

METHODS OF GENERATING DESIGN SOLUTIONS FOR CAD ELECTRONIC PRODUCTS BASED ON A SINGLE DIGITAL PASSPORT

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Abstract: *In this paper are considered various options for the interaction stages of the life cycle of an electronic product, initiated by the application for the development or supply of products, reclamation act or application for service. At the same time, variations of procedures and product data are formed, which form a digital passport and are used to generate several types of design solutions. It is shown that the content of a digital passport allows you to automate the procedure for obtaining design solutions, for which an appropriate methodology has been developed.*

KEYWORDS: DESIGN SOLUTIONS FOR CAD, DIGITAL PASSPORT, CAD FOR ELECTRONIC PRODUCTS.

Introduction

At present, an industrial enterprise can not be imagined without the implementation and operation of modern automated information systems, such as PDM, ERP, MES and / or EAM. This allows you to create, store and manage data about the electronic product at each stage of its life cycle [1-3]. This creates an information space, called a single digital passport of the product. As a rule, its content is used to solve the following tasks:

- analysis of the remarks recorded in the preparation of production and during the production;
- control of the processing of each individual remark;
- analysis of the causes of failures in the operation of electronic products;
- formation of lists of so-called "unscrupulous" suppliers;
- management of the structure and composition of the electronic product and its modifications;
- management of design and technological representations of data on an electronic product, etc.

These tasks are part of the data management processes that determine the interaction options of the stages of the electronic product life cycle. Each option contains a sequence of steps and processes that characterize the chain of actions to be performed, which is caused by the occurrence of one of the events initiated by the customer - the sending of an application for development or delivery of a product, a complaint with a copy of the product or a service request.

Receipt of an application for product development determines the search for analogues, the result of which is the determination of the list, cost and deadlines for the stages of work. With a positive search result (including obtained by several parameters), two planning tasks are solved. The first is the development of documentation for the original parts of the product, the second is the need to adjust the documentation for borrowed parts of the product [4,5]. This is the reason for planning the development or adjustment of documentation, as well as the stages of preparation for production.

Upon receipt of the application for the supply of products in the same way, it is necessary to adjust the documentation for the product according to the comments identified during the previous production cycle of the product. In accordance with this, the stages of development, preparation of production and production are planned. Further, after the transfer of a copy of the product to the customer, work on it at the enterprise will resume after the sending of the reclamation act. This implies the solution for several problems. The first is to determine the cause of the failure of the product copy. The second is planning the adjustment of design documentation or the entire preparatory stage of production, including production - the manufacture of parts and assembly units, as well as the assembly and testing of the product [5, 6].

Therefore, the occurrence of any of these events means the generation of actions that constitute data management processes. They are characterized by lists of processed data on an electronic product, and the sequence of execution is determined by the work schedules and steps specified in the contract with the customer. In other words, the data, along with the event that occurred, constitute the initial requirements, in accordance with which the lists of actions and processes are formed, which are design decisions [7].

Since a single digital passport contains information about the processes of managing data about an electronic product at all stages of the life cycle, it is possible to pose the problem of automating the generation of design solutions based on initial requirements. This paper is devoted to the creation of methods for its solution.

Formation of the content of a single digital passport

The practice of building an information space of data shows that each enterprise creates its own digital environment, using as a basis the experience of similar enterprises. This means doing the following:

- definition of the stages of the life cycle of an electronic product, which implements the activities of the enterprise;
 - formation of sequences of data management processes for each stage of the life cycle;
 - identification of options for automating the actions that make up each process using different types of systems;
 - implementation of the process automation option in accordance with the functionality of the implemented systems and system requirements imposed on the enterprise.
- The life cycle of an electronic product is formed by a set of stages (Figure 1), for each of which the corresponding lists of processes for managing product data are defined, and for each process - a list of its constituent actions. This allows you to describe the procedures for the interaction of units, on the basis of which to identify processes that require automation, taking into account the experience of similar enterprises.

The result is the creation of descriptions, for example, in the form of diagrams in IDEF0 notation, which takes into account only the type of systems used - PDM, MES, ERP and / or EAM - and their functionality. Specifying the names of the systems is not required, since they differ from each other due to the implementation of the interface. Consequently, the variety of software solutions allows enterprises to independently choose their best option and work out the integration mechanisms [8].

In other words, a single information space is created about the product at all stages of the life cycle, which allows it to be used in making design decisions.

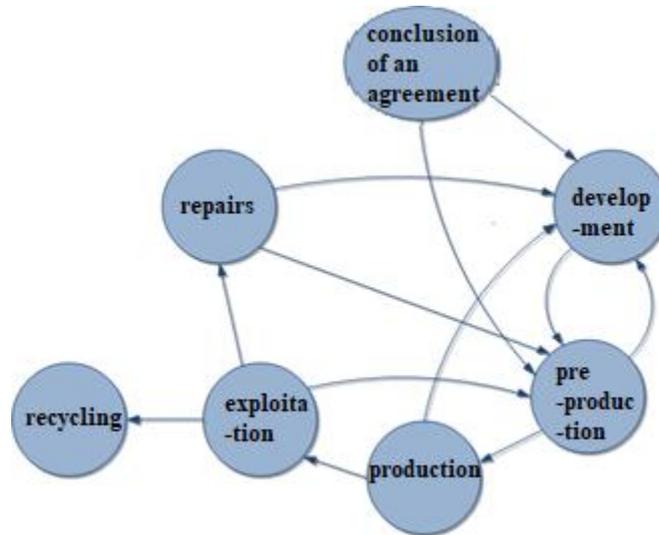


Figure 1 - The interaction of the stages of the life cycle of an electronic product

Variants of CAD design solutions

An analysis of the organization of the activities of enterprises shows that the adoption of a project decision is due to the receipt of the application from the customer. This involves determining the set of procedures performed in a given sequence, and product data generated at different stages of the life cycle.

So, if the company received an application for the development or delivery of products, then the following sequence of procedures and lists of product data can be generated:

1. A list of available data on products developed by the enterprise is being formed. In case of receipt of an application for development, the products being developed are analogous with respect to that indicated in the application, and in the event of receipt of an application for supply, data on the product indicated in the application.
2. The procedures of the contract conclusion stage are formed and launched.
3. Forms a list of data about the product, from among those found in accordance with claim 1, requiring adjustment according to the comments. In the absence of unprocessed comments list will be empty.
4. The procedures of the development stage are formed and launched, and lists of data on purchased components are generated. In case of receipt of an application for development, the stage consists in creating constructive data on a new product, and in the case of receipt of an application for supplying products, in adjusting previously released data on comments. In the absence of unworked comments, the stage in question is skipped.
5. The procedures of the preproduction stage are formed and launched.
6. The procedures of the production stage are launched in accordance with the content of the technological process maps.

When the claim act is transferred to the enterprise, the sequence of procedures and lists of data are generated depending on the results of the investigation of the failures that occurred. The following options are possible:

1. The procedures of the development stage are formed and launched, taking into account some factors:
 - if the reason for the refusal is a poor-quality supply of components, then the stage may consist in the creation and filing into the archive of the list of substitutes for replacing the purchased component parts;
 - if the cause of failure is an error during development, the stage involves the correction of previously released design data about the product.
2. The procedures for the pre-production stage are formed and launched, taking into account the following factors:

- if the cause of failure is poor quality supply of components, the stage implements the procurement activity;

- if the cause of failure is a production error, then the stage involves the adjustment of the technological data on the product (for example, based on the results of the adjustment of the design data or the presence of unworked comments on the technological documentation).

3. The procedures of the production stage are formed and launched in accordance with the content of the technological process maps.

In case when a service request is received by an enterprise, the generated design solutions are a generalization of the options considered, since it combines the procedures for entering into a contract, preparation for production and production; the possibility of adjustments to structural and / or technological data about the product; as well as the formation of lists of data on various products [7].

It should be noted that the information required for the formation of the listed sequences of procedures and types of product data is stored in a digital passport. This makes it possible to use it to develop a methodology for generating design solutions.

Methods of generating design decisions based on a digital passport

The results of the analysis of the company's activities form two groups of requirements for the use of a single digital passport for generating design solutions. First group

Request_System = $(RS_1 \dots RS_s)$ contains generalized invariant requirements for the formation of a single digital passport at a particular enterprise:

- stages of the life cycle of products in which the company operates;
- functional properties of control systems;
- data requirements for an electronic product in a single digital passport.

Second group

Request_Process = $(RP_1 \dots RP_r)$ contains generalized variant parameters of the current stage of the life cycle of an electronic product:

- product specifications required by the customer;
- characteristics of the states of the product development process;
- characteristics of the state of the preparation process of the product;
- characteristics of the states of the product manufacturing process;

- characteristics of products operated by the customer.

Taking into account the above, it is logical to say that the listed groups of parameters initiate interaction between different stages of the life cycle of an electronic product, similar to the interaction initiated by an application for the development or supply of products, a reclamation act or an application for service. This allows you to use the components of a digital passport to generate one of the following variants of CAD design solutions:

1. The sequence of processes for presenting data about an electronic product at various stages of its life cycle.

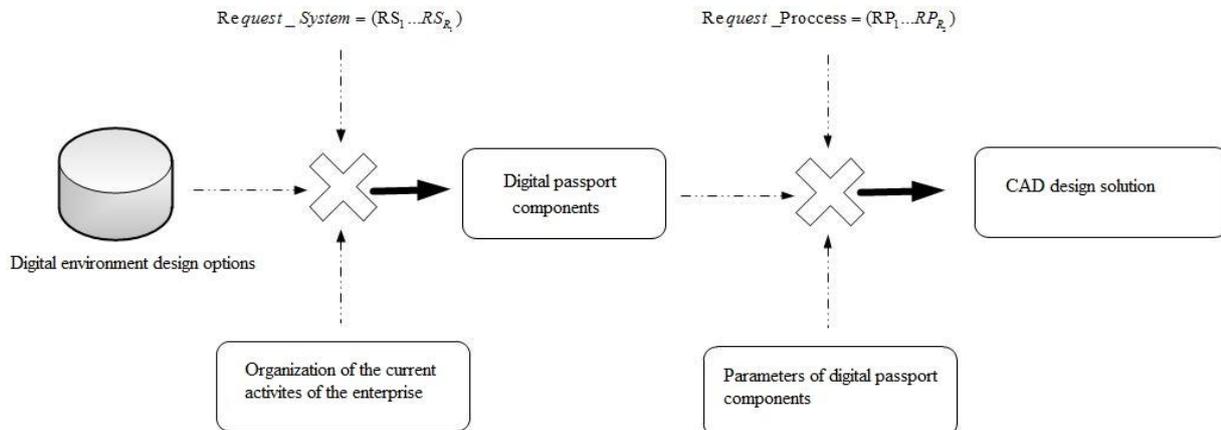


Figure 2 - Generation of design solutions for CAD electronic products based on a single digital passport

Conclusion

Thus, the design solution of CAD is a sequence of components of a single digital passport, describing the real object of production at a certain stage of its life cycle. Each component is characterized by a list of parameters selected in accordance with the requirements *Request_System* и *Request_Process*.

The obtained results were used to develop a methodology and algorithm for CAD electronic products based on a single digital passport.

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2. Lists and structures of electronic products and their components.

3. Sequences of manufacturing operations for the manufacture of an electronic product and its components.

4. Sequences of the data processing process on the electronic product at the stages of development and production preparation.

According to Figure 2, the idea of generating a design solution for CAD is to form one of these options in accordance with the list of parameters of the current state of the electronic product *Request_Process*.

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