Integrated information system of life cycle support of networks and electrical network equipment

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Abstract. Taking into account the concept of seamless integration, this paper presents the structural and functional scheme of information systems’ integration. The proposed scheme is specified for typical life cycle control systems of networks and electrical network equipment in information systems, with the dominant use of domestic software products. In the proposed scheme, the functional features and limitations of the module for controlling and correcting drawings, as well as the module for digitizing archive documentation, are clarified to form a unified system for digital prototyping of products in the context of a continuous lifecycle. We present the developed structure of the integrated information system for lifecycle support of networks and electrical network equipment. An integrated information system for lifecycle support implies the implementation of software in the form of a series of specialized platform-independent software intermodular interfaces, which allows for quick configuration of the system for the existing industry and enterprise specifics.

1. Introduction
The analysis of the existing practice of implementing digital network design systems reveals the systemic presence of a number of problems, characteristic for domestic design enterprises as a whole. This is due to the fact that the creation of the park of software products, used to automate the design process, was carried out at the time when the maintenance of systemic design data integration was technically impossible and not expected. In the course of design, the automation means from various manufacturers were applied (primarily, those of foreign origin) [1, 2]. In this connection, the existing and newly created project documentation is not strictly standardized, being presented in various, often non-integrable formats. The contemporary approach assumes providing the information support of the designed product at all lifecycle stages.

Nowadays, the Russian software market witnesses the generation of domestic software products, meeting all present-day requirements and providing the preparation of project documentation in strict conformity with industry standards. These factors demonstrate the necessity of creating integrated information systems of lifecycle support of networks and electric network equipment, focused on priority use of domestic software products.
2. Materials and methods

2.1. The research objective

The development of informational, methodological and software means of providing highly effective interaction within a set of domestic software products, included in the IISLCS of networks and electric network equipment, is aimed at achieving the following goals:

- raising the quality of the information structure of design enterprises;
- the integration of the information structure components of an enterprise into a single information space;
- providing the use of a universal data standard in the design of networks and equipment;
- handling electronic catalogues and databases of standard technical solutions;
- providing the centralized storage, processing and management of data, obtained from various elements of the information structure of the enterprise in a single database;
- providing the possibility of the effective use of archive design engineering documentation;
- providing data exchange between all elements of the information structure of the enterprise;
- improving the quality of project documentation by using the means of automatic search and correction of standard errors in project data;
- reducing the time of product manufacture due to providing the possibility of parallel execution of product design stages;
- providing the comprehensive support of the product lifecycle.

2.2. The list of procedures related to the organization of the study

The development of algorithms for data communication between the elements of IISLCS, related to:

- identification of possible areas, related to the organization of the data communication;
- the analysis of formats, methods and means by which data communication is organized;
- organization of the data communication;
- the analysis of applicable CAD systems and formats of graphic files, storing the data, related to the 3D models;
- the comprehensive analysis of methods and means of graphic data exchange in formats used;
- the analysis of archives of graphic project documentation for the purpose of detecting standard errors and graphic data elements, not subject to translation;
- the classification of standard errors and graphic data elements, not subject to translation;
- graphic data translation.

The development of software components and other means of software complex elements’ integration, i.e.:

- translation programs or customization of third-party translators;
- the automated system of graphic data analysis and correction;
- software tools for the interaction of graphic systems with the formation of the integrated database of graphic data;
- software products for the organization of data communication between the elements of the IISLCS.

3. Results and discussion

3.1. The structure of the IISLCS of networks and electrical network equipment

Taking into account the comprehensive analysis, the integrated information system of life cycle support of networks and electric network equipment was formed, with priority use of domestic software products, providing the most effective solution of the following tasks:

- raising the efficiency of the information structure of an enterprise;
- the integration of the information structure components of an enterprise into a single information space;
• providing the use of a universal data standard in the design of networks and equipment;
• handling electronic catalogues and databases of standard technical solutions;
• providing the centralized storage, processing and management of data, related to all elements of
  the electronic structure of the enterprise;
• providing the possibility of the effective use of archive engineering design documentation;
• providing the comprehensive support of the product lifecycle.

The structure of the IISLCS of networks and equipment is presented in figure 1.

![Figure 1. Structure of the IISLCS of networks and equipment.](image)

3.2. The modules for digitizing archive design engineering documentation (DED), the analysis and correction of graphic data

Providing the effective use of the archive DED is one of the essential conditions for creating an effective system of product lifecycle management.

The reasons, hampering the reuse of the archive DED:
• the DED exists in hard copy only, which hinders the search and use of such documents;
• the DED is executed in outdated formats, not used by CAD;
• the DED is presented in the form of orthogonal projections and 3D models are missing.

All reasons, listed above, exclude the possibility of using the archive DED in modern design systems.

The same reason makes it difficult to include such DED as part of present-day corporate e-archives, storing design documents and data in the electronic product structure (EPS).

The problem of archive graphic data digitization may require the solution of the following sub-tasks. Scanning and vectorization of drawings, existing in hard copy only. During the execution of this procedure, the following problems are most likely to occur:
• the bitmap, obtained by scanning, may not meet the requirements for systems for graphic data vectorization. Therefore, the results of scanning, presented in the form of bitmap data, must be subjected to methods of automated quality restoration and correction of corrupted images;

• the execution of a 2D drawing, obtained by the use of vectorization systems, does not comply with the enterprise standards and may prove to be inappropriate for use in the system of spatial model restoration. To solve this problem, it is required to develop the module of complex control and correction of graphic objects, allowing for automatic solution of such tasks as, elimination of open contours, rearrangement of projection types on the drawing field, the set of procedures for model-based formatting of graphic primitives (the correction of text attributes, the creation of a layer list, the layer distribution of primitives, etc.)

The conversion of data storage formats into the one, eligible for use in the module of archive DED digitization.

The importance of the problem of translating graphic formats is, as a rule, determined by the following factors:

- the use of CAD systems of various complexity levels to solve various project tasks;
- the use of various highly specialized CAD systems at certain design stages with the integration of the results at later stages.

The solution of the problem assumes the creation of the graphic data conversion system, making it possible to perform the conversion of all required formats for both 2D and 3D graphic data.

The implementation type of the module of archive DED digitization is presented in figure 2.

![Figure 2. The structure of the archive DED digitization module.](image)

3.3. The problem of reusing archive DED

The enterprises, engaged in project activities for a long time, possess substantial archives of design engineering documentation, the reuse of which seems problematic for the following reasons:

- the DED exists in hard copy only, which hinders the search and use of such documents;
- the DED is executed in outdated formats, not used by CAD;
- the DED is presented in the form of orthogonal projections and 3D models are missing.
All reasons, listed above, exclude the possibility of using the archive DED in modern design systems, focused on the use of 3D models, since these systems do not possess the means for the restoration of 3D models using orthogonal projections.

The same reason makes it difficult to include such DED as part of present-day corporate e-archives, storing design documents and data in the electronic product structure (EPS), formed on the base of the 3D model.

Figure 3 presents a type of a structural diagram of the module for control and correction of drawings.

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 lifecycle maintenance systems. They are oriented to the preservation of functional client-server model integrity. The software is realized in the form of a series of specialized program intermodular interfaces.

The proposed structure of the integrated information system is based on the use of the model of seamless integration of large software complexes in integrated lifecycle support systems, as described in [3-6], which ensures the preservation of functional integrity of the client-server model of software systems. The software is implemented as a series of specialized platform-free software intermodular interfaces.

By creation and implementation of the IISLCS of networks and electrical network equipment, it is planned to achieve the following scientific and technical results:
• the components for IISLCS creation are focused on the application of domestic software products;
• the optimal structure of the IISLCS for solving the problems of automation at an enterprise;
• the application of present-day formats and author’s algorithms of data communication between graphic and non-graphic components of the IISLCS;
• the contemporary methods and algorithms of control and translation of graphic data;
• the use of software solutions for implementing seamless integration and organization of single information space for IISLCS components focused on the specific nature of an industry and an enterprise;
• providing the centralized storage, processing and management of product data, obtained from all elements of the information structure of an enterprise;
• standardization and unification of the DED due to the use of domestic software products;
• providing the possibility of the effective use of archive DED;
• providing the information support of networks and equipment throughout their lifecycle;
• reducing the cost of network and equipment design due to the use of domestic software products.

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