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Assessment of Project Risk in the Hierarchical Organization of the Process of Design of Complex Technical Systems

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Abstract: When designing quarries initial data are stochastic in nature. From the results of determination of these initial data depends not only the final result of design or evaluation, but expediency of development of the field. This may cause significant errors related to the probabilistic nature of the source data and measurement errors and errors of calculations. Risk assessment is an integral part of project documentation. As a result of analysis of traditional approaches to the design of the carrier-the moat, in the conditions of uncertainty of the input data, it is established that the application off design methods fail to account for the risk that entails the adoption and implementation of inefficient design decisions. Currently, the normative acts regulating relations in the preparation of project documentation, are one of the areas of domestic legislation, which has not yet acquired a final form and underlies further development and improvement.

Key words: Design · Complex Technical Systems · Decisions, Terms of Reference · Project Organizations · The Theory of Fuzzy Sets

INTRODUCTION

Design of complex technical systems (CTS) often leads to the situation where the assessment of the adequacy of the design decisions with the requirements determined in the technical and private terms of reference (TTR and PTR)) on the development of the CTS and its elements, it becomes frustrating task [1-3]. This situation is due to the presence of the following factors of uncertainty, reducing the validity of decisions made:

- Absence in some cases of formal criteria of the CTS, leading to the impossibility of fully quantitative analysis of project solutions;
- The need to manage a large amount of quality information about the behavior of the CTS;
- Sustainable dialectical contradiction of the concept of “effectiveness of CTS”, which is both external internal category, which characterizes the CTS [4].

The consequence of the described difficulties synthesis of rational appearance of the CTS was the formation of the present concept of the automated systems of search design (ASSD) with elements of artificial intellect, whose basic task is to view heuristic considerations designer in the form of formal rules and operations [5].

To this class of problems can be attributed task of design decisions for CTS in accordance with the heuristic procedure, implements the principle of series-parallel formation of the "top-down" PTR on the development of its subsystems.

One of the problematic issues in the implementation of design procedure is the account of the increasing impact of these uncertainties in a consistent detailed description of the image of CTS various levels of the hierarchy. The presence of uncertainty factors determines the presence of the risk of default of requirements of the TTR for the development of the CTS and the need to find ways to evaluate it [6].

Principal part. In the general case TTR generated by the project organizations, is a set of global objectives, defining the main directions of research in the process of making design decisions. Often these goals represent the approval of the General nature concerning the quality and peculiarities of implementation of certain functions of the

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CTS or inaccurate wording of the restrictions, which together account wishes, requirements etc. thereby a problem situation, in which the designer is faced with the necessity perceptions indisputable inaccurate and vague concepts [7].

Descriptions of options any technical solution in a formalized manner, we introduce the designation purpose of the design and properties of the technical solution:

<Target>=<Notion of & Intensity of manifestation>,
<Property>=<Notion of & Intensity of manifestation >,

where category < Notion of > defines semantic (conceptual) description of the properties of the CTS and < «intensity» of manifestations>, which is a linguistic variable [8], characterizes the required quality level of this property in terms of properties that are higher in the case of the description of the purposes of design and in the description of the properties is the result of evaluating the quality option considered relative to other options of constructing the elements of CTS as an independent object.

For example, if ${}_{01}G_0 0 = U_{s01} g^0_{s0}$ -the formalized representation of TTR that is interpreted in the language of the theory of fuzzy sets as a group target, which is the association of private purposes ${}_{01}g^0_{s0}$ as fuzzy sets, in accordance with the formalized definition of fuzzy goals

$$ {}_{01}g^0_{s0} = < {}_1x^0_s \,\&\, {}_{01}L^0_{s0} > \quad (1)$$

${}_{01}L^0_{s0}$ – «intensity» of the manifestation of the properties of the STS-defined concept ${}_1x_s^0$ corresponding to the needs of the ñcontracting organization. We introduce the following notation [9]:

${}_dA_m^n$ - m-th variant of the decision ${}_dS^n$ the n-th level of the hierarchy;

${}_dM^n_{pm}$ - the intensity of manifestation of the properties option ${}_dA_m^n$, defined concept ${}_dx_p^n$

${}_d\nu^n_{pm}(u)$ - the membership function , describing the "intensity" ${}_dM^n_{pm}$ as a fuzzy set, with the scope of definition specified numeric scale $U=\{u\}$ with a capacity of split $\Pi_0(U)$;

${}_dG^n = U_p\ {}_dg_p^n$ - the group property options $A_d{}^n{}_m$ solution ${}_dS^n$;

${}_dg_p^n = <{}_dx_p^n \,\&\, {}_dM^n_{pm}>$ - p-th property options ${}_dA_m^n$;

${}_{cd}G_q^n = U_{pcd}g^n_{pq}$ - group target solution development ${}_dS^n$, defined property group ${}_cG^{n-1}$ (n-1)-th level, where c is the number of the considered on the (n-1)-th level solutions ${}_cS^{n-1}$ includes solution ${}_dS^n$;

${}_{cd}g^n_{pq} = <{}_dx_p^n \,\&\, {}_{cd}L^n_{pq}>$ - private design aim to solve ${}_dS^n$;

${}_{cd}L^n_{pq}$ - the required intensity of manifestation of the properties ${}_dg_p^n$ to achieve a desired quality level of the properties ${}_cg_q^{n-1}$;

${}_{cd}[myou]^n_{pq}(u)$ - function facilities, describing the degree of compliance ${}_{cd}L^n_{pq}$ as fuzzy sets, with the scope of definition $U=\{u\}$;

${}_dX^n = U_p\ {}_dx_p^n$ - the system of notions, which constitutes the basis of the semantic description of the properties $\{{}_dg_p^n\}$ and goals $\{{}_{cd}g^n_{pq}\}$;

${}_{cd}H^n_{pq}$ - the degree of semantic proximity concepts ${}_dx_p^n$ and ${}_cx_q^{n-1}$, determined through the operation íåñèììåòðè÷åñêóé difference in terms of the theory of fuzzy sets ;

${}_{cd}f_p^n$ - function facilities, fuzzy sets the binary relation importance on the set goals $\{{}_{cd}g^n_{pq}\}$: ${}_{cd}G_q^n * {}_{cd}G_q^n \to [0, 1]$ with regard to the group objectives ${}_cG^{n-1}$.

Measure the attainability of the private purpose ${}_{cd}g^n_{pq}$ ïðè âûáîðå âàðèàíòà ${}_dA_m^n$ in terms of the reachability properties ${}_cg_q^{n-1}$ define indicator ${}_{cdm}E^n_{pq}$, expressing semantic proximity of parameters ${}_{cd}L^n_{pq}$ and ${}_dM^n_{pm}$. In the interpretation of the theory of fuzzy sets

$$ {}_{cdm}E^n_{pq} = [1 - SUM_u |{}_d\nu^n_{pm}(u) - {}_{cd}[myou]^n_{pq}(u)|] \,/ (\Pi_0(u) + SUM_u \min[{}_d\nu^n_{pm}(u), {}_{cd}[myou]^n_{pq}(u)]). \quad (2)$$

Attainability of group properties ${}_cG^{n-1} = U_q\ {}_cg_q^{n-1}$ if you select ${}_dA_m^n$ can be assessed using the algorithm F proposed for calculating the facilities I object arbitrary nature the solution:

$$ F\,[{}_{cdm}R^{n-1}_{kr}, {}_{bc}T^{n-1}_q] \to t({}_cG^{n-1}) = {}_{cdm}B^{n,n-1}; \quad (3)$$

$$ {}_{cdm}R^{n-1}_{kr} = ({}_{cdm}B^{n,n-1} - {}_{cdm}B^{n,n-1} + 1) / 2, \quad (4)$$

${}_{cdm}B^{n,n-1}$ - measure the attainability of the properties ${}_cg_q^{n-1}$ if you select ${}_dA_m^n$, that with minimal interpretation [10] can be defined as follows:

$$ {}_{cdm}B^{n,n-1} = \text{argmax}\ \{{}_{cdm}B^{n,n-1}({}_dA_m^n)\},\ \text{ïî}\ {}_dA_m^n, \quad (5)$$

` ${}_dA_m^n$ - the selected version of the decision ${}_dS^n$. Let ${}_{cd}B^{n,n-1} = {}_{cd*}B^{n,n-1}$. Then the estimate of reachability group properties ${}_cG^{n-1}$ solution ${}_cS^{mn-1}$ at the end of the selection on the set of all solutions of the n-th level, included in the ${}_cS^{mn-1}$ is determined through the operation of restraint of fuzzy sets:

$${}_{b}B^{n,n-1} = \min_{d}({}_{cd}B^{n,n-1}) \quad (6)$$

Similarly, we can evaluate the degree of attainability ${}_{b}B^{n,n-2}$ group target formulated in the description of the solution ${}_{b}S^{n,n-2}$ (n-2)-th level at the completion of the selection decision (n-1)-th and n-th hierarchical levels, included in the ${}_{b}S^{n,n-2}$.

$${}_{b}B^{n,n-2} = \min_{d}({}_{cd}B^{n-1,n-2}). \quad (7)$$

CONCLUSION

Thus, the above system of ratios defines the recurrent process of selection of variants of technical solutions on different hierarchical levels of decomposition of the CTS and the assessment of the degree of attainability "intensity" of the manifestation of the properties specified in PTR different levels and TTR for development of CTS.

From the last inequality formula should be: ${}_{b}B^{n,n-2} <= {}_{b}B^{n-1,n-2}$, expressing the fact that there is a rational depth of the conducted when designing CTS decision analysis (as the levels of the hierarchy and power of many variants), due to the increase of the influence of the factors of uncertainty , in which the degree of the attainability of the objectives will be lower than specified, or, in other words, where the requirements of the tor for the development of the CTS will be satisfied with a given degree of risk.

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