CHAPTER 2

STRUCTURE OF THE COMPUTER NETWORK DESIGN, AND METHODOLOGY OF ANALYSIS AND SYNTHESIS OF COMPUTER SYSTEMS

2.1. STRUCTURE OF THE AUTOMATED DESIGN OF COMPUTER NETWORKS.

Let us examine some questions about the construction of the automated design system (ADS) of computer networks. Base of a "ADS-network" is the set of interconnected blocks of calculation that form a structural plan, which will serve for elaborating a package of programs applied in the process of the computer network design.

Through the process of the computer system design, three levels of structural representation and system functions are distinguished: system-technical level, scheme-technical level, and level of construction.

In the system-technical level, the structure and composition of hardware and software are established. The topology of the computer network, the dynamic states of job, and the system of the network's control are elaborated in this level, too. In the scheme-technical level and level of construction, the structures of installations in form of integrated electronic and electromechanical circuits are determined; the questions of concrete interconnections and constructions are analyzed.

The automation of the computer network design is particularly effective in the system-technical level since here it is necessary to use complex multidimensional mathematical models and a series of algorithms for a significant set of initial data. The general order of the system-technical design foresees the following sequence of elaboration phases: definition of initial data and their structure, definition of the network topological structure, definition of the maximum speed of transmission and flows of information by each communication line, choice of equipment, control procedures designation upon the network, definition of the demands that should be imposed to the mathematical software, elaboration of the general software, and execution of economic calculations. Practically, these phases can form iterated cyclic procedures. In other words, the process of the computer network design should pass several times the phase of analysis and synthesis, doing each time, the respective change of input/output variables.

A purpose of the computer network design consists in reaching high indices of: security, productivity, speed of information transmission, keeping in mind limitations in costs. The ADS-network does not foresee to reach the best indices in a single mathematical model. Therefore, the ADS is divided into various models where these indices participate by turns, or as criteria of optimization or restrictions. However, as we will see farther on, when the mathematical model is described with the help of a k-geodetic graph-model, high values for the indicated indices are obtained to a moderated cost.

Initial data for such model are: an initial network structure (topology), a data flow matrix, the cost of leasing by the use of a maximum unit of speed of information transmission along a kilometer of communication line, the probabilities of nodes and communication lines' refuse to process and to transmit information, the allowed maximum time of information packages' transmission among sender and addressee, the restrictions in the number of paths with different vertices (edges) among each pair of nodes, and other specific characteristics for the concrete network.

As a result of the network synthesis, it is necessary to determine the network structure (the network graph), the maximum speed of information transmission for each communication line, the imposed demands of commutation to the network nodes, the network administration and control mechanisms, and the fundamental hardware. Thus the general process of design of a distribution network represents a heuristic set of seven blocks of calculation which are interconnected among themselves, on time that these connections can be strictly established, or in agreement with the designer's desires and his expectations.

The block of the computer network topological synthesis, in the initial phase of design, is in detail described in the following sections and chapters. Here it can be added that the required data flow matrix determines the input operation element to that block, and the network topology determines the output operation element from it. In the first block, the optimization criterion has the following general form: $\min \Sigma\, f{\cdot}l$, where f is the realizable flow by communication line, l is the length (in kilometers) of the corresponding communication line, and practically, it corresponds to the cost's minimization since the expenses of information transmission by communication line, in the initial phase of calculations, can be considered proportional to the product of the values of maximum information transmission and length. The fact that the network obtained in this block has diameter given (d = 4) means that any path has a not very large number of commutation nodes, and consequently, a not very large time of delay in the process of information transmission.

In block 2, the maximum speeds of information transmission obtained in the previous block, and possibly, corrected after the calculation of the real possibilities of the initially conceived interconnection system, become exact restrictions of upper order. In the job process of this block, the network topology is defined more precisely (is synthesized), and flows are the block output operation element. Such flows are calculated by the minimization criterion of the mean time of information packages' transmission.

We will examine the block 3, keeping in mind the following variants:

(a) Given a network nodes distribution, it is required to determine the network structure with vertex-connectivity greater than or equal to 2, keeping in mind the restriction in time of delay. Here in fact, the restriction of security to a structural level (through the connectivity) is considered, while the numerical appraisal of security is not examined.

(b) Given a network nodes distribution and nodes (or edges) refuse probabilities, it is required to determine the network structure that minimizes the maximum probability of breaking the paths among any pair of nodes.

(c) Build a network structure with minimum number of edges such that for each pair of vertices s and t, $w_{st} \geq r_{st}$, where w_{st} is the number of pairs of paths with different vertices among s and t, r_{st} are given numbers.

(d) The same thing that in the previous numeral, but for each pair of vertices s and t $\lambda_{st} \geq r_{st}$, where λ_{st} is the number of pairs of paths with different edges among s and t.

Block 4 contains an optimum procedure of location by nodes of sets of functional problems and user information arrays. Depending on its dimension, such a procedure can be divided into two parts (particular location of problems and information arrays location), connected among themselves in iterated way.

Block 5 can be examined from two different points of view:

(a) The first one corresponds to an information system whose base is constituted by a set of equipment catalogues. Any call to this database is executed in an input special language known by the user. Since the equipment of nodes and network, as a general rule, is connected according to its characteristics, these connections are kept in mind upon performing a search in the database.

(b) The second one is that the problem of optimum selection is formalized according to a discrete programming model type, in which to the original data (to the technical characteristics of the equipment) the network restrictions obtained as a result of the job in blocks 1-4, and the restrictions that have been specified in the equipment's databases are imposed: the cost or security of the chosen equipment can be a criterion.

In block 6, the calculations of computer network fundamental characteristics, which correspond to the phase of analysis of the designed network, are executed. This block can be included after any of the remaining blocks. Here, the functional and structural characteristics of the given network are calculated (the number of nodes, the number of communication lines, the lengths of shortest paths, the minimum and maximum values of information flows, the value of flows for each path that is indicated by the designer, the diameter of the given network, the vertex-connectivity and edge-connectivity of the network graph that is to say, the minimum number of vertices and edges whose deletion conducts to a non-connected graph with respect to the vertices i and j). In block 6, the probabilistic characteristics of network fragments are also determined, as well as that ones of the whole network; they are calculated based on the probabilities of refuse of its vertices and edges, cost, index of effectiveness of the control system, network control security, and timed indices of information transmission by communication line. This block includes as simple algorithms of direct calculations and optimization procedures as complex analytic models. In block 7, for those cases when it is not achieved to build analytic models, network operation process imitation models are represented. For computer networks with packages' commutation, when adapted and quasi-adapted procedures of network control are researched, the imitation models utilization is in force. These models are also effective in the analysis of processes of network transition, and in the research of the network behavior in state of damage.

2.2. PRINCIPLES OF THE APPROACH OF SYSTEMS APPLIED TO THE RESEARCH OF CS.

The CS hardware and software represent particular classes of dynamic systems, which are distinguished for a high level of organization, independent presence of functions and objectives. Objects of such a kind are related to the category of the so-called complex systems since they posses the following four characteristic properties [33] that are fundamental in the definition of complex systems in terms of set theory.

Integration and individualization. In general, a system is an integrated set of elements. This means that on the one hand, a system is an integrated formation, and on the other hand, in its conformation can be clearly distinguished individual elements (objects). It is necessary to keep in mind that those elements exist only in the given system. Out of it, they are at best objects that possess system-significant properties. Those objects acquire system-specific properties instead of system-significant ones when they are included in the system.

At the same time, we will indicate that the concept of system in terms of set theory is not adequate for the description problems of specific systemic formations and can be only examined as one of the auxiliary analytic middles in the study of those formations. Besides, a complete description of a real system in all its volume, using the tools of set theory, is impossible since the system is examined as a whole, including interact components with different properties that are obligatorily compatible.

Connections. The stable essential presence of connections among elements and (or) their properties that by their power exceed the connections of these elements with others, which are not included in the given system, is an attribute of that system.

In any system different connections among elements are established. However, from the viewpoint of systemic positions, not only those connections that are essential have value, but also any connection which, according to the needs, determines integrated properties of the system. The indicated properties differentiate the given system of any other group of systems and separate it of its habitual middle through an integrated formation.

Connection is examined as a physical link through which the (substance, energy, information) exchange among system elements and among the given system and its habitual middle is guaranteed. A relation is also a connection among specific elements; it is represented in abstract way and this abstract way reflects real connections that are physically completed.

The essential particularity of a connection consists in transforming a magnitude or a space without changing its physical nature. Among the main characteristics of a connection are distinguished: physical completeness, power and role in the system.

Organization. This property is characterized for the presence of a specific order, which is revealed in the decrease of the system's entropy, (that is to say, of the degree of the system's non-determination) in comparison with the entropy of factors in system-formation which determine the possibility of creating the system in itself.

The rise of the system's organization is due to the essential formation of connections among elements; the ordered distribution of connections and elements in space and time. In the formation of connections a specific structure of the system is obtained, while the properties are transformed into functions (operations, behavior) related to one more property of the system: to its integration qualities.

Qualities of Integration. The presence of integration qualities that is to say, the presence of those qualities which are entirely adjudicated to the system, but that are not peculiar to none of its individual elements, shows that, in spite of the fact that the system's properties depend on the individual elements' properties; the first ones are not completely determined by the second ones. From here it follows a series of important conclusions:

1. A system is not reduced to a simple set of elements.
2. Dismembering the system in parts and studying individually each one of them, all the system properties as a whole will not be able to be recognized.

Any object that possesses all the four properties described previously is called a complex system.

The external influences conduct to the destruction of the system just at the moment when its force (its power) is greater than the force (power) of its internal connections. The development of counter-functions exploits the system from inside. The growth of entropy is due to the disorganized external influences; the use and degeneration of its connections.

The study of objects and phenomena as systems stirred up the formation of a new scientific method: the approach of systems. The approach of systems is a concretization of dialectical principles, is a manifestation of the importance of interconnection, and is an interdependency of processes and phenomena. The approach of systems represents one of the ways of the methodological knowledge what is directly related to the research, design, and construction of objects as systems. By its nature, such a method is interdisciplinary and scientific-general. In the approach of systems three fundamental problems are distinguished:

(1) Conceptual elaboration of middles (of content and formal ones) of representation of the objects investigated as systems.

(2) Construction of generalized models of systems of different classes and properties, including the dynamic model of systems, its orientation toward objectives of behavior, its development, its hierarchical construction, its processes of control by systems, etc.

(3) Research of methodological foundations of different theories of systems.

Frequently there is no the possibility to cover totally a complex system and to represent it in detail. In practice, this is not always necessary. In both cases a problem of commitment among the simplicity of description arises, but it represents one of the premises of comprehension, and the need of calculation of numerous characteristics of system multiple planning. One of the problem solution ways consists in the so-called stratified description. The following stratums are the fundamental ones: morphological, functional, of information, of processes, and pragmatic. Depending on the object of researching, the stratums can be examined in different levels. The microscopic and macroscopic levels are the fundamental levels of study. The macroscopic level consists in ignoring the detailed structure of the system, in observing only the general behavior of the system as a whole and in the appraisal of its qualities of integration. The microscopic level of the system refers to the detailed description of each system component and all the complex of internal processes. The concept of element is very important in the microscopic representation. Inside the limits of the microscopic approach, the relations and the functions that perform the elements, the effectiveness of elements, and also, the component structure are studied.

The scientific technique which guarantees, based on the approach of systems, the elaboration of methods and procedures of solution of problems weakly structured of complex systems, in the case when there is a presence of non-essential determination, is called systems analysis. The systems analysis is oriented to the creation of the model (evidently, of the model of many levels, actually, of the system of models of many levels) of a competent system. The scientific technique which supplies the construction, by means of generalized models, of complex systems of different classes, and the organization of their development and their clear behavior in objectives, is called systems synthesis. The creation of a concrete complex system with realizable concrete characteristics is the finalization of the so-called systems synthesis.

2.3. STRUCTURAL MODELS OF CS.

When the processes of CS operation are studied, a researcher concentrates his/her attention on those properties, particularities of behavior, and characteristics of the complex system that change with the time. On the other hand, when the CS structures are analyzed, the interest is concentrated on these complex systems' properties and characteristics which are independent of time and conserved either constant or without changes in the entire interval of operation or its long components.

Nevertheless, the operating (functional) and structural properties are directly related among themselves. For example, studying in detail the laws of operation of separated elements, without knowing the structure of the system, is not possible to represent it as a whole, and consequently, to understand how it operates. And conversely, not knowing the general laws of system operation is impossible to determine its structure. In this way, the analysis of operation and the structural study are two interconnected components, that are complemented each other in the research process of any system.

The study of any system assumes the creation of a model of description, which allows predicting its behavior in a specific set of conditions. A model constitutes the description of a system, which reflects a specific group of properties. There exist 3 possible approaches in the description of a system: functional, morphological, and informational.

The problems proposed in this job are resolved based on the use of a morphological model, which reflects the structure of the system.

In order to reach a univocal comprehension of the subsequent material, we will define the concept of structure applied to the examined problems.

Definition 2.1. The structure of a system is defined as a fixed set of elements and connections among them.

Previous definition reflects well the main properties that should been present in any system: the elementary component, the presence of connections, and the invariability in an interval of examined time. Essentially, only the last property allows delimiting the concepts of system and structure. Nevertheless, to consider only the system invariability is not enough. Since the structure is a system component, it is necessary to determine clearly which components, properties and criteria are structural, and which are not.

Let us examine the methods of description of the structural properties of a complex system. If we represent the system by means of a group of blocks, which carry out certain functional transformations, and connections among them, then we obtain a generalized structural plan that describes the structure of the system. It means that the structures of CS, CS work algorithms, and separated nodes and installations, as soon as the structures of the processes that happen in nodes and installations, can be represented in a way of structural plan. In fig. 2.1 is represented the structural plan of the algorithm of conjugation of a computer with its communication line. Nevertheless, a structural plan does not represent a mathematical model of the own structure. Such a plan is not susceptible of formalization and is a natural connection that facilitates the transition of system content description to the mathematical description more than an active tool of analysis and structural formation.

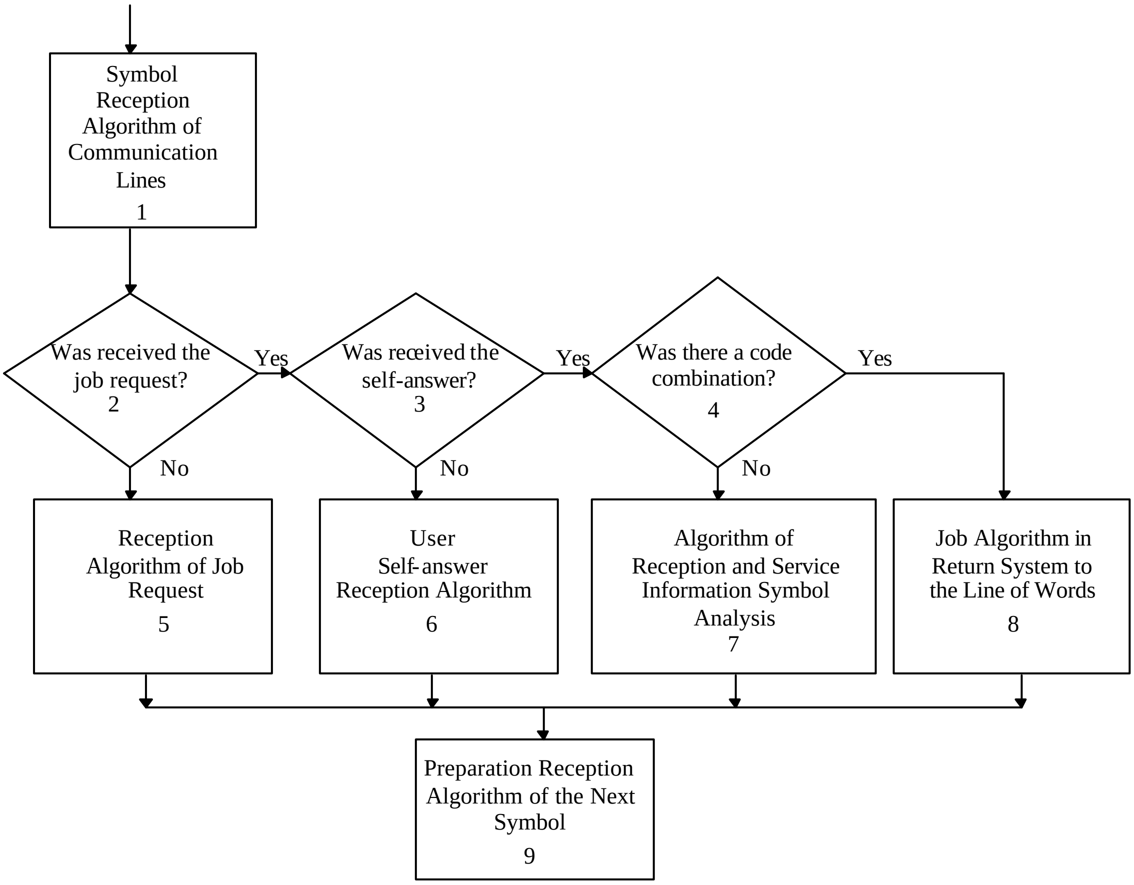

Fig. 2.1. Structural plan of the algorithm of conjugation installation operation of a computer with a communication line.

One of the most important categories that determine a structure is its topology that is to say, the set of elements and structural connections "purified" of any property, except of those properties of existence and connectivity. The relations among the structural elements, which are represented by means of a topological graph, are formalized through the use of mathematical techniques established in Graph Theory. The principle of structural representation using a graph is very simple. When certain type of problems is resolved, edges correspond to the object's elements and vertices correspond to the connections. When another type of problems is resolved, vertices correspond to the elements and edges correspond to the connections.

We suppose that the reader is familiarized with the Graph Theory definitions and general concepts, since it is going to be necessary for the formal analysis and synthesis of structures (we guide ourselves using [7] in the study of such definitions and concepts).

2.4. TOPOLOGICAL ANALYSIS OF STRUCTURES.

On a graph, vertices and edges are given due to the simple fact of their existence. For now, to study the properties inherent to the graph is not necessary. Therefore, a graph is a structural model which requires of a minimum quantity of information for its construction. Nevertheless, it is necessary to keep in mind that the analysis of the structural properties of a system using graphs acquires inevitably topological character.

The topological character of objects assumes the use of a series of characteristics that determine the quantitative measure of the object's topology. From the viewpoint of the general theory of systems, the advantage of utilizing the definition of those characteristics consists in that already in the first phases of design, the need of appraising the quality of the system's structure and its elements arises. The calculation of the most of the indicated characteristics is sufficiently complex. Besides, depending on the concrete system, the same topological characteristics can have different physical interpretation in the process of analysis. Consequently, we will enumerate only the class of the topological characteristics used in the analysis of systems, and the mathematical definitions of those characteristics will be considered in the analysis of concrete objects.

Without intending to carry out a complete analysis, we will study the classes of characteristics [33] which reflect the corresponding property of a complex system.

(1) **Complexity.** It is defined as the number of elements and connections that compose the topology of the structure. In case of need, the elements that correspond to isolated vertices should be separated. The isolated vertices are not incidents to any edge of the given graph. The presence of isolated vertices on the graph is frequently an evidence of errors assumed in the formation or description of the structure since all the system should be always an integrated object.

The research of the number and particularities of connections among the structure's elements is oriented to clarify the existence of cycles and strong connected subgraphs.

(2) **Hierarchy.** It is revealed in the structure of connections among elements. The examined characteristic allows distributing the elements of the structure according to their order of importance. It gives the possibility to carry out a classification of topologies. The importance of each element is determined according to its location and connections on the graph in relation to other graph component elements. For example, for a geodetic graph, which is represented in the form of the union of a tree with levels 0, 1, 2,..., d (d is diameter) and set of edges that join in a specific way the vertices of levels 1, 2,..., d, the level of each element allows to suggest an acceptable supposition: the level of the element of greater height has more influence in the remaining elements, and the consequences of refuse will be more serious.

(3) **The structure's diameter.** It corresponds to the metrical characteristic introduced to the graph in order to determine the shortest path between more distant vertices. In a series of cases, designers of structures utilize the concept of mean diameter, which has great systemic importance. Through the mean diameter is indirectly possible to judge about a series of limit parameters in a system, its security, the timed interval of information delay, the inertia, the quantity of cut vertices and edges.

(4) **Connectivity.** It is the capacity to be opposed to the partition, the topology's division in independent parts. This quantitative characteristic allows determining in the topology the presence of cut-vertices, bridges, etc. In graph theory, all a series of connectivity definitions conditioned by different criteria exists. The calculation of these characteristics allows valuing the topological structure from different points of view.

(5) **Density.** It is the number of vertices on the topological graph which has given diameter and the vertices' degrees. In practice, this characteristic is applicable only to those graphs whose set of vertices have equal degree.

(6) **The Topology's variability.** It is the possibility of changing the topology of connections among elements in order to reach greater adjustment between the system and its function of execution. The Topology's variability is a complex characteristic that includes in dependence on the analyzed object such parameters as accessibility, blockade, and separation.

(7) **Adaptation.** It is the facility of the system's topology to be accommodated to the external conditions, what allows reaching in an optimal way the objectives of operation.

(8) **Security.** It is the capacity of the system's topology to guarantee its operation in the course of a given interval of time. Security is one of the most important multi-parametric characteristics and is defined as much by the security of elements as by the scheme of those elements' union. The existing indices of security are divided into deterministic ones, and probabilistic ones.

(9) **Vitality.** It values the preservation of the topology's parts, what guarantees the realization of the proposed problem. Vitality has direct functional relation with the indices of the topology's security.

(10) **Parallelism.** It allows supplying the simultaneous operation of elements in order to increase the system's productivity.

(11) **Growth.** It is the capacity of the topological structure to be developed. This can be carried out (without altering the process of the main functions' realization) changing the number of vertices and (or) the number of edges.

(12) **Topological abundance.** It reflects the increase of the general number of connections on the necessary minimum. This topological characteristic is utilized for an indirect economic appraisal, and the security of the investigated systems.

(13) **Cost.** It is the characteristic that values the cost of the structure's realization. The best topological structure is considered that one what is the most effective for a given cost or has the given parameters (characteristics) for a minimum cost. The cost of topological elements is supposed to be independent of time and the extension of connections. With the exposed topological characteristics is possible to characterize completely the analyzed structures. Nevertheless, if different topologies have the same list of such characteristics then the analysis of structures is necessary to carry it out with other outputs of the system's representation better determined.

Because of large volume of calculations, to find an exact and integral solution of the problems of analysis for real topologies with a large number of interaction nodes is difficult. Therefore, most of the works in the field of analysis of topologies are directed to look for methods of approximation that allow resolving the problem with acceptable accuracy and computer time use for practical purposes.

2.5. TOPOLOGICAL SYNTHESIS OF STRUCTURES.

It is understood for a topological synthesis of structures, the determination of the number of vertices and the composition of connections among the vertices of the graph corresponding to the structure of the given system. Such a structure is frequently called a topological structure.

It is necessary to indicate that the synthesis of a topological structure constitutes the first phase of the system's construction. Frequently, such a representation in graph form is not the only one since a sufficiently extensive set of graphs there exist. Each of them describes one of the possible structures for the given system of topological structures.

The synthesis of a topological structure is defined as the process of choice or separation of the general set of graphs of a subset, which corresponds in better way to the given functions and purposes. As we will see, such a choice will be optimum in characteristics of productivity, security, speed of information transmission, and cost if the given system has a structure of k-geodetic graph G, $k = 1, 2$, or 3 (For $k = 1$ G is geodetic, for $k = 2$ G is bigeodetic, for $k = 3$ G is 3-geodetic).

In this way, by synthesis is understood in a general sense, the problem of decreasing the diversity (non-determination) of systems on account of the corresponding analysis of information about functions, appraisals, demands, and topologies of the given object.

Synthesis as a problem of determination increase is an inverse concept to that one of analysis. The main particularity of the problem of synthesis is that universal methods of formal transition from the given properties to the topological model of the object do not exist. It is partially explained due to the fact that such a transition is not univocal since the same set of objects can correspond to the same set of properties, on time that in general way to conclude in advance if the set is empty, it contains or not an only element, it is a finite one or infinite one is not possible. Therefore, the problem of synthesis as a general rule is resolved through a repeated analysis of systems chosen according to specific rules taken of the general set of variants. Synthesis has sense only in the case when the initial set of objects contains more than one element that is to say, when the designer has the possibility to choose. This choice is carried out in one of the phases of design and this determines in general way its future characteristics. Therefore, the tendency to build not only one of the possible topological structures, but also in certain sense to build the optimum one is completely a normal action. The list of characteristics that can be introduced as integral criterion was presented in the previous paragraph.

In general, the structure, which is a part of the system, should be valued according to the same criteria chosen to value the own system. But that approach is improbable that we carry it out particularly for complex systems. Therefore, to calculate the values of the system's criteria with sufficient accuracy in the phase of the structure's design is not possible. The choice of structure should be done in conditions of non-determination of the system that is required to be designed. If such a non-determination cannot be described with the corresponding probabilistic measures for example, in the case when very special systems are designed, a problem that should be usually resolved utilizing game theory arises. The most diffused case is constituted by the design of systems related to those ones on which researchers have already accumulated such a volume of engineering experience that allows them to think about the possibilities of realization of the system's elements.

In topological synthesis, the simplest method of construction with integral criterion is used. It consists in that a criterion belonging to a set Q_i of criteria is taken as a general criterion and the remaining ones are taken as restrictions, which determine the dominion of admissible alternatives:

$$\begin{aligned} &E = Q_i; \\ &Q_j \geq Q_j^{(0)},\ j = 1, 2, ..., r, \\ &Q_j \leq Q_j^{(0)},\ j = r+1, r+2, ..., n, \\ &\qquad n \neq i, \end{aligned} \tag{2.1}$$

where E is the value of effectiveness, Qj are the values of the examined criteria, $Q^{(0)} = (Q_1^{(0)}, Q_2^{(0)},..., Q_n^{(0)})$ is the vector that determines the admissible values for the entire set of criteria. In this case, the problem of alternatives' comparison according to the vector criterion of effectiveness is reduced to the problem of taking decisions with scalar criterion, while the remaining criteria become a part of the set of restrictions. The alternatives that themselves are not located in the given limits are immediately excluded as a part of the model because of their incapacity of competency. The obtained practical recommendations should depend on how the restrictions for auxiliary criteria are chosen. For such a formulation, the problem of taking optimum decisions, when alternatives are chosen, is written in the form of a model of mathematical programming:

$$\max_{a\in \mathbf{A}} [Q_i(a)] \ (\text{o} \min_{a\in \mathbf{A}} [Q_i(a)]) \tag{2.2}$$

$$\text{Subject to} \quad Q_j(\mathbf{a}) \geq Q_j^{(0)},\ j = 1, 2, ..., r ;$$
$$Q_j(\mathbf{a}) \leq Q_j^{(0)},\ j = r + 1, r + 2, ..., n ;$$
$$j \neq i.$$

To resolve the problem of the choice of optimum alternative, different methods of optimization are used depending on the type of functions $Q_i(\mathbf{a})$, $Q_j(\mathbf{a})$ and the type of set $\mathbf{A}$. The advantage of the examined approach consists in the comparatively simple way of criterion construction. Other methods of criteria construction there exist.

We will formalize the problem of the structure's synthesis for a given system. For this purpose, we should introduce the following designations [33]:

P is the possible set of principles $p \in P$ of the system's construction or its elements. The possible principles are usually given or are known.

F is the set of interaction functions executed by the system. A set of functions $F(p)$ corresponds to each set of principles p. From this set, $f \in F(p)$ conditioned by the objectives of operation is examined.

A is the set of the system's interact elements, A' is the examined set of such elements; M is the operation of application between the elements of set F and the elements of set A. The optimum application should reach an extreme value of some main function subject to a set of given restrictions. We will get the following system of correlations:

$$p \in P, \tag{2.3}$$
$$f \in F(p), \tag{2.4}$$
$$A' \in A, \tag{2.5}$$
$$[f \in F(p)]\ M\ [A' \in A]. \tag{2.6}$$

If the principles of the system's construction are given, the problem of optimum topological synthesis consists of definitions (2.4) - (2.6). If the principles of the system's construction and the functions executed by the system are given, the problem consists of definitions (2.5) - (2.6). If the principles of the system's construction, the functions executed by the system, and the system's elements are given, the problem consists of definition (2.6). The problem of topological synthesis is considerably reduced if we restrict ourselves to a specific class of topologies. Applying this approach to the topological synthesis of systems, the number of structures to examine searching optimum solutions is widely decreased.