation of joint documents are not only difficult, but also costly for the company.

It is important that each organizational unit operates and processes its information in its own manner. That is why in the course of corporate systems implementation special corporate standards are introduced for data exchange formats. Their integration is ensured by means of data conversion from one format to another, which often causes errors and degrades the information quality.

Among the shortcomings of the existing information systems developed by most design companies are:

- Narrow specialization of design and calculation causing incorrect problem statement and insufficient complete analysis of the results. At the same time there is no possibility for designers to carry out their own preliminary calculations of developed product, which results in complexity and timing increase in the project work as a whole.
- A large number of paper documents which has the following disadvantages: slow retrieval of documents; difficulty in document tracking at all stages of its life cycle; the duration of the

timing and coordination of documents; the greater likelihood of errors in the processing and transmission of information collection; increase in the information processing terms.
- A set of specialized and poorly integrated techniques implemented in the Microsoft Excel environment is usually used in calculations [1-2].
- Considerable length of the calculations caused by the need to perform time-consuming procedures of phased iterative calculation and parameters associating.

2. Materials and methods

2.1. Justification of the need to improve engineering enterprise's information system

Information systems of most engineering enterprises as a rule are not optimal and do not provide the possibility of carrying out all the necessary calculations for the company's specialists. It requires the involvement of third parties.

The computerization of traditional methods to solve engineering design problems at the machine-building enterprises is not systematized. This is mainly carried out by means of in-house design applications providing only particular design problems solutions [3].

Currently a full design study of the object characteristics with the required parameters of accuracy and turnaround time can be achieved through the creation of automated software and hardware systems that are based on a computer analysis using physical and mathematical models that describe the hydrodynamic, thermal, and other processes occurring in created product.

The method of defect elimination and improving the existing engineering techniques is the development of comprehensive automated software and hardware modules to be integrated into a single computational environment for managing and sharing data between software applications within a single company's information environment.

2.2. Methods of corporate software support systems for product life cycle maintenance integrating

Integration provides a solution to data mismatch problems in two or more systems used in the design organization and the construction of the organization's IT infrastructure.

Technical problems to be solved in the course of work on the systems integration include [4-5]:
- semantic data reconciliation - bringing data in different systems for "total solution";
- construction of single classifiers and directories - building a one-one correspondence between the elements of directories in different systems and fixing in the additional structures which exercise the "translation" functions;
- creation of software interfaces of integrable systems for data transfer and call system functions on external events;
- development of converters for data transmission from one system to another and output data formats for transmission including the realtime;
- logical systems binding - building algorithm which enables to display one system "events" to other systems;
- designing mechanisms for remote synchronization (replication) of data and their distributed development;
- designing interfaces that enable one to control the data flow, logic transformation and structures, define a single access rights and mechanisms for working together with data, etc;
- development of additional means of access, analysis, and collaboration in data processing.

An information system comprises the following components:
- The platform on which the other system components, including the hardware and system software, operate.
- The data that the system works with consists of DBMS and database [6].

- The applications that implement the business logic of the data system. They consist of the components of the business logic, user interface, auxiliary components and the application server which provides storage and access to application components.
- The business processes which are the scenario of the user interaction with the system [7].

It is believed that the integration of information systems is the integration of one or more components of integrable information systems.

The objectives of the platforms integration are:

- Ensuring interoperability between applications running on different hardware and software platforms.
- Enabling applications developed for a specified software and hardware platform to operate on platforms.

There are several ways to achieve these goals. Within each approach, there are different technologies:

- Remote Procedure Call.
- Middleware.
- Virtualization.

RPC (Remote Procedure Call) technology enables you to publish the procedure and to call it for applications running on other platforms. The elements of such technologies are common to all platforms description interface procedures language (IDL, WSDL), procedure's "adapter" which translates external calls into internal ones and transmits the results back, and managers responsible for the delivery of enqueries and results between platforms in the network.

The middleware ideology is to develop application software without using particular operating system services by means of middleware services.

"Virtualization" is the newest concept of platforms integration, as it greatly simplifies the use of different platforms and, accordingly, the use of systems demanding the presence of specific platforms for their functioning.

An information system works with data and is composed of a database consists of a database and a database management system. Integration at the data level suggests the data sharing from different systems. Often it turns out to be easier than the applications integration, as industrial databases which store data information systems have advanced programmatic access capabilities to stored data from other applications.

Approaches to Data Integration:

- Universal access to data.
- The data warehouse.

The universal data access technology provides uniform access to data of different DBMS through a dedicated driver [8-9].

The concept of data warehousing is to create a corporate data warehouse. A data warehouse is a database that stores the data collected from various information systems databases for further analysis. OLAP technology is used to create a data warehouse. Approaches to the creation and filling of data warehouses are reflected in the ETL paradigm (extraction, transformation, loading) [10-12].

The application level integration is put into practise through the use of ready-made application functions by other applications.

Existing approaches to application integration are:

- Applied Programming Interfaces.
- Messaging.
- Service-Oriented Architecture.
- User interfaces Integration.

Application Programming Interface of a particular system is a "declared" system's functionality which can be used outside. The functional is published as a set of functions or an object model.

Service-oriented architecture (SOA) is a modern and popular paradigm. It is a logical continuation of the Web-services concept which is to publish the functional blocks of an application form permitting other applications to get access to them by the Web. Web-service is a small add-on software application functionality that converts calls obtainable via the Web into the internal application function calls and returns the results back.

Integration at the level of enterprise applications (EAI, Enterprise Application Integration) means the use of shared code, not the internal application data. Programs are divided into components that are integrated via standardized programming interfaces and special communication software. This approach of to these components means to create a universal software kernel, which is used by all applications.

Integration at the level of user interface enables applications interconnection by means of special user interface tools.

The most comprehensive systems integration is the integration at the level of business processes. It provides application integration and data integration. Business Integration is "natural" for companies, since their work is based on business processes rather than applications, databases and platforms.

Corporate systems are complex software solutions. So it is impossible to use a single method for their integration. In order to provide specialized software integration, we suggest an approach structurally based on the individual functional features of the following methods of integration:

- platforms integration (remote procedure call, the use of middleware);
- data integration (the formation of a unified database as a part of enterprise information systems);
- integration of applications (using the API, work with a service-oriented architecture);
- integration at the level of enterprise applications;
- integration at the user interface level (creating cross-platform and inter-system interfaces, interaction of software systems);
- integration of business processes.

It is significant that the joint use of the various methods individual elements is not contrary to the basic requirements for the enterprise software interaction and operation organization. This solution creates a single solutions database for support, maintenance, and planning of the product life cycle, and for ensuring full interoperability between them. Some aspects of integration will ensure the software interaction without user's direct participation which is not typical for any of the original methods. Thus, the use of the composite system integration will allow seamless integration with the formation of a single, integrated database.

Seamless integration is ensuring the interaction of two or more software systems with a "simplification" of the user's influence on the data exchange between systems, due to the formation of a structured shared database; "embedding" translationing devices, conversion and transmission of data into the original software solution while maintaining its integrity and stability; creation and use of inter-module interfaces.

3. Results and discussion

3.1. Structural and functional schemes of the seamless enterprise software systems integration

Throughout the product lifecycle the same information is treated by different life cycle support software systems, but each system operates with data as generated and stored in an electronic database and unique information generated by this process.

Paperless technology strategy is to create a single information space for all participants throughout the product lifecycle with the creation of the EPD (Electronic Product Definition).

Software system in a single information space (SIS) provides:

- joint development of an interactive environment;
- structured electronic product description;
- data protection and access to information about the product;
- change management in an integrated database.

Without the formation of the SIS it is not possible to provide a functional, technological, information and logical compatibility and harmonization of the automated system design and technological complex with other software systems it interactes with. This means that the common principles and general rules for the formation and maintenance of information resources and information and telecommunication systems installed in the SIS should be respected by all actors of information relations, carrying out their activities and exchange of information within the framework of the company's SIS.

The main elements of the SIS are:

- information resources recorded on data carriers;
- organisational structures for the operation and development of the SIS;
- means of information interaction of subjects of information relations in the SIS to ensure regulated access to information resources on the basis of appropriate information technologies, including software, hardware, and legal documents.

The software as a part of corporate solutions is a set of highly specialized software products, what leads to a number of problems, such as their interaction and integration of software from different manufacturers. To resolve these problems, in accordance with the concept of seamless integration based on the structure of the interaction of an integrated information system in accordance with the paperless ideology we formed the scheme of functional interaction with support systems, planning and support of the product life cycle shown in Figure 1. Interaction with solutions support planning and tracking the life cycle involves the use of structural typed datasets, the introduction of the unification of data on the interaction of elements for all kinds of descriptions of Digital Prototyping allows us to develop cross-cutting process which provides a seamless integration with external software.

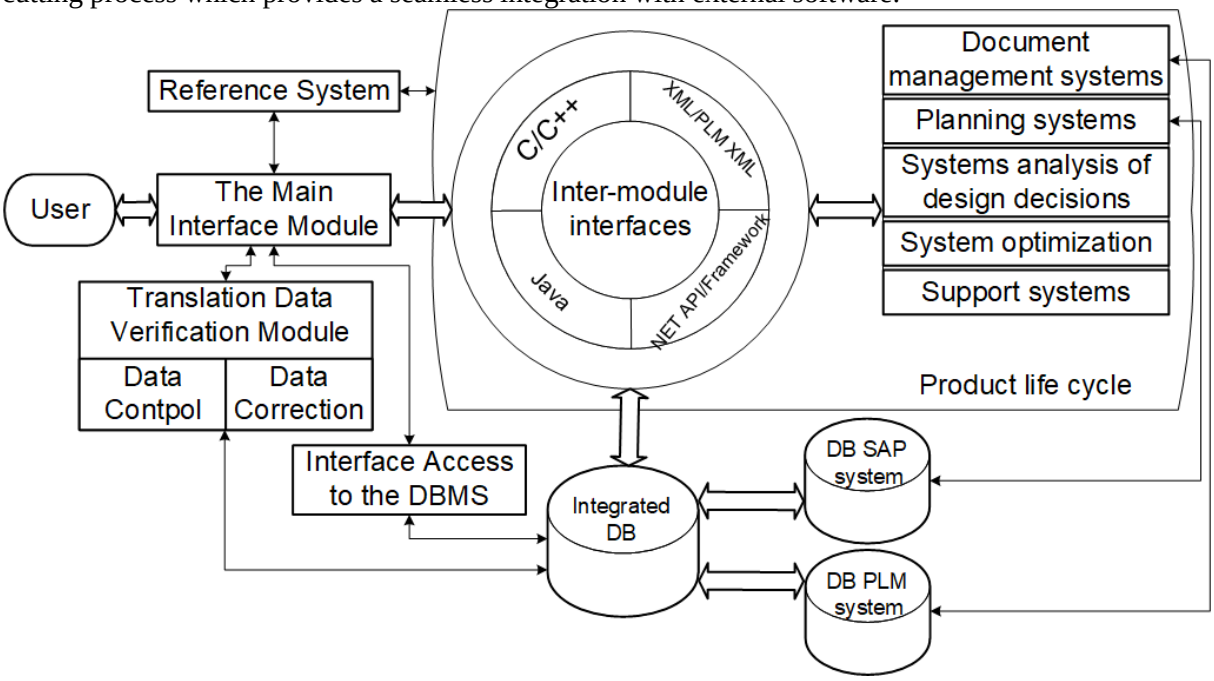

Figure 1. The general scheme of interoperability with the systems of planning, maintenance and life cycle support.

The Feature of seamless integration software solution is the organization of interaction with support creation, maintenance and life cycle planning with a single information systems integrated database by means of program interfaces inter-module integration (Figure 2).

On the basis of structural and functional scheme of software solutions a model of inter-module interfaces integration based on project data management with external specialized software was synthesized, Figure 3. The advantage of this is the formation of a seamless integration and integration

of used software solutions in a single information space with an integrated data management system project.

The interaction with the database enables us to solve the problem of modules consistency and create a common information data space. The structure of the information system includes an external plug-in program graphics system, external information life cycle supporting environment, built-in reference system, external information design support environment, built-in projects integration environment, built-in information recovery data model that includes modules for interfacing with PLM, PDM, and ERP systems, modules of recovery data models, business model verification and correction modules. The structure and composition of the proposed software is not limited to the following list of modules, and it may be changed depending on the task.

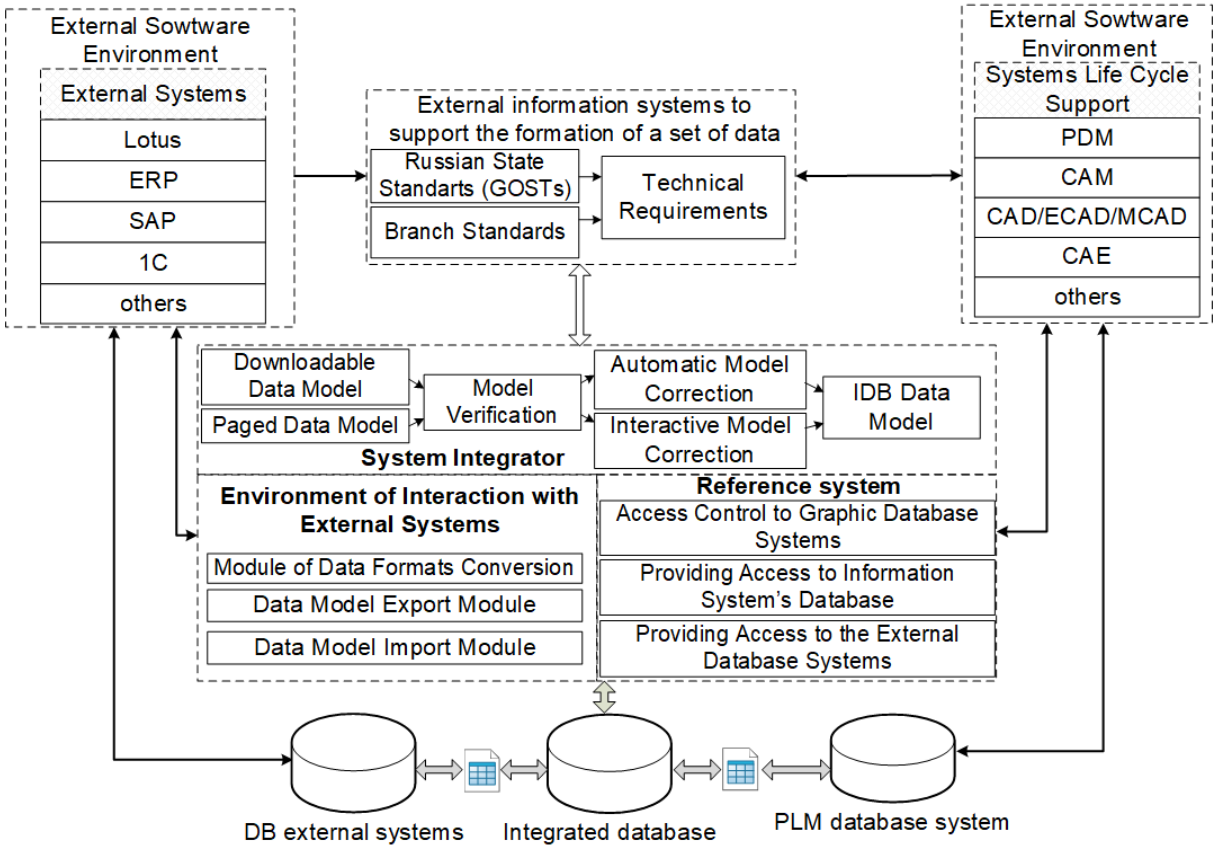

Figure 2. The Block diagram of seamless integration information system with an integrated database.

Thus, the proposed model of inter-module interfaces integration of enterprise software, modular structure of the information system and integrated graphic elements database provide a seamless integration of software systems and a complete solution to a wide range of tasks, taking into account the specificity of the subject area.

3.2. Decisions on system and subsystems structure

As an example, the realization of the automated system of a design and technological complex (AS of DTC) consisting of a set of the firmware modules (FM) is considered.

The AS of DTC has the flexible organization and possibility of adaptation under the changing external factors (such as changes in the organization of business processes, the current legislation, etc.) and provides:

- scalability by number of users and the processed information;

- archival storage of information – according to the legislation of the Russian Federation and the existing nomenclature of the engineering company affairs.

Each FM provides carrying out all necessary types of calculations and has a possibility of adaptation under the changing external factors. The offered subsystems allow capturing full activity of all projecting divisions and technological preparation of production divisions, executing integration of firmware modules into common information space, adjusting electronic document circulation and creating archive of electronic documentation.

The modules, making AS of DTC part are also intended for ensuring seamless input and output data integration. The data exchange module of electronic manufacturing techniques of products (EMTP) and standard reference information are intended for data exchange with external systems.

In PDM system, seamless integration of the input and output data of design and technological documentation preparation modules is provided by a set of the means allowing to make the automated formation of EMTP descriptions on the basis of data from the electronic structure of the product (ESP).

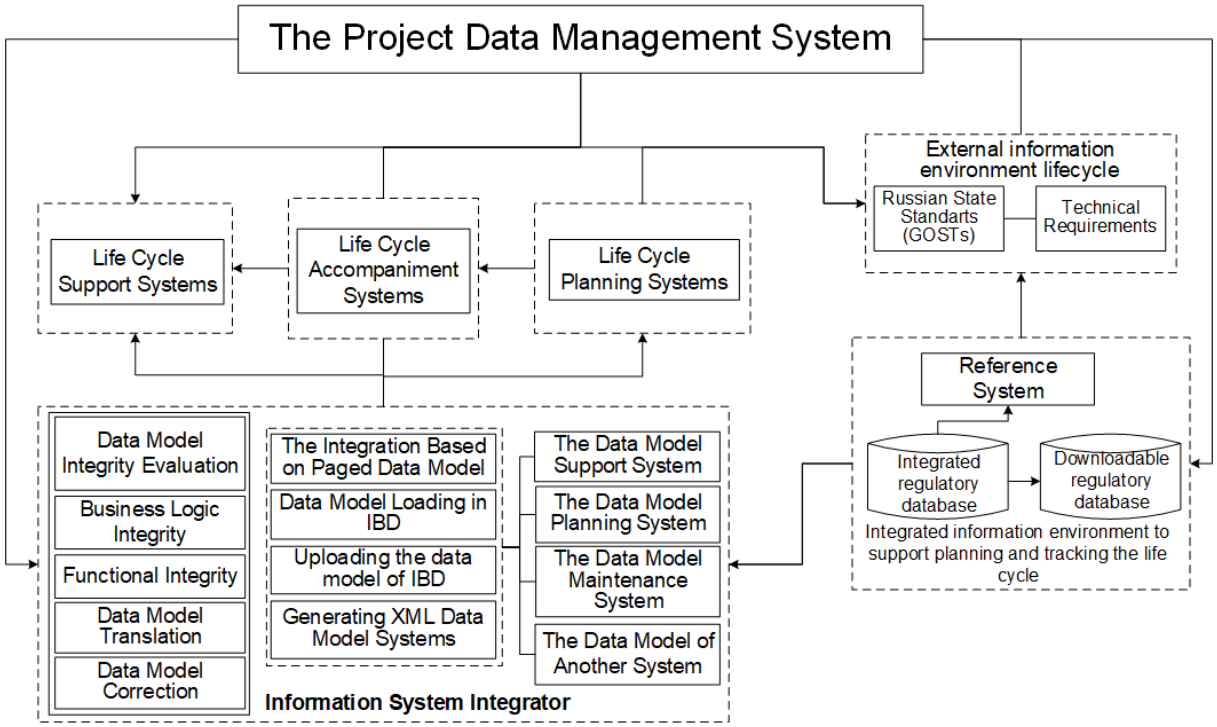

Figure 3. The Model of intermodule interfaces integration based on the project data system management.

All means of information exchange can be divided into two parts:

- means of the internal information flows organization;
- means of interaction with external information systems.

The AS of DTC provides the centralized storage, processing and control of data received from various design systems in the central database realized by means of PDM. For the solution of this task the following functional subsystems are allocated:

- design data formation subsystem;
- subsystem of the automated control and design data updating;
- subsystem of graphic design data translation;
- external information environment of design support;
- life cycle support maintenance subsystem;
- business management subsystem;
- maintenance and support subsystem.

The version of the system's block diagram is shown in Figure 4.

The Basic purpose of FM "EIS" in the AS of DTC structure is creation of a single information space taking into account maintaining electronic structure of the product, the organization of electronic document circulation of all types of the design documents prepared in AS of DTC subsystems and the solution of several tasks on the organization of the top level developed design system management functions.

The main information structure providing creation of SIS is ESP. Formation of ESP can be made in the following modes:

- the automatic mode – formation of the structural description of a product is made automatically, based on a product 3D model with use of the special modules providing the analysis of an object model of a graphic system;
- the automated mode – ESP is created based on specially prepared electronic spreadsheets (specifications) storing structure declaration and composition of a product;
- the manual mode – electronic structure of a product is created manually by ESP controls provided by PDM system.

Storage of all data as a part of ESP provides the integral description of a product used by all SIS components at all stages of life cycle.

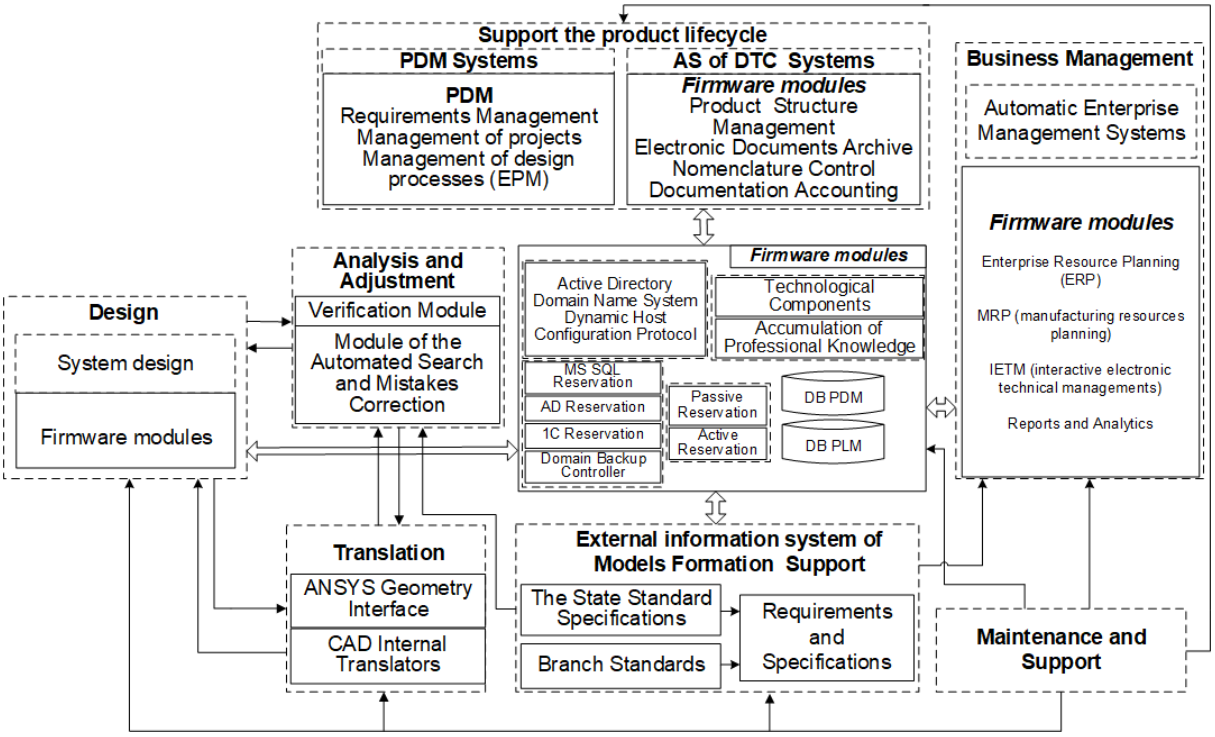

Figure 4. The blok diagram of AS of DTC.

One of the functions of FM "EIS" in AS of DTC structure is giving program and information means for design-engineering preparation of the production.

Today PDM-systems are widely used as an integration tool of the automated design and technological preparation of production systems. Also they are used for the electronic document flow organization, creation of the common information space at the enterprises engaged in design and production of difficult technical products; the organizational and technical systems providing management of all product information.

For firmware modules integration in the AS of DTC structure, for engineering data management solution, management of product information, specifications management, maintaining electronic archive of documentation it is possible to use system "1C:PDM. Engineering Data Management".

3.3. Means and ways of interaction for information exchange between system components

All means of information exchange can be divided into two parts:

- means of the internal data streams organization;
- means of interaction with external information system.

Taking into account the requirements and procedural restrictions, the decision is made:

- AS of DTC should be desighned with formation of a single information space on the basis of local area network (LAN) with newly formed FM usage.
- The expedient type of LAN organization is the multiuser client - server architecture constructed on "multicascade star" topology in the form of an independent information cluster.
- The structure of a cluster has to include client FM, servers, calculators, switching equipment, peripheral equipment.
- It is expedient to arrange cluster compactly.
- It is expedient to license the specialized software used on client AM on client-server architecture.

3.4. The basic methodological provisions

A single information space is the integrated set of the spatially distributed bases and databanks of the systems, technologies of their maintaining and use, information and telecommunication systems and networks functioning on the basis of the uniform principles and common rules, providing information exchange of all participants.

AS of DTC has hierarchical and multilevel structure of information resources.

The 1st level is the database of primary, most detailed, reliable and actual information about objects stored and used at the shop level in the system of integrated management.

The 2nd level includes the databases of the aggregated indicators characterizing condition of the subjects, objects and processes controlled by governing bodies and the enterprise.

The corporate network of data transmission for providing information exchange of AS of DTC with remote sources of information needs to be developed according to the following principles:

- possibility of further integration and use of the existing infrastructure of communication and telecommunication;
- priority investment into such infrastructure elements which will allow to achieve solving problems optimum expenses and in the shortest possible time, also will provide possibility of long operation and networks modernization without their essential reconstruction;
- choice of the specific telecommunications operator in accordance with the established procedure for carrying out management and administrative functions on the organization of users work in the corporate network;
- specific technological decisions and organizational forms of cooperation with the telecommunications operator striving for providing optimum operational costs and expenses.

Functioning of the software and hardware complex of AS of DTC and its interfacing to territorially remote local area networks is realized within a uniform corporate area network of machine-building enterprise.

4. Conclusion

The offered block and function schemes of the specialized software are developed on the basis of the concept of seamless integration with support, planning and life cycle maintenance systems. They are oriented to preservation of functional client-server model integrity.

As the integration platform management system is used for engineering data, providing structured storage of all product data in the electronic structure of the product. This approach makes it possible to construct a complete description of the product that can be effectively used components of the information structure of the enterprise at all stages of the software development life cycle.

The main requirement for support of a seamless integration of enterprise information systems is the organization of the centralized storage, control and uses of the descriptions of production executed using uniform qualifiers and reference manuals.

The software of a seamless integration is realized in the form of a series of the specialized program intermodular interfaces expanding possibilities of PDM system.

The offered means are aimed at providing interaction of planning, maintenance, support systems and problem-solving in the sphere of production life cycle management.

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