

ECOLOGICAL INVESTIGATIONS AT TECHNICAL UNIVERSITIES

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Modern technical universities in Russia are educational institutions that carry out an extensive complex of research studies in the field of fundamental and applied sciences, ecology included.

Ecology is a science about relations between vegetable and animal organizations and the communities they form among themselves and with the environment and as such it requires the application of a systemic approach to its problems. Ecology considers populations of organisms, species, communities, the ecosystem and the biosphere as a whole as its possible objects. Accordingly, the above-listed objects define those components of the environment that are negatively, affected by human activity. Ecological investigations have lately acquired particular importance due to the dramatic, it is highly important to find the solution for the problem of revealing the laws of interrelations between nature and society.

Then we consider the principles of identifying undesirable consequences for

nature from different aspects of human activity as well as how to minimize undesirable harmful influences of technologies of technologies artificially created in process of human industrial activities. The systemic characteristics of nature

objects and industrial factors negatively affecting the environment are presented in the matrix:

nature objects factors	populations	species	communities	ecosystem
power engineering				
metallurgy				
chemical industry				

We can easily see that the characteristics of the negative situation existing in space of "ecological objects" - "industries" given in the matrix allow us to identify initial negative influences only in a most general way. However, in reality each of the industries considered has its own hierarchic structure of affecting nature objects because each of them possesses a wide enough range of specific technological characteristics alongside with providing necessary specifications for a technological process. The target conditions can be specified by requests such as equations, inequalities or in the form of minimizing appropriate functionals. The systemic characteristics of the family of problems can be given as a matrix:

types of technological target conditions				
ecological target conditions	types of	equations (E)	inequalities(I)	functional minimum (F)
	equations (E)	E-E	E-I	E-F
	inequalities (I)	I-E	I-I	I-F
	functional minimum (F)	F-E	F-I	F-F

The last table identifies all possible classes of problems that combine both technological and ecological requirements.

If we introduce vectors $X_{(T)}$ and $X_{(E)}$ defining technological process specifications and ecological requirements (limitations) respectively then the systemic matrix given above will specify among other things a set of possible problems, e.g. on mathematical programming. This, in its turn, will allow us to design technologies meeting specified requirements. The limitations for such problems can include conditions of the following type in particular.

$X_{(T)}$ belongs to an admissible technological, $X_{(E)}$ belongs to an admissible ecological field, write both vectors should be connected by operators of mutual influence

$$W(X_{(T)}, X_{(E)}) \equiv 0$$

Obviously, conditions given define requirements set for technology and ecology, Using minimization of functionals we can add the following conditions to the problem:

$$\begin{aligned} F_T(X_{(T)}) &\rightarrow \text{extr}, \\ F(X_{(E)}) &\rightarrow \text{extr}. \end{aligned}$$

As a result we can formulate a package of mathematical programming problems adequately presenting technological requirements and ecological limitations.

The department of Ecological Principles of

Nature Use has been successfully functioning at the Hydraylic engineering faculty of St. Petersburg Technical University for more than ten years. Students at the department study the essentials of ecology and technical means of environment protection, The department deals mainly with the final year students working towards their graduation papers and as managers of large plants and enterprises. The department four other faculties of St. Petersburg Technical University.

The center for Ecological Education has been created and is functioning successfully. Its aim is to coordinate the efforts in ecological education at different faculties of St. Petersburg Technical University and also at technical universities and secondary schools in the North-west region of Russia. The CEE is accumulating the information and then distributes it among the organizations that need it. The information is distributed both in electronic (computer games, video films) and paper (handbooks) environments. The established structure aims at implementation of the ecological education concept.