

## **Development of Decision-Making Support Systems to Design Chemical Process Equipment for Batch Production**

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### **Abstract**

It is impossible to create new and modernize the existing batch process production without the development of modern process equipment based on innovative technological processes. In this case, the decision-making system is a multi-level hierarchical system of interconnected local processes, which should be provided with information of various kinds, storing and processing the results of solving local problems, forming project documentation necessary for the manufacture of process equipment with minimal human participation, etc.

To perform such functions, a decision support system (DSS) should be created, which accelerates decision-making processes, eliminates errors in the transfer of information between local design decision-making tasks, formalizes knowledge of the subject area, processes and stores them, reduces the number of design and technological enterprise services. The existing DSSs used in the development of process equipment have fundamental shortcomings, the main of which is the lack of decision-making capability using the knowledge of the subject area, which in practice is compensated by an increase in the number of design departments of enterprises. The scientific problem of creating a DSS is to develop a methodology based on information models of objects, assumptions, a large number of restrictions, principles, methods, algorithms, modern forms of information representation and processing, the application of which will increase the efficiency of the development process of devices (reducing development time, increasing productivity developer labor and reducing their number).

### **Keywords**

Chemical batch production; system analysis; decomposition; process equipment; design; decision support.

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### **Introduction**

In compliance with the development strategy of the chemical and petrochemical industry in Russia for the period up to 2030, the Russian Federation provides for the modernization of the existing chemical plants and construction of new ones.

Chemical batch processes (CBPs), such as the production of varnishes, paints, various additives, etc., are widely used in the chemical industry. They largely determine the quality of products from other industries: textile, automotive, rubber, radio-engineering, etc.

The creation of new CBPs and modernization of the existing ones is impossible without the development of effective process equipment, consisting, as a rule, of a large number of elements. The process equipment passes through the following stages (product life cycle):

marketing research, research and development, development of technical specifications, development of design and technological documentation, production preparation, manufacturing, supply, operation, repair, disposal.

The process equipment costs as well as its quality, competitive ability, compliance with modern requirements are largely determined by the following stages – R&D and design. Preparation for manufacturing and manufacturing itself, of course, affect the quality and cost of process equipment, but research and development are still primary, since all the main parameters of process equipment are laid down at these stages. About 80 % of the process equipment costs is formed at the stage of its design.

The result of the process equipment design stage is the development of technical documentation required

for its manufacture, transportation, installation, operation and repair.

In modern conditions of digitalization of economy, the development of process equipment should be carried out with the use of information technology, including the DSS at all stages of development, up to formation of technical documentation.

The structure of automated systems, including the DSS, is determined by the tasks to support the decisions for which it is intended. However, it should always contain elements that provide input, storage and processing of information in the subject area. Thus, the construction of the DSS is based on the integration of domain knowledge and information technology knowledge.

In this regard, below is an overview of the current state of the development of decision support systems for the automated design of process equipment for chemical batch production.

### **Computer-aided design of chemical batch production**

The technical documentation of modern chemical production is the result of the combined intellectual creative efforts of a number of research, design and construction organizations and associations.

The complexity and variety of tasks arising in the development of chemical production resulted in several stages of this process [1].

The existing practice of developing chemical production processes widely uses the principle of decomposition to solve complex problems, on the basis of which separate subtasks are allocated, the solution of which is entrusted to specialized departments, such as process, design, construction, ventilation, etc.

The global long-term experience makes it possible to determine the following main tasks for the development of chemical batch production:

- marketing research;
- selection of the construction site of the designed object;
- development of production technology;
- selection of main and auxiliary equipment;
- placement of equipment in industrial premises and pipeline routing;
- architectural and construction solutions;
- energy supply;
- environmental protection and industrial sanitation;
- civil defense and emergency prevention;
- development of a master plan and transport system;

- development of production management systems and production processes;

- development of budget documentation.

The above-mentioned problems are solved sequentially or in parallel, and are interconnected by the following information flows:

- information obtained as a result of solving one problem is the source data for solving another;

- feedbacks, i.e. when the information received in solving subsequent problems is transmitted to previous problems in order to correct their solution.

Methods for the development of chemical production processes, methods and algorithms for optimizing their work were considered in scientific publications by V.V. Kafarov, L.S. Gordeev, V.V. Makarov, A.F. Egorov, E.N. Malygin, S.V. Karpushkin, S.I. Dvoretzky, V.P. Meshalkin, I.E. Grossman, G.V. Rekleytis, etc.

Chemical batch production processes are characterized by:

- the use of various types of technological processes (various reaction processes, drying, filtration, rectification, etc.) and, accordingly, various types of equipment for carrying out these processes;

- the use of various modes of equipment operation (periodic, continuous, quasi-continuous);

- the need to introduce additional operations;

- the possibility of different physical and chemical characteristics of products processed on the same equipment;

- the insufficient knowledge of the processes occurring in the equipment, the lack of information about their kinetics, about the thermo-physical characteristics of substances and, as a result, decision-making based on previous experience;

- a large proportion of standard equipment used.

The theory, methods and algorithms of automated design of CBPs are currently being developed in the following main directions:

- 1) design and calculation of individual units of process equipment and its components [2];

- 2) hardware design of chemical process systems, the search for the optimal size and number of the main and auxiliary equipment at the stage of development or modernization [3];

- 3) the search for the optimal process modes of chemical process equipment operation [4];

- 4) the layout of the process equipment and the routing of pipelines in various types of industrial premises, including hangar-type rooms [5];

- 5) scheduling CBPs at the stages of development and operation [6];

6) development of computer-aided control systems for the planning of production and sales of finished products [7];

7) development of the systems for computer-aided monthly and annual scheduling for repairs of main and auxiliary equipment on the basis of plans for the production of finished products and the technology of their manufacture [7];

8) development of control systems for machine-building companies [8];

9) virtual simulation of chemical process systems [9];

10) development of the methodology of continuous engineering education using the technology of remote access to laboratory equipment [10];

11) the creation of information and educational system for students' training and staff professional development [10].

In all these areas, researchers focus on the process of developing a facility (directions 1 – 4) or the process of facility management (directions 5 – 9) or the process of training and raising the qualifications of service personnel (directions 10 – 11) and almost do not touch upon issues related to the creation of tools for solving these problems, including the information support.

In the studies aimed at the computer-aided development of process equipment, the authors focus on the search for optimal design and operational parameters of the process equipment, through the development of mathematical models of the processes occurring in the working area of the equipment. At the same time there are several most significant parameters of the equipment, which largely determine its effectiveness, but which are clearly not enough to create a complete set of technical documentation intended for the manufacture of the process equipment. It should also be borne in mind that the authors use for the problems of finding the optimal parameters of CBPs as a criterion of optimization, the reduced costs that can be calculated only after the development of the full technical documentation of CBPs. Only in this case can we reasonably talk about the calculation of the cost of creating and operating the CBPs. Otherwise, these costs can only be determined indirectly. Under these conditions, we can talk about getting a “good solution”, but not optimal.

Thus, the results obtained in the abovementioned studies represent the knowledge and methods of the subject area and are the basis for building a system of information support for decision-making.

Creating a system of information support for decision-making in the development of process

equipment, in turn, is a separate task that has to be solved, and which in the studies described above has not been considered.

### **Problems of synthesis of process systems**

Any technical facility is a system consisting of elements and relations between elements. Elements and relations have certain parameters (attributes).

Formally, the development of process equipment consists of:

- determining the structure of process equipment, i.e. what elements the equipment consists of and what are the relations between the elements (structural synthesis);

- determining the values of the parameters of elements (parametric synthesis).

In this case, it is possible to obtain many alternative options. The choice of a single option is carried out using some estimates (criteria) and selection models.

Below is an overview of the problems of synthesis (development) of process systems.

There are various classifications of the problems of synthesis. The stages, levels, steps in the synthesis process, the types of solutions obtained, the complexity of the problems being solved, the methods of solution, etc. can be selected as a classification criterion.

The result of solving the problem of structural synthesis is the description of the composition of process equipment and the relations between its elements. Depending on the type of solution obtained, this description may include a simple list of elements and relations between them, an incidence matrix, a table of connections, a block diagram, a link graph, a sketch, a layout drawing, a block diagram, etc.

The problem of parametric synthesis is to find, the values of the parameters of the elements that provide the conditions for operability for a given structure of process equipment.

Uncertainty is always typical in complex systems. In [11] there were three types of uncertainties arising in the simulation of complex process systems:

- structural incompleteness of the target model formulation;

- uncertainties characterizing the conformity of the model structures of the target model;

- uncertainties characterizing communication models and the degree of compatibility of subsystems.

Under these conditions, the problem of optimal parametric synthesis of process systems is to determine the nominal values of the system parameters that ensure

the maximum likelihood of the performance of the system during a given period of time [12].

The state and problems of the structural synthesis of process facilities are presented in I. P. Norenkov's papers [13]. Design solutions can be associated with the definition of forms and the location of the components of a developed process facility in space or its location in space and time. Accordingly, in [13] classes of problems of making spatial and space-time decisions were distinguished.

Structural synthesis as a discrete optimization problem is presented in [14]. In [15], the existing methods of synthesis of the physical principle of operation of process systems were analyzed to solve the problems of developing technical facilities at the conceptual level. In [13], approaches to solving problems of structural synthesis were described; these can be divided into two groups:

- discrete optimization methods;
- intellectual methods.

In [14], the existing methods of structural analysis and synthesis of systems were considered and their following disadvantages were noted:

- the negligence of complex data structures;
- the absence of any means of systematizing the implementation of typical operations in the functioning algorithms of complexes and systems;
- the lack of methods for the formal generation of variants of the system structure;
- the absence of a formal definition of the minimum indivisible parts of the designed system, into which the system can be decomposed.

Based on the above, it can be concluded that a large number of publications discussed the issues of synthesis of process systems, while no publications were found that address the synthesis of process systems and the creation of a system of information support for decision-making from a unified perspective. Meanwhile, informational support is a tool for solving problems of process equipment synthesis, and not only the completeness and correctness of the solution obtained, but also the material costs and time required for obtaining a solution largely depend on it.

### **Methodologies for the development of computer-aided systems**

As mentioned above, information support for decision-making in the development of process equipment is based on the integration of knowledge and methods of the subject area with the knowledge and methods of information technology. The state of automation of the subject area was discussed in

previous subsections. The following are methods and trends for development of computer-aided decision support systems.

Decision Support System (DSS) is a computer-aided information system (CAIS), which is designed to help the decision maker in their professional work.

Currently, there are no clear definitions and features by which the CAIS can be classified as DSS. Many different classifications of DSS have been proposed. So, there are classifications of DSS based on the methods used for searching and processing information, for example, searching databases and knowledge bases [15] or using genetic algorithms and neural networks [16]. The authors [17] propose an integrated classification of DSS on numerous grounds, which should further help to build a block construction of DSS.

By architecture the DSS can be divided into local and distributed. In local DSS, all their components are located on the user's computer. The components of distributed DSS are physically located on different computers. In the latter case, DSS is divided into file-server architecture and client-server architecture. The principal difference between the client-server architecture and the file-server architecture is that client applications send a request to the server and receive a response to this request, i.e. they do not participate in the execution of the request.

If the DSS has a knowledge base, then it is called an intellectual or expert system [18].

The considered classifications of DSS are mainly of interest to developers. From the user's perspective, the classification of DSS by the subject area for which it is intended is of primary interest. The literature analysis showed that the development of DSS is applicable in various areas of human activity: military science [19], medicine [20], technological systems, including for chemical enterprises [21].

The problem is that although there is a problem-independent component of the DSS, the main difficulty lies in developing the problem-oriented component of the DSS, since not only the content of the DSS, but also its structure depends on the technical problems to be solved. The DSS used in the development of chemical reactors differ from the DSS, which are used, for example, in medicine.

However, since the DSS is one of the types of automated systems, all CAIS development methodologies apply to them. Regardless of the substantive focus of the DSS, there are several methodologies for their creation, the main ones of which are listed below.

### *Methods and technologies for the development of computer-aided information systems*

Information systems have certain stages of the life cycle. The second of which, after the technical design specification, is design itself.

Currently, the main methodologies for drafting the CAIS project are IDEF, UML and ARIS, the latter being used more for modeling the structure of companies than for developing CAIS projects.

IDEF is family of notations, the standard of the US DoD recommended by the Government of the Russian Federation for the use in public institutions (not object-oriented).

UML (Unified Modeling Language) is the industry standard OMG (Object Manager Group).

ARIS (Architecture of Integrated Information System) is a methodology and notation for professional modeling of business processes (modeling of organizational structures of a company).

IDEF is a cathedral set of functional, informational, and behavioral modeling techniques. These techniques are recommended for the initial stages of designing complex AIS management, manufacturing, business, including people, equipment, and software.

The unified modeling language (UML) is designed to visually represent the results of object-oriented analysis and design of information systems. It is a set of diagrams, the main of which are the following: object diagram; sequence diagram; state diagram; precedent chart; class diagram; interaction diagram; activity diagram.

These methodologies are a means of displaying (visualizing) the structure, information flows, links of CAIS modules, and not the means of its development.

In contrast to the methodologies described above, [22] presented a methodology for the automation of intellectual work, the essence of which is to obtain a sequence of mappings of the objective problem in the form of formalized models (info-logical and data-logical) based on the originally formulated conceptual model.

At the turn of the 21st century, a multi-agent methodology for developing information systems emerged; it was based on object-oriented methods [23], traditional methods of knowledge engineering [24], or a combination of different methods [25].

The regulatory framework of the CAIS is a series of standards; the main ones are listed below.

The standards of the GOST R 10303 series apply to the machine-oriented representation of product data and the exchange of this data. The purpose of the

development of these standards is to create a mechanism for describing product data throughout its life cycle, regardless of the automated system used. The product description is suitable not only for exchanging invariant files, but also for creating product databases, sharing these databases and archiving relevant data.

To define the information requirements of the standards of the GOST R ISO 10303 series, the EXPRESS language has been developed; it is the formal data definition language. EXPRESS provides a standard description mechanism for product data, both in integrated resources and application protocols. In the EXPRESS language, objects are defined through their attributes or characteristics, which are important for understanding and using systems.

ISO 13584 Parts Library (**PLIB**) is a series of international standards intended for computer representation and exchange of component library data. The purpose of the standard is to provide such a data transfer mechanism of the library of components that would be independent of any application software system using the library. Data presentation allows you to exchange files containing data about components, as well as use them as a database containing component libraries.

In PLIB, a language similar to EXPRESS and the same implementation methods as in STEP are used (Physical File is an exchange file, SDAI is a standard interface for accessing data defined by means of STEP). The difference between PLIB and STEP is that STEP allows you to simulate one product, and with the help of PLIB you can model families of similar products.

GOST 2.052–2006 “Unified system for design documentation. Electronic model of the product” establishes the general requirements for the implementation of electronic models of products (parts, assembly units) of mechanical engineering and instrument making. The basis of the electronic model of the product is a geometric 3D-model of the product, which is supplemented by the attributes of individual elements and process requirements.

The interaction of standards ensuring the interaction of all industrial automated systems is presented in sufficient detail in the BIGOR training system developed at the Department of CAD at Bauman Moscow State Technical University [26].

The value of the electronic model of the product and the way it is described increases in the era of digital production. This model is the basis for creating a single information space of a machine-building enterprise. At the same time, the role of ISO 25000 standards,

which are intended to describe the quality of software products, and GOST R ISO/IEC 20000 "Information technology. Service Management" is increasing.

These standards impose certain requirements on the presentation of information for transferring it from one system to another, assessing the quality of software products and IT services. The main goal of the described standards is to unify the formats of the electronic model of products and information flows at different stages of the product life cycle.

Based on the above, we can draw the following conclusions:

- the existing methodologies, (IDEF, UML, ARIS), are not a CAIS development tool, but are means of documenting (displaying) the structure, information flows and links of information system modules;
- the methodology for the automation of intellectual work does not address issues related to information support for decision-making in the development of process equipment;
- the container technology, the multi-agent technology and others consider the creation of CAIS only from the standpoint of ways of presenting information objects, without at all affecting the subject area for which the CAIS is developed;
- the existing regulatory documents (standards) governing the development of CAIS are a means of describing the finished product or its state at a certain stage of development, and not a means of decision support.

### *Artificial intelligence systems*

Over the last decade, information technologies have been focused on human intellectual activity. The result of this is expert systems and ontologies that accumulate the knowledge of specialists in various subject areas (medicine, design of technical objects, management, equipment diagnostics, etc.).

Intellectualization of information systems requires the development of:

- approaches to the description of the knowledge of specialists;
- ways of presenting and processing this knowledge in information systems;
- ways of interaction of an information system with a person as well as with other information systems, etc.

Below are the main trends in the development of systems with elements of artificial intelligence.

There are many definitions of artificial intelligence. The following is proposed as a working definition in [27]. Artificial intelligence is one of the

areas of computer science, the purpose of which is to develop hardware and software tools that allow the user to a non-programmer to set and solve their problems, which are traditionally considered intellectual, by communicating with a computer on a limited subset of natural language.

Creating software for intellectual systems is associated with the development of knowledge acquisition methods and knowledge representation models, the creation of knowledge bases and the development of methods for their processing.

There are two main groups of automated knowledge acquisition. This is the acquisition of knowledge from experts using a variety of proven technologies and methodologies [27] and the extraction of knowledge without the participation of experts from existing knowledge, from texts and data arrays (Data Mining, Knowledge Discovery in Databases).

Data Mining allows you to gain new knowledge by processing the available information. This information can be unstructured and stored in natural language texts, or structured and stored in databases. The presence of unstructured information reduces the possibility of automatic or semi-automatic processing of knowledge.

For example, in [28], an algorithm and software were described for solving the problem of synthesizing technological solutions and documenting them based on the extraction of engineering knowledge from an electronic archive of technical documentation. In [29], the following knowledge management tasks are extracted from text documents: classification and clustering of documents; document annotation; information retrieval; ordering documents; decision support. The author of [30] proposes to add to the described tasks the development of tools for the automatic processing of natural language texts and the development of products for the Semantic Web.

The main models of knowledge representation are the production model; logical model; frame model; semantic network model.

Recently, an information portal has become one of the most popular tools in various areas of human activity. In [31] a concept of choosing essential attributes and links of portal documents based on their semantics was proposed, in [32] an approach to automating the collection of ontological information about Internet resources relevant to the subject area of the scientific knowledge portal was proposed.

Descriptive logics are becoming popular for presenting and processing knowledge [33]. The basic concepts of descriptive logics are concept and role. The concept is used to describe entities, objects,

classes, etc. the roles describe the relationship between objects.

With the help of descriptive logics, object-oriented models [34] (object-oriented databases) and Codd algebras [35] (relational databases) are built.

It should be noted that work is also underway to create hybrid systems that combine different knowledge models [36].

At present, the CAIS based on ontology is being actively developed to solve various problems, including problems of structural and parametric synthesis of technical objects.

The term “ontology” first appeared in the 18th century and designated the science of being, i.e. a section of philosophy devoted to the problems of the world order. In the 20th century, it was also used in artificial intelligence, where by ontology is meant a system of concepts (concepts, entities, classes), relations between them, and rules of operations on them in a certain subject area [37].

The emergence of the need to develop ontologies is explained by the following reasons [38]:

- understanding of the structure of information by people or automated systems;
- the multiple use of knowledge in the subject area;
- the identification of assumptions in the subject area;
- the delineation of operational knowledge and knowledge of the subject area;
- the analysis of knowledge of the subject area.

There are many signs by which ontologies can be classified. So, depending on the specific problem being solved and the subject area, one can distinguish [38]:

- common (generic) ontologies that describe such fundamental aspects of conceptualization as “part”, “cause”, “participation”, “presentation”;
- intermediate ontologies containing concepts and relations characteristic of a specific subject area. In the ideal case, they are used as an interface between domain ontologies and general ontologies, but they can also act as top-level ontologies for describing knowledge of a specific subject domain;
- top-level ontologies that describe very general concepts, such as “space”, “time”, “matter”, “object”, “event”, “action”, etc., which are independent of a specific subject area;
- domain-oriented ontologies;
- problem-oriented ontologies;
- applied ontologies.

Domain-oriented ontologies and problem-oriented ontologies describe the vocabulary related to a specific subject domain or a specific problem, respectively, due

to the specialization of terms introduced in the top-level ontology.

Applied ontologies describe the concepts that depend both on a specific subject domain and on the problems that are often specializations of ontologies focused on the subject domain, and ontologies focused on a specific problem.

Ontologies based on soft computing are considered in [39], the authors of [40] proposed an extension of the existing semantic WEB to combat uncertainty.

The main problems solved with the help of ontology include [41]:

- creation, use and maintenance of knowledge bases;
- effective information search in databases, information catalogs, knowledge bases;
- creation of systems based on reasoning (expert systems, control systems, intelligent robots, etc.);
- semantic search by textual information, including the Internet;
- creation of thematic servers with ontological support for the systematization of the submitted materials;
- building common knowledge bases for various intellectual systems;
- providing common terminology for a variety of specialists and shared applications;
- multiple use of databases and knowledge bases containing information on technical objects at various stages of their life cycle.

For ontology recording, special ontology languages are used (for example, Ontolingua, CycL); languages based on frames (Flogic, OKBC, OCML), languages based on descriptive logic (LOOM). For the exchange of ontologies via the Web, the following languages were specially created: RDF, DAML, OIL, and OWL.

Ontological knowledge bases designed to support decision-making in corporate information systems were considered in [42]. Decision support is based on the metadata of documents stored in the corporate information system. The compliance of a document with a query was determined by the proximity, assessed by some metric of the document and the query.

In [43], problems of managing complex production objects were considered and an approach to the development of a decision support system for these objects based on ontological knowledge bases was presented. The article also presented the principles and technologies for modeling the information-controlling production environment, on the basis of which the construction of decision support systems was proposed.

The use of an ontological approach to support decision-making in the development of process systems was considered in [44]. The authors proposed to search for the necessary documents using design patterns that were successfully used in software design [45]. The basis of the design pattern proposed in [44] is a phrase (a complex concept) denoting a problem that consists of simple concepts. For example, the authors proposed six types of patterns, among which are: action – object, action – property – object, means – action – object or means – action – property – object. The last pattern is formed by the combination of the concept “remedy” with the two previous patterns. The ability to produce combinations of patterns opens up absolutely unlimited prospects, although the process of creating patterns remains unformalized [44].

The literary review shows that a lot of research has been carried out to develop object-independent component systems with artificial intelligence. The description of ontologies, expert systems in a specific application area is much less. So, for the informal presentation of ontology models at IAPU of the Far Eastern Branch of the Russian Academy of Sciences, a multi-sorted language of applied logic was developed, with the help of which a modular model of the ontology of chemistry was described [46]. The ontology of the choice of electrical equipment, the ontology of the development of drying equipment was presented in [47], presented in [48].

Based on the above, we can conclude that the use of knowledge is a promising direction for the development of AIS, and it should be used for the problems of developing process equipment.

Despite the heightened interest of researchers in using ontologies in the CAIS, no study has been found that would jointly consider the knowledge of process equipment development and the problem of creating a system of information support for decision making.

### Conclusion

The studies related to the development of process equipment aimed at calculating the design and operational parameters of the apparatus, delivering an extremum to some optimization criterion. The number of required parameters in such problems is small, and they are insufficient to develop a complete set of technical documentation necessary for the manufacture of the device. In addition, using the equipment cost and the operating cost as a criterion is not correct for optimization by several parameters, since it is possible to calculate the cost performance indicators of process equipment only when the design is completed. Otherwise, the cost indicators can be determined only

indirectly, for example, by the unit cost per unit volume, which, naturally, is a rather rough approximation.

The solutions obtained in the research into the problems of the CBP development represent the mathematical support of the CAIS, which must be supplemented by information tools and software. The problem of creating a system of information support for decision-making in the development of process equipment requires a separate statement, which should include the requirements for information support in the applied area.

In the studies on the solution of problems of structural and parametric synthesis of process systems, researchers focused on the methods of the synthesis itself and did not address issues related to the storage and processing of information necessary to solve synthesis problems. The decision-making information support system is a tool for developing process equipment, and it largely depends not only on the completeness and accuracy of the technical solution obtained, but also on the material costs and time required for obtaining a decision.

The analysis of existing methodologies for developing information systems has shown that IDEF, UML and the like methodologies are a means of visualizing information system projects, rather than a methodology for their creation. The methodology for the automation of intellectual work is universal, but it does not address issues related to the development, presentation and processing of information models in the CAIS.

The existing regulatory and legal framework for the creation of CAIS related to the development of technical products (systems) is aimed at obtaining a description of a technical product that can be used at different stages of its life cycle. Therefore, we meant an adequate description of the finished technical product or its state at a certain stage of the life cycle, and not about the development of the product.

One of the promising areas of the CAIS development is intellectualization. This also applies to the DDS system during the development of process equipment, which should allow accumulating and processing knowledge of the subject domain.

Creating the DDS system in the development of process equipment is a problem that requires its formulation, taking into account the requirements of the subject area to information support, including the provision of the ability to store and process large amounts of information related to the tasks of process equipment development.



To determine the requirements for the DDS system by the subject domain, it is necessary to carry out a system analysis of the decision-making processes of the hardware design of the CBP based on the results of which a formal statement of the optimization problem of creating a DDS is developed during the development of process equipment, namely, the optimization criteria are defined, variables and restrictions are set, the implementation of which allows for the ability to store and process information necessary for making a decision when developing process equipment.

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