

Optimization Models for Making Infrastructure Investments for Coal Mines

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Abstract—The paper describes analysis of the environmental activities state in the industry. Methodology implementation of the three-level models system will not only create a competitive technique and technology with a conscious and controlled quality level for environmental safety and purity, but will also provide a high integration degree of information that is necessary to predict the development of social engineering systems as elements of the noosphere.

Keywords—*competitive technique; social engineering systems; integration; noosphere*

I. INTRODUCTION

Analysis of the environmental activities state in the industry, its informational, labor and resource support allows us to identify three levels of decision-making to ensure environmental cleanliness and safety:

- the level of national coordination of work to ensure environmental safety and cleanliness in the industry;
- the regional level of decision-making on socio-economic development, environmental protection and industrial infrastructure issues;
- the level of specific developments implemented in the creation of systems of machines, equipment and technology of new generations.

II. METHODS AND MATERIALS

The main elements of the decision-making structure in the form of a three-level model are presented in Fig. 1, 2, 3.

When solving environmental problems, the design and manufacturing processes are closely linked over time. Therefore, effective environmental and investment arrangements implemented at all levels of decision-making should be aimed at temporary optimization of design and

technical production processes so that the results of development and manufacturing processes would be consistent and could guarantee the required and controlled level of environmental cleanliness and safety of industrial products and technologies [1, 2, 3].

National level of coordination of activities in the system of ensuring environmental cleanliness in industry, which is represented by the "Model 1" (see Fig. 1), agreed with the need to determine the strategic and tactical plans for the development of industry as an element of the national economy of all types necessary for the effective operation of structural adjustments (demonopolization, change of ownership) [4]. The main functions of this level prognostication and management system are follows:

- formation of priorities and strategies of socio-economic development of society and scientific-technical process in industry;
- determination of the required financial resources, formation of the optimal investment environmental policy and points of basic expenses, control over the effectiveness of the environmental investments use;
- formation and coordination of environmental activities in the industry scientific programs in legal, information and personnel support field;
- coordination and control of interstate obligations on environmental issues.

The implementation of an effective decision-making system on environmental activities in industry at the national level will allow to form a generalized conceptual prognosis scenarios of step-by-step problems solution to ensure environmental safety and cleanliness in the industry, methodically comprehend the general moral and philosophical problems of the technosphere, to coordinate work at the intersectoral level [1, 3, 5-11].

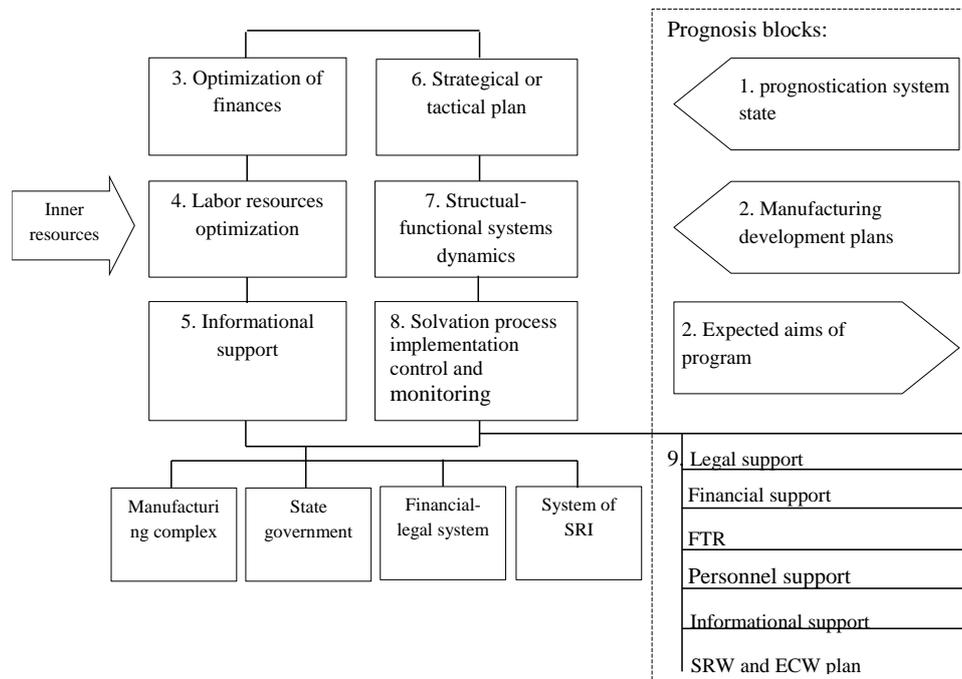


Fig. 1. Model 1

III. RESULTS AND DISCUSSION

The effectiveness of environmental activities is also determined by decision-making:

- at the level of specific developments - in prognostication and design;
- at the regional level - in the production and operation of the system [1, 3, 12-18].

To assess the effectiveness of environmental activities, a system of relevant criteria can be proposed, which should be refined and improved in the process of implementing the model and in solving specific problems. At the national level, it is proposed to develop a system of acceptable generalized criteria for assessing the effectiveness of decisions, for example, criteria for assessing the effectiveness of the use of investment. In general, such a system of criteria can be represented as:

$$W_{o.l.} = F\{L(\alpha, \beta, \dots); B(\alpha, \beta, \dots); E_c(K, T, \dots)R(A, B, \dots)\dots\} (1)$$

where $W_{o.l.}$ - the overall effectiveness of environmental measures for the national level; $L(\alpha, \beta, \dots)$ - the index of life length change for different (α, β, \dots) risk groups of the working and non-working population; $B(\alpha, \beta, \dots)$ - the index of the general level of health; $E_c(K, T, \dots)$ - the index of socio-economic efficiency of environmental measures, determined by the set where, for example, K, T - penalties, benefits, investment costs, effects, etc.; $R(A, B, \dots)$ - the index of optimal use of renewable and non-renewable resources, here A - materials, B - human resources and other types of resources.

The full set of functional $F\{\dots\}$ elements for the general case is difficult to determine correctly. Apparently, such a system of criteria should be formed as a consistently interactive process of "model 1" "blocks" functioning and on the basis of contacts with elements of the second and third levels models [19-22].

In the course of implementation of innovative programs in industry, formed at the national level, there is a particular importance of the time and availability factors of all resources types in specific regions.

The task of optimizing the ecological-economic and social systems is fundamentally multi-criteria, its solution is possible and should be evaluated at the regional level, where there are all necessary flows of information generated at the national level and the level of specific developments.

Each new development in the industry somehow finds its solution and acquires a complete environmental understanding only at the regional level, taking into account its specifics.

An important part of the model of the regional level - "Model 2", which determines its essence, should be taken as a systematic consideration of the anthropogenic impact on the system of the region. The main aspects of this process are: environmental pollution, consumption of natural resources, impact on health, social, cultural and spiritual development of the population, regeneration of the natural environment of the region.

Ecological and economic regional models began to form in the 90th of the last century, the degree of integration in them for the prognosis system in industry is insufficient, they are not yet focused on the prognosis of the dynamics of the technosphere of the region.

The creation of a system of prognostication social and economic development of the region, taking into account the environmental feasibility due to the complexity of the problems, should focus on the ideology and architecture of expert systems. It is necessary to develop the required data banks and methodological approaches for prognostication and decision-making in environmental activities.

The structure of the main blocks of "Model 2" is shown in Fig. 2. The target function of the system is information support of planning and prognostication of ecological, social and economic activity of the region. In the block "Primary data" are formed the necessary quantitative ratings, containing characteristics, standards, pollution levels, environmental passports of enterprises, demographic, medical, resource and other data characterizing the current state of the biosphere, technosphere, social sphere of the region.

The block "Regional topologies" presents maps, charts, graphs and other information structured in space and time, characterizing the statics and dynamics of the simulated regional system or its hotel processes.

The block "Cause-and-effect relationships" contains analytical data that establish the required logical relationships necessary for the analysis of possible scenarios of regional processes in subsystems and in the system as a whole.

The analytical apparatus and the system of models should be concentrated in the block "Predictive models", allowing carrying out the examination of plans for 1-2 years, to build predictive scenarios for the period up to 20 years, as well as to give an expert assessment of projects for the future over 20 years.

In the "Model 2" unit "Industrial complex" needs to contain the topology of the regional industrial enterprises, data on the levels of contamination determined in the tariffs of the enterprises and the real results of the activities of the technosphere enterprises, resource balance scheme of industrial enterprises and plans of their development, the structure and dynamics of labor resources, normative-technical documentation, data for environmental impact assessments that accompany industrial development: a data bank for "environmental services" (ecomachines, expertise, know-how,

training, design, etc.). The same block should contain legal information on environmental issues.

At the regional level, it is also necessary to develop a system of generalized criteria for assessing the effectiveness of decisions. In general, such a system can be represented as:

$$W_{r,l} = F \{ {}^E W_{o,l}; L_p^{(A,B,...)}; E_p^{(K,T,...)}; I_p^{(M,H,...)}; {}^E W_{r,l} \} \quad (2)$$

where $W_{r,l}$ - the overall effectiveness of environmental measures at the regional level; ${}^E W_{o,l}$ - a subset of the criteria of the system of the national level, for example, such as $LE(\alpha,\beta,...)$ - life expectancy, $B(\alpha,\beta,...)$ - disability losses, $I_{op}(A,B,...)$ - the index of optimal use of all types of regional resources (renewable, non-renewable, internal, external); $E_p^{(K,T,...)}$ - index of economic efficiency of nature protection measures in the region, determined on subsets (K,T,...), where (K,T,...) - the infrastructure of economic, socio-demographic and other characteristics of the region, $I_p^{(M,H,...)}$ - the index of environmental safety and cleanliness of subsystems (M,H,...) of the region's infrastructure, here M,H, for example: industry, transport, etc.; ${}^E W_{r,l}$ - a subset of the level criteria: specific development ("Model 3"), taking into account the specifics of innovation in the region.

Currently, there is an extensive information base of domestic and foreign systems of environmental standardization, the regulatory system of control over the management of environmental requirements is developed and improved. There is a large scientific and technical potential for the introduction, but the development of methodological support is needed - methodology for the design and creation of environmentally safe and clean industrial systems.

It is necessary to formulate methodological principles and methodological approaches to solve the problems of environmentally safe and clean systems design of, machines, equipment and new generation technologies, carried out on the specific developments level.

The structure and main blocks of the system which will implement these principles and approaches are presented in the "Model 3" (Fig. 3). Let's form the target function.

Prognostication models

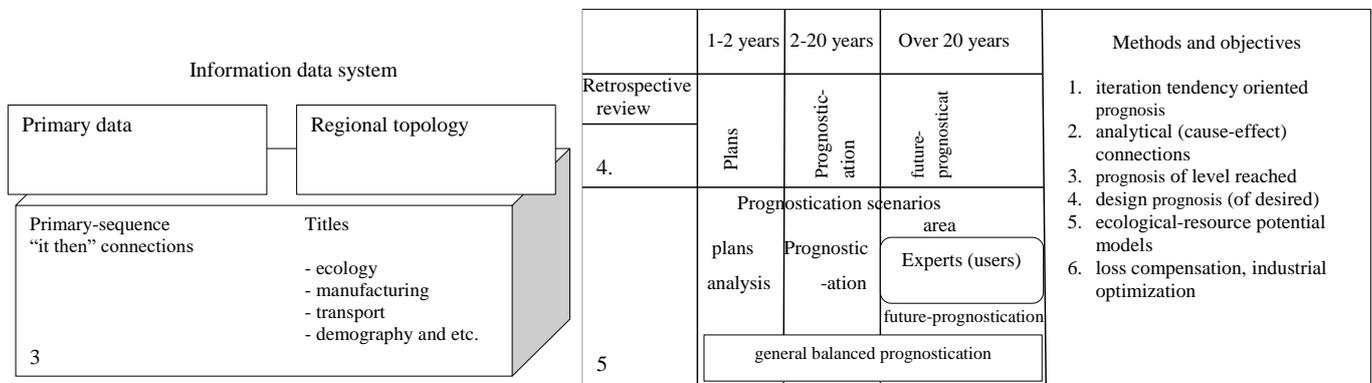


Fig. 1. Model 2

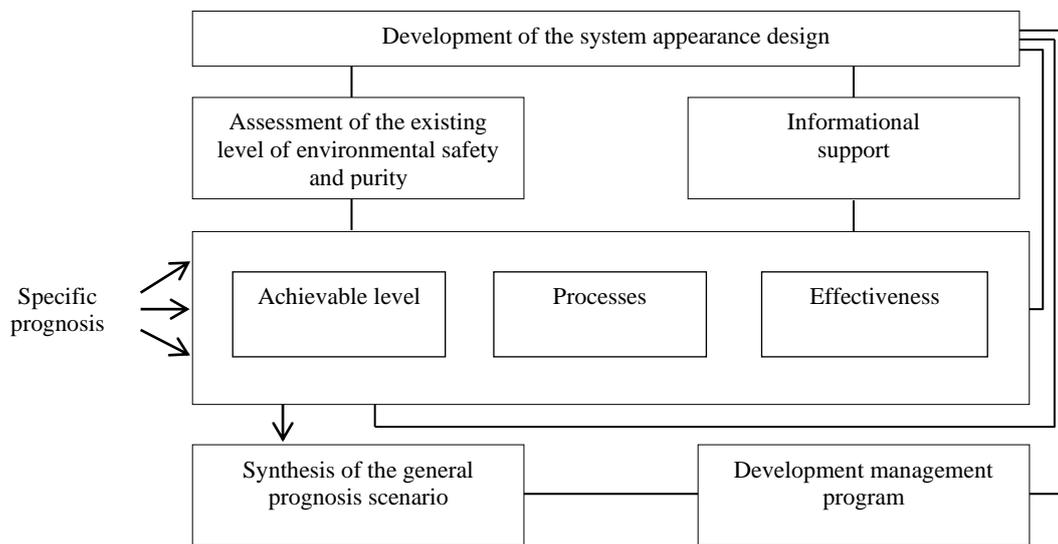


Fig. 1. Model 3

The block “Development of the system appearance design” is a formalized description of the nature and environmental safety, purity problems of the created technical or social engineering system at all stages of its life cycle: manufacturing, production, operation, disposal.

Block “Informational support” – is a development’s service, including the selection of data on domestic and foreign normative and technical documents, innovative data, data by attribute (allocated by the user) quality.

Block “Assessment of the existing level of environmental safety and purity” - obtaining the projected system, as well as the definition of the basic (spontaneous) level of “environmental quality”, the actual achieved level of quality according to the environmental system map and the quality level limit.

Block “Analytical private prognosis” is the translation of the system design appearance qualitative and quantitative characteristics of the in a set of technical environmental indicators. Such prognosis should be carried out not only at the level of indicators, but also at the level of processes and mechanisms for their implementation effectiveness.

Block “Synthesis of the general prognosis scenario” is a system association of private prognosis, analysis of the “achievable level” and “limit characteristics” space, the formation of a reasonable, implementing level of the environmental quality in the project.

Block “Development management program” - is the formation of criteria for assessing the effectiveness of the implementation of the development plan with the estimates of resource, financial, personnel, matrix-technical and information support.

The model 3 system also provides a list of problems to be solved at the state and regional levels.

The innovativeness of technology design in solving environmental problems is the emphasis to the initial stages of

design - the synthesis stage of the created system conceptual appearance. This approach involves the abandonment of the prognostication by strict individual criteria practice, such as the maximum permissible concentrations of harmful substances and the transition to the systemic synthesis of the ecological essence and quality of the system practice, including all stages of its life cycle. This is achieved by analyzing the complex of three predictive characteristics: the achieved level of safety and purity; possible, achievable real development level; maximum achievable boundary levels of the main system characteristics.

The project at an early stage should show both socio-economic characteristics of the positive development qualities and socio-economic and environmental damage from the system implementation in life.

The general decision-making efficiency criteria system for the level of a particular development $W_{K,D}$, can be defined by a functional on subsets:

$$W_{r,l} = F \{ EF(\alpha, \beta, \dots); EM(M_1, M_2, \dots); E_k(L_r, L_{ch}, W_{ec}, \dots) \} \quad (3)$$

where $EF(\alpha, \beta, \dots)$ - a subset of environmental factors inherent in the development; $EM(M_1, M_2, \dots)$ - a subset of environmental measures, for example, M_1 - for structural materials, M_2 - for design, technology, etc.; $E_k(L_r, L_{ch}, W_{ec}, \dots)$ - criteria system: L_r - achieved level; L_{ch} - limit characteristics; W_{ec} - information quality criterion characterizing the real introduced information amount into the development.

IV. CONCLUSION

For “Models 1, 2, 3” description and development of the complete set $F\{\dots\}$ can be achieved by implementing models and adapting them to specific developments. Methodology implementation of the three-level models system will not only create a competitive technique and technology with a

conscious and controlled quality level for environmental safety and purity, but will also provide a high integration degree of information that is necessary to predict the development of social engineering systems as elements of the noosphere.

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