SYSTEMS ANALYSIS: THE STRUCTURE-AND-PURPOSE APPROACH BASED ON LOGIC-LINGUISTIC FORMALYZATION

Lyudmila M. Lukiyanova

Abstract: Systems analysis (SA) is widely used in complex and vague problem solving. Initial stages of SA are analysis of problems and purposes to obtain problems/purposes of smaller complexity and vagueness that are combined into hierarchical structures of problems(SP)/purposes(PS). Managers have to be sure the PS and the purpose realizing system (PRS) that can achieve the PS-purposes are adequate to the problem to be solved. However, usually SP/PS are not substantiated well enough, because their development is based on a collective expertise in which logic of natural language and expert estimation methods are used. That is why scientific foundations of SA are not supposed to have been completely formed. The structure-and-purpose approach to SA based on a logic-and-linguistic simulation of problems/purposes analysis is a step towards formalization of the initial stages of SA to improve adequacy of their results, and also towards increasing quality of SA as a whole. Managers of industrial organizing systems using the approach eliminate logical errors in SP/PS at early stages of planning and so they will be able to find better decisions of complex and vague problems.

Keywords: industrial organizing system, problem situation, systems analysis, quality of systems analysis, purpose structures correctness, structure-and-purpose approach, situations control, logic-and-linguistic simulation, analytic evaluation.

Introduction

We consider here industrial organizing systems. Along with such general characteristics as uniqueness, unpredictable behaviour in concrete situations, capacity to adapt to changing environmental conditions, and to alter a structure, industrial organizing systems possess several particularities. Their structures are usually hierarchical. Their purposes depend on social and other factors. Their production and technological equipment are standardized and unified to a great degree. Volume and assortment of their products are changing dynamically. Their level of technological renewal is very high. These and some other factors give rise to complex problems that are often characterized by a high level of vagueness. Therefore SA becomes a necessary means of efficient function and development for the majority of industrial organizing systems.

Initial stages of SA (analysis of problems/purposes and synthesis hierarchical SP/PS) are based on expert knowledge and experience. Experts elicit problems/purposes, determine the main problem/purpose, decompose it to create the structure of problems/purposes of smaller complexity and vagueness, estimate PS-purposes to combine them into a final PS. All these tasks are creative, but determining the main problem/purpose, decomposing them to obtain the ones of smaller and smaller complexity, greater and greater certainty, and then combine them into hierarchical SP/PS are more crucial because a lot of informal factors have to be allowed. Tthe majority methods of decomposing purposes are based on a collective expertise in which the logic of the natural language is used. Experts use subjective models and collective interpretation of purposes, achieving which allows the managerial staff (MS) to solve problems. Natural language logic and high level of subjectivism very often stipulate the results that are not logically valid. Logical errors in a PS very often cause insufficient solving of the main problem and sometimes even failure in solving that problem.

Widely used approaches to systems analysis stem from the PATTERN method [1] and among the methods of decomposing purposes to reduce their complexity and vagueness the methods proposed in [Черняк, 1975], [Поспелов, Ириков, 1986], [Перегудов, Тарасенко, 1989], [Saaty, Kearns, 1991], [Силич, Тарасенко, 1982], [Кондратов, Ростанец, 1982], [Романов, Клыков, 1974] are more useful for industrial organizing systems. However, together with their evident value for theory and practice of SA these and the majority of other well known methods and approaches have two essential drawbacks: the requirements to the wording of the purposes (problems, criteria, functions) have not been clearly defined, rules of decomposition of the purposes to form hierarchical PS have been formulated in a general way. It means that the methods are not constructive enough. Well-constructed methods have been also developed ([Nilson, 1973], [Романов, Клыков, 1974], etc.), but the method [Nilson, 1973] and similar methods are effective for closed and not so large worlds. The method [Романов, Клыков, 1974] and similar methods can be used for open and large worlds, but the majority of syntactically correct decisions automatically generated by means of them are semantically meaningless, pragmatically useless and therefore inefficient. Besides, conformities to natural laws, and principles of problems/purposes setting in industry have not been investigated enough. That is why scientific foundations of SA of industrial organizing systems cannot be considered completely formed.

So, the following *SA*-scientific-and-technical problem may be formulated for industrial organizing systems: there is *no objective, constructive to a great degree and integral approach to systems analysis that could guarantee the development of correct SP/PS and defining efficient PRS which are adequate to the main problem solved.* Namely because of the SA-problem, MS often create a contradictory, incomplete SP/PS and an inadequate PRS. This fact, resulting in logical errors in a PS, usually reveals itself only in the course of achieving the purposes, hampers determining SP/PS-substantiation and creating a sufficient enough PRS as the system that can achieve the main purpose and solve the main problem of an organizing system. So, it also reduces SA-quality as a whole.

To solve the SA-scientific-and-technical problem it is necessary *to determine basis concepts and establish conformities to natural laws of purpose-setting* (the first sub-problem of SA-problem), *to explore semantics of problem/purpose formulations and relations between them in SP/PS* that so far have been declared in a natural language and have not been studied enough (the second sub-problem), *to determine strict to the wording SP/PS-properties such as discrepancy and completeness because* so far they have also been declared in the natural language, consequently they are usually polysemantic and not clear enough (the third sub-problem of SA-problem). Therefore integral, the more objective and constructive SA-methodology has to be investigated.

Basis concepts of problem/purpose-setting

SA involves two main processes with inter-reverse time motion: purpose-setting (p-setting) in which a desired result of activity is being formulated and purpose-achieving (p-achieving) in which a real result of activity is being achieved by means of the PRS. Here we determine basis concepts of problem/purpose-setting for industrial organizing systems such as a problem, a need, a purpose, a SP/PS (all concepts of SA-semantic field are considered in detail in [Lukiyanova, 2002]).

A *need* in something is always objective. If a need cannot be satisfied simply, it is a reason of the problem situation in the organizing system. *A problem* is contradiction between something desired and something that is being (e.g. between a desired situation and a current situation; it means that a current situation needs correction).

A purpose is always subjective. We consider concept ‘purpose’ as a general name to designate a desired result of activity that is used in p-setting to characterize MS-desire, and a desired result of activity that is used in p-achieving to characterize MS-ability in his own system. Analysis of different definitions of ‘purpose’ allowed us to formulate the following generalized definition of this concept:

<a purpose> ::= < a desired result of activity > [<a structure >] [<time>]. (1)

The definition (1) consists of three semantic multipliers. The two last semantic multipliers marked by square brackets are facultative. Actually, not each purpose is considered as a structure (e.g. a simple purpose; for its achieving MS know and has the means). The second facultative semantic multiplier usually characterizes a task of purpose achieving (time is one of redistributed resources for purpose achieving).

Analysis of more than thousand formulations of problems and purposes showed that semantics of connections between formulations of problems and purposes that solve the problems are very close, and purposes of industrial organizing systems are often like negations of the problems, and according to (1) purposes may be simple or complex. Analysis also showed that relations between PS-problems and between SP-purposes are usually identical.

A structure of the main, complex and vague, problem/purpose is a SP/PS in which problems/purposes are combined by means of structural relations such as subordination, compared, completeness, and the other relations that are used to evaluating of SP/PS-correctness or allow for resources that MS has to purpose achieving [Lukiyanova, 2002].

Conformities to natural laws of purpose-setting in industry

Problems hamper function and development of a system and can stipulate needs in something. A simple problem stipulates a simple need. A simple need can stipulate a simple purpose:

$$\text{a need} \xrightarrow{\text{motivation}} \text{a purpose}. \qquad (2)$$

The formula (2) expresses *the first law of purpose-setting*. For a simple purpose, p-setting according to (2) is completed if MS has the means to p-achieving:

$$\text{a purpose} \xrightarrow{\text{means}} \text{a result.} \qquad (3)$$

A new problem is not arisen in this case. But p-setting is continuing if MS has not the means to p-achieving. Therefore t*he second law of purpose-setting is:*

$$\text{a desired result} \rightarrow \text{desired means.} \qquad (4)$$

Complex problem is a reason of a complicated purpose. A complicated purpose is considered as a system and its structure is analyzed. Formula (4) defines *a basis strategy of PS-creating. A few additional strategies of PS-creating* are considered in [Лукьянова, 2001]. Besides, purposes descriptions and possibilities of its decomposing in organizing systems are studied. The following aspects of purposes in their formulations are defined: rational limiting of redundancy and significance; evident (in contrast to implicit) semantics of purposes descriptions of an industrial organizing systems that expresses purpose parts of their natural language formulations, functions of the parts, basis elements of the systems and their determination in space of properties. We use the following possibilities of complicated purposes decomposing: status (external-internal, etc.), aspects of activities (social, economical, control, industrial, etc.), kinds of economical activity (in according to the classificatory of the economical activity kinds), control functions, kinds of industrial activity, etc.

P-setting in any industrial organizing system orients on an external purpose (purposes) established by the above-system. Therefore we suggest that external purposes express absolute value for the subordinate organizing systems and purposes that are set in the analyzed system as sub-purposes of the external purpose express utilitarian value. Thus in PS-creating every purpose excepting the main purpose and purposes- leaves of PS may be considered as absolute value to the subordinate purpose and as utilitarian value to the above-purpose. This is *the third law of purpose-setting*.

Structure-and-purpose analysis of industrial **organizing systems**

We suggest a new 'structure-and-purpose' paradigm of SA in industrial organizing systems. It uses two determining concepts of purpose systems ('a structure' and 'a purpose') and allows for purpose domination in SA. Actually, an organizing system is a means of its complex purpose achieving. Therefore it is useful to analysis the structure of the purpose (a purpose may be considered as a problem negation) to reduce its complexness and vagueness. Criteria and functions of PRS are also semantically connected (it is used criterion form of a purpose description and there are functional properties in purpose formulations [Lukiyanova, 2002]). Besides, purposes (and PS) determine PRS itself and dominate as in p-setting as in p-achieving processes. Therefore for industrial organizing systems we postulate the following.

Postulate 1. Abstract semantics of purposes and relations between the purposes determines logical models of problems and purposes analysis and hierarchical SP and PS as the results of these process.

The postulate is based on the hierarchical structures of the industrial organizing systems, on the roles in activities of different parts of such systems, and on the concept of absolute and utilitarian value of the parts.

Postulate 2. Formal logic-semantic analysis of problems/purposes will able to help MS to obtain discrepancy and completeness SP/PS.

To orient in variety methods, techniques, procedures of problems/purposes analysis-synthesis of SP/PS and investigate a method using of which can guarantee against logical errors in SP/PS we classified, as shown on the figure 1, all possible methods including well-known and wide used ones. We used informal, partial-formal and formal degrees of describing their following aspects (bases of the classification): a *purpose description language* to realize input interface between the experts/MS and the formal logic-semantic system (the first level of the classification), *rules of decomposition of purposes* that check correctness of PS-creating (the second level of the classification), *means of description of PS and its characteristics* to realize output interface between the formal logic-semantic system and the experts/MS (the third level of the classification). The empty classes of methods are shown on the figure 1 as black circles.

Among the classes, we note the following three homogeneous ones: K^{111} involves informal methods, K^{222} involves partially formal methods, K^{333} involves formal methods. Methods of the rest classes are inhomogeneous.

So, *the first realized class is* K^{111}. It involves the most number of the methods such as [Лопухин, 1971], [Черняк, 1975], [Перегудов, Тарасенко, 1989], [Saaty, Kearns, 1991] and similar ones. Advantages of the methods of this class are a universal and an all-round analysis (i.e. purpose decomposition and at the same time PS-estimation). The main disadvantage of these methods is polysemy of purposes, rules of decomposition of purposes, and means of description of a PS and its characteristics. Polysemy causes high-level subjectivism of analysis and hampers finding logical errors in a PS.

The second realized class is K^{113}. It involves methods that are similar the method [Поспелов, Ириков, 1986]. Advantage of these methods is a formal description of a PS, but this ability does not increase a constructive level of the methods to reduce logical errors in the PS.

The third realized class is K^{221}. It involves methods that are equivalent the method [Силич, Тарасенко, 1982]. They standardize purpose descriptions in a very strict form and PS-description in a scenario form. The methods allow decomposing purposes automatically at some steps of PS-forming. The main drawbacks of these methods are impossibility decomposing new purposes (problems) and using the methods for other organizing systems. *The fourth realized class is K^{231}*. It involves methods like the method [Романов, Клыков, 1974] which is well-constructive and flexible at the same time. However, the automatically formed PS may be semantically meaningless and pragmatically useless. Besides, the methods do not define PS-characteristics by means of which it can be checked logical validation of PS.

The fifth realized class is K^{311}. It involves methods that are equivalent the method [Кондратов, Ростанец, 1982]. These methods used formal purpose descriptions that are faintly connected with decomposing possibilities.

The sixth realized class is K^{331}. It involves methods that are similar the method [Nilson, 1973]. As a rule, these methods work in closed and not so large worlds. The other their disadvantage is impossibility of allowing for semantics of purposes, relations between them, and PS-properties.

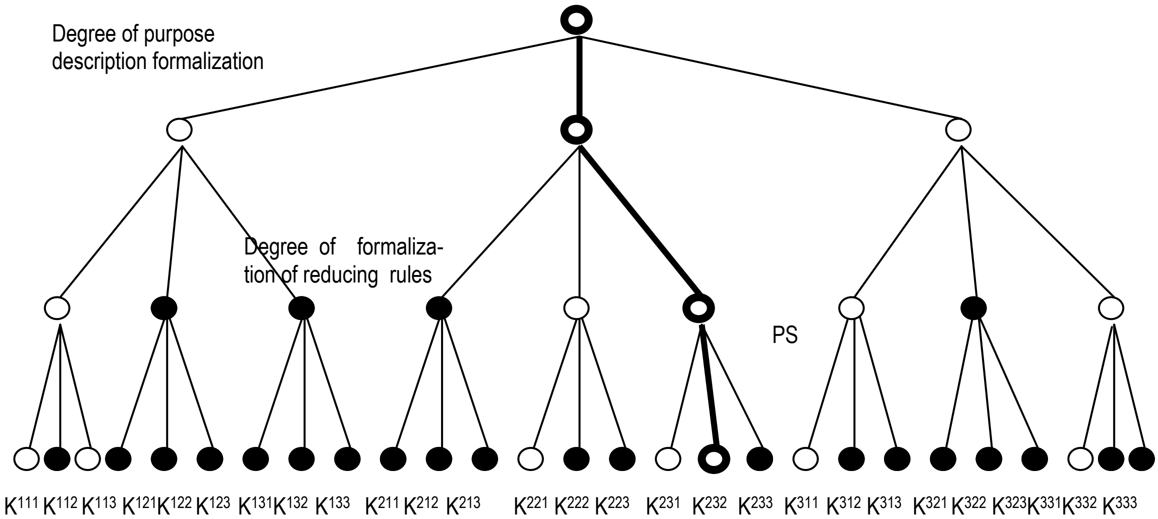


Figure 1. The classification of methods of creating hierarchical PS

The classification helped us to find the more adequate class of methods than classes used so far, to set and solve the SA-scientific-and-technical problem of industrial organizing systems. It is a class K^{232} which characteristics marked out on the figure 1 by the bold line. Methods of this class use a necessary (for perception) level of partial-formal description of problems/purposes, partial-formal description of SP/PS, and formal rules of problems/purposes analysis. Man-machine systems based on such methods have the following advantages: 1) problems/purposes descriptions in a constraint natural language are effective as for experts/MS as for formal systems that analyze problems/purposes, and realize intellectual interface between them; 2) a logic model of problems/purposes analysis based on problem area semantics does possible eliciting errors of problems/purposes structure analysis; 3) graphic SP/PS imaginations together with problems/purposes descriptions in a constraint natural language are effective to realize output interface.

According to characteristics of class K^{232} and the postulates 1 and 2, the following principles of structure-and-purpose analysis (considered in detail in [Lukiyanova, 2002]) are established:

1. It is inter-reverse time motion logical causality between p-setting and p-achieving processes.
2. Man-machine structural analysis of problems/purposes (criteria, functions of PRS) as adequate practical reasoning (*in contrast to inadequate man reasoning or decomposing problems/purposes algorithm*) is expedient.
3. Hierarchical system structures such as SP and PS, PS and structure of functions (SF) of PRS, SF of PRS and structure of PRS, etc. are connected semantically and logically.

4. Current situations in industrial organizing systems stipulate problems/purposes (criteria, functions of PRS) analysis.
   4.1. Formalization of problems/purposes analysis must allow for semantics of problems/purposes and relations between them (*logical stratum*):
      4.1.1. Partial linguistic formalization of problems/purposes (criteria, functions of PRS) provides evident expressing its semantics.
      4.1.2. Logic-semantic formalization of analysis of problems/purposes provides logical discrepancy, model completeness of conclusion and semantic applicability of inference rules.
         4.1.2.1. Discrepancy of a hierarchical SP/PS is stipulated by the principle 3.1.2.
         4.1.2.2. Completeness of a hierarchical SP/PS is stipulated by the principle 3.1.2.
      4.1.3. Classification of purpose situations simplifies selection of current analyzing strategy.
      4.1.4. Partial graph-and-linguistic formalization of SP/PS (structure of criteria (SC), SF of PRS) provides adequate imagination of structural analysis results.
   4.2. Formalization of p-achieving estimation provides allowing for resources of p-achieving (*mathematic stratum*).
5. Narrow-minded perception principle (facultative principle).

To realize principle 4 we suggest a conceptual model problems/purposes (criteria, functions of PRS) analysis using the fundamental idea of the situation control theory [Поспелов, 1995]. Let us consider the conceptual model shown on figure 2. In accordance with the 4.1-4.2-principles of structure-and-purpose analysis of problem situations in industrial organizing systems, it is stratified into two stratums: logical and mathematical. The logical stratum of SP/PS-creating uses logical methods to check correctness of SP/PS. The mathematical stratum uses mathematical methods to problems/purposes estimating.

In accordance with the 4.1.1-principle, intellectual interface language (L_{in}^1) of structure-and-purpose analysis to describe problems/purposes (criteria, functions of PRS) is suggested. As it is studied the most suitable kind of a language to describe problems and purposes is the frame language [Лукьянова, 2001] that is based on the two-level linguistic model of problem/purpose. The first level (macro-describer) is a role frame expressing a functional formula of activity in an industrial organizing system. The second level (micro-describer) is a describer of functional elements in space of their properties. The space of properties is divided into some groups. By means of the groups it is ordered in-role problem/purpose description by means of specific terms. Each group of properties determines its own way of problems/purposes decomposition. Because of natural language redundancy the problem/purpose parts of problem/purpose formulations are marked by special pointers. The roles, the kinds of properties and a problem/purpose pointer (H/G) express external semantics of problems/purposes. Internal semantics of problems/purpose is expressed by basis concepts that form terms. It is also developed the language L_{in}^2 to realize input interface with basis knowledge. It is developed as simplified version of L_{in}^1.

According to the 4.1.2-principle logic-semantic formalization of problems/purposes analysis is investigated [Lukiyanova, 2002]. It is used the semiotic model theory [Осипов, 1995] and the logic of utilitarian values [Ивин, 1970]. As it is shown on figure 2, the three-components semiotic system consists of a formal subsystem S_T, Ψ-re-constructor that reconstructs S_T in accordance with the current situation in the bush of problems/purposes, O-reformer that reforms the current linguistic representation of problem/purpose into a logical formula and vice versa:

$$O : p = (H/G)\, f_j [\, [\, [\, H/G\,]\, f_s] \ldots] \leftrightarrow \begin{Bmatrix} (H/G)\, f_j [\, [\, \wedge [H/G\,]\, f_r] \ldots]\, [\, \supset f_7] \\ \\ [\, f_s [\, [\, \wedge f_r] \ldots] \supset]\, (H/G)\, f_7. \end{Bmatrix} \quad (5)$$

Here p – a linguistic representation of a problem/purpose (alternatives of a linguistic representation of a problem/purpose are involved in figured brackets);
f – a role phrase in p (j, r, s={1, 2, …, 6}).

According to the 4.1.3-principle it is classified situations on purposes [Lukiyanova, 2002]. Six classes are defined, but the only one is correct. Discrepancy and completeness of the hierarchical SP/PS are also defined.

In accordance with the 4.1.4-principle of structure-and-purpose approach to SA, the partial-formal structural language (L_{out}) to realize output interface of the SP-s and SG-s bases is suggested. It is used a theory-graphic tree-model which nodes are described in L_{in}^1 and theory-set language to describe (semantically) complicated arcs [Lukiyanova, 2002]. The semiotic system via Intellectual interface takes away experts/MS linguistic descriptions of problems/purposes, reforms them by means of O-reformer into logical formulae and checks correctness of a current bush of the SP/PS-problems/purposes by means of its logical subsystem S_T. Logical subsystem S_T uses adequate fragments of basis knowledge of the problem situation as its own domains by means of Ψ-re-constructor in the time of checking the bush of problems/purposes. If the current bush of problems/purposes of the SP/PS is not valid, S_T identifies the logical error and forms recommendation to correct the problem/purpose of the bush of the SP/PS. The semiotic system and knowledge base of problem situation are realized in Delphi.

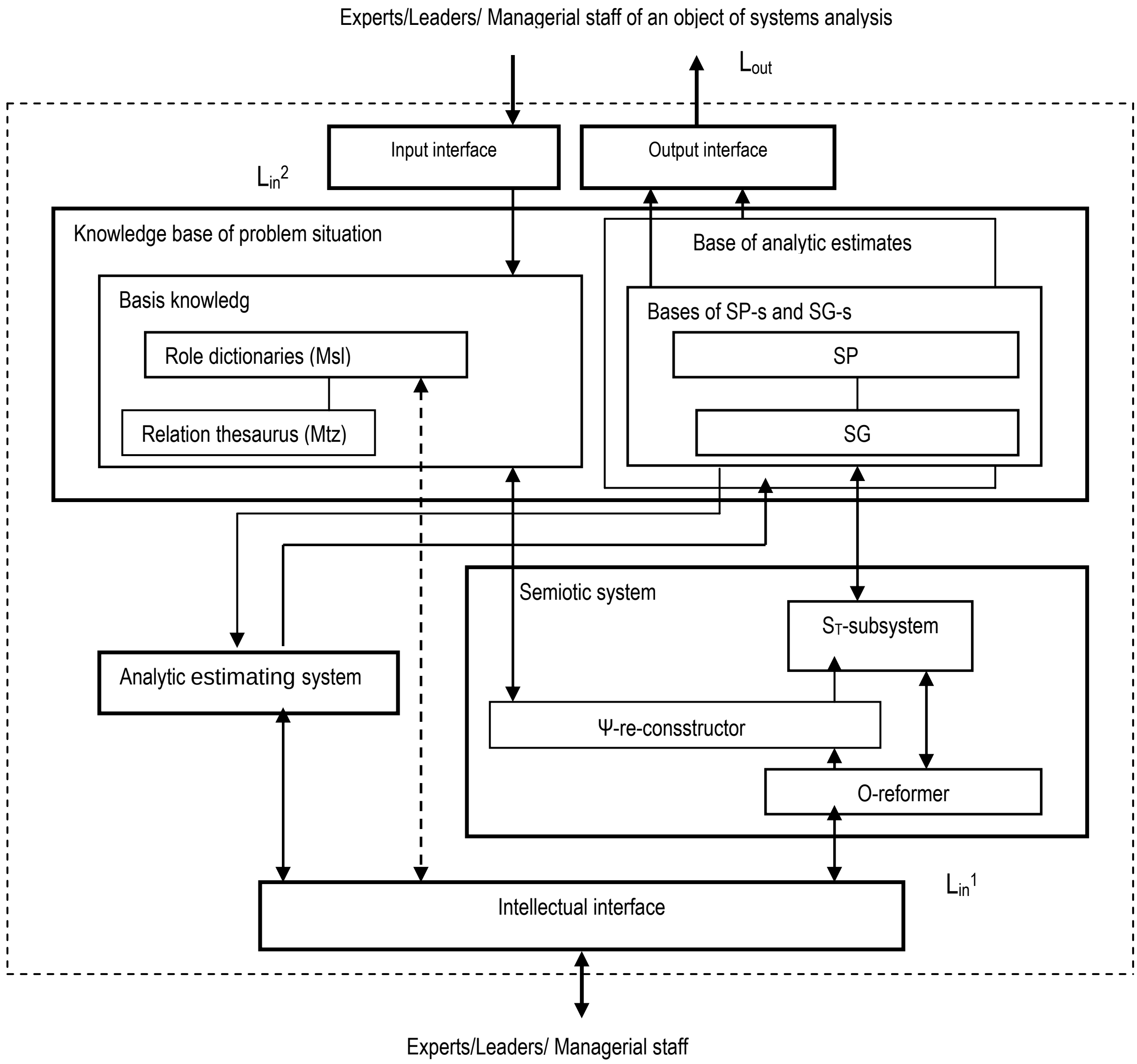


Figure 2. The conceptual model of problems/purposes analysis

According to the 4.1.4-principle an analytic subsystem realizing the analytic hierarchy process [Saaty, Kearns, 1991] can be used as to the separate problem/purpose as to the bush of problems/purposes estimating, and even to the SP/PS estimating as a whole.

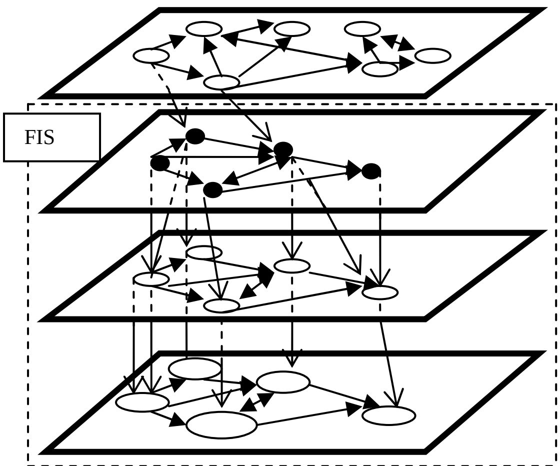
In the time of analysing the bush of problems/purposes of the SP/PS S_T is invariable and works by steps. One step is an inference that produces in according with a scheme: $p_1 \models\Rightarrow p_2$ (p_1 and p_2 are problems/purposes) in which semantic relations are conditions of inference rule applicability. In contrast to traditional relations semantic ones are determined as $< l_j, R_j >$ in which the first component (l_j,) is a relation name, $l_j \in I$, I is a set of names expressing relative basis Mtz of a problem field [Lukiyanova, 2002]. An inference consists of the following acts: for $< p_1, p_2 >$ it is hypothesized implicative connection $p_1 \rightarrow p_2$ in which p_1 supposed as truth and a corresponding purpose as an absolutely valuable; truth meaning of $p_1 \rightarrow p_2$ is estimated by basis knowledge (fig. 2) and if it is truth then in according with modus ponens p_2 is supposed as truth. If in according with basis knowledge truth meaning of $p_1 \rightarrow p_2$ is false it is identified as contradiction and S_T inferences permissible p_2'. An inference is simplified by classification of situations on $< p_1, p_2 >$ and $< p_1, p_2 , p_{i.}, \ldots, p_n >$. Analysis of criteria of purposes achieving is based on the PS. The main criterion usually corresponds to the main purpose and local criteria correspond to local purposes of the PS. Analysis of functions of the PRS is also based on the PS. MS determines function for every purpose in the PS. Thus, a SF is formed. The partial-formal method forming two- or three-levels organizing structure of PRS is suggested in [Лукьянова, 2001], [Lukiyanova, 2002]. It consists of systemizing the list of SF-functions and based on the following characteristics grouping: subject-object, control levels and phases, character of production process and life cycle of production. Systemizing leads to determine functions of the control subsystem and the controllable subsystem. Then according to generally accepted rules and norms functions into the subsystems are grouped. The results of analysis are a base to PRS organizing structure synthesis.

Conclusion

The new structure-and-purpose approach to SA is suggested. It covers all stages of SA, makes it possible to systematize as SA-procedures as its results. P-setting laws, problem situation basis knowledge, control of problem solving by means of purposes situation classification, partial-formal imagination of problems/purposes/criteria/functions, its structures, logical-linguistic formalization of a structural SA are established.

The approach is used in fishery industry systems (FIS). Several complex program [Лукьянова, 1986], problem situations in technological equipment designing [Лукьянова, 1988] and in region FIS were analyzed.

So, there were elicited 43 problems in a FIS. At preliminary problems analysis each of problems was analyzed semantically. Also degree of uncertainty and complexity of the problems were fixed: status, aspects and kinds of economical and industrial activities, control functions. Preliminary analysis changed content of some problems and their number (50). Further systematization of problems list showed that the percent of external problems is 10.5%, the majority of internal problems are problems of control (55.5% from a general number of internal problems) and economic problems (26.5%). There are many financial problems (13.5%) among economic ones; organizing (22.5%), planning problems (9.5%) and analyzing problems (9%) among control ones. Systematization of problems stipulates their correct stratification and more exact determination of expert groups. Simplified result of problem stratification is shown on Figure 3.



Social stratum:
social indices (e.g. necessary value of producing fishing production).

Economic stratum:
economic relations and indices (e.g. minimal profit from produced fishing production).

Control stratum:
control relations and parameters (e.g. reduce of demurrage of equipment).

Industrial stratum:
industrial relations and indices (e.g. value of produced fishing production).

Figure 3. The example of the complex problem decomposed

Then cause-and-effective connections into each aspect, kind of economical and industrial activity, control function were analyzed. This analysis helped us to define the main problem which further analyzing was given the correct SP. Analogically the PS was created. Then the PRS was simulated and logically valid line diagram of p-achieving was formed. Example of the intermediate line diagram realized in Delphi is shown on Figure 4. The line diagram based on the PS as a result of p-setting obtained by means of logical-linguistic simulation.

Correctness of the structure-and-purpose approach to SA for FIS is confirmed by problem solving practice. Experts agreed with all logical errors in PS and SP that the semiotic system found and with all recommendations for their correction that the semiotic system formed.

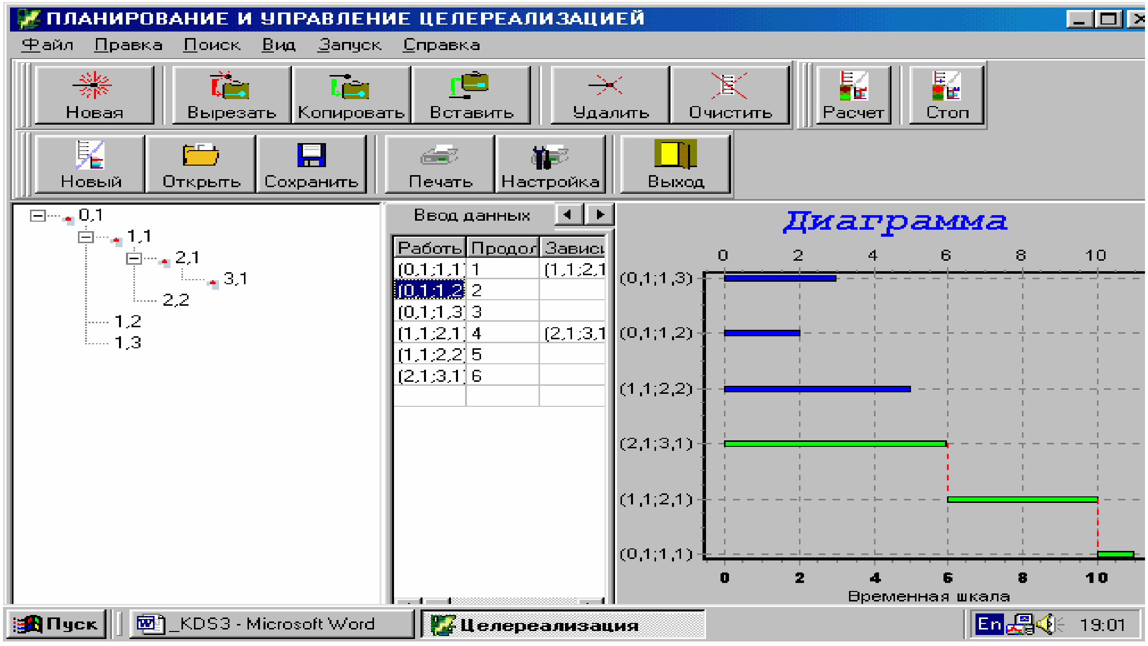


Figure 4. The example of the intermediate line diagram designed in according with fragment of the PS

Bibliography

[Лопухин, 1971] М.М. Лопухин. ПАТТЕРН – метод планирования и прогнозирования научных работ. М., 1971.

[Черняк, 1975] Ю.И. Черняк. Системный анализ в управлении экономикой. Экономика, М.,1975.

[Поспелов, Ириков, 1986] Г.С. Поспелов, В.А. Ириков. Программно-целевое планирование и управление. М.,1983.

[Перегудов, Тарасенко, 1989] Ф.И. Перегудов, Ф.П. Тарасенко. Введение в системный анализ. Высшая шк., М., 1989.

[Saaty, Kearns, 1991] Thomas L. Saaty, Kevin R. Kearns. Analytical planning: The organization of systems. N. J., 1991.

[Силич, Тарасенко, 1982] В.А. Силич, В.П. Тарасенко. Алгоритмизация и автоматизация процесса построения содержательной модели организационной системы и формирования на ее основе дерева целей. В кн.: Вопросы кибернетики. Методы и модели оценки развивающихся систем, с. 14-35. ВИНИТИ, М., 1982.

[Кондратов, Ростанец, 1982] В.А. Кондратов, В.Г. Ростанец. Применение программно-целевого метода в планировании развития науки и техники. В кн.: Совершенствование показателей плана, с. 153-165. НИИ план-я и нормативов, М., 1982.

[Романов, Клыков, 1974] В.Г. Романов, Ю.И. Клыков. Формирование дерева целей в системах ситуационного управления. Изв. АН СССР: Технич. кибернетика, № 5, с. 11-15,1974.

[Nilson, 1973] Nilson N. Problem Solving Methods in Artificial Intelligence. 1973.

[Поспелов, 1995] Д.А. Поспелов. Ситуационное управление. Новый виток развития. Изв. РАН: Теория и системы управления, № 5, с. 152-158, 1995.

[Осипов, 1981-1982] Г.С. Осипов. Две задачи теории семиотических моделей управления: I. Представления семиотических моделей. Изв. АН СССР: Технич. кибернетика, № 6, с. 100-110, 1981; II. Семиотический анализ. Изв. АН СССР: Технич. кибернетика, № 1, с. 131-137, 1982.

[Ивин, 1970] А.А. Ивин. Основания логики оценок. МГУ, М., 1970.

[Лукьянова, 1986] Л.М. Лукьянова. Метод структурирования целей (на примере структур целей для целевых программ). Изв. АН СССР: Технич. кибернетика, №3, с. 65-75, 1986.

[Лукьянова, 1988] Л.М.Лукьянова. Моделирование анализа проблем проектирования технологического обору-дования. В сб.:Тезисы докл. Всесоюзн. конф. по искусств-му интеллекту, Т.1, с. 195-200. ВИНИТИ, М., 1988.

[Лукьянова, 2001] Л.М. Лукьянова. Система поддержки структурно-целевого анализа проблемных ситуаций. В сб.: Труды Междун. научно-практич. конф. KDS-2001, Т. I, с. 446-453. СЗГЗТУ, С.-Петербург, 2001.

[Lukiyanova, 2002] L.M. Lukiyanova. Methodology of Structure-aimed Analysis of Problem Situations in Organization Systems for Industry Branches. SPIIRAS Proceedings. Issue 1, v. 1, p. 297-315. SPIIRAS, SPb, 2002.

Author information

Lyudmila M. Lukiyanova – KSTU, Associate Professor, Active member of International Information Academy; 236000, Kaliningrad, Sovietsky pr, 1, KSTU, Department of Control Systems and Computer Science, Russia;
e-mail: llm_llm@mail15.ru