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THE SYSTEM OF EXAMINATION OF EFFICIENCY FOR COMPETITIVE PROJECT

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Authors have developed the method of selecting the efficient variant of designing a systems or products from a some number of competition variants in the conditions of vagueness of the initial information.Registration of information vagueness degree concerning the quantity index values is carried out of the expense of giving to the expert the possibility of using different methods of index evaluation:numerical evaluations with physical scale;phrases of limithed language; and points evaluation.Using of this method and software is important for marketing research,for systems of quality control of products.

1. INTRODUCTION

The process of developing new tehnical products and systems includes a set of stages sequential in time.A stage of seaching the main principles of building a new product, evaluation of the being expected technical characteristics analysis of various expenditures for development and exploitation and also other design researches defining the view of the future product can be refered to a number of basic ones.This stage of preliminary design is often carried out by independent groups of workers on the competitive base.The aim of such work recognition - is receiving of the most efficient product design for its further detailed development and completing it to the stage of tests and production.

The problem of option, that is defining from a number of alternatives the most efficient one, is often dificult to solve.The cause of that is the complicated product, as a rule, is characterized by a great number of parameters.And one of the design products can be better or worse of the alternative design according to a set of particular characteristics.In this case the task of option is not simple, but becomes the most important at the given stage taking into account the possible material losses of its incorrect solution.Compexity of the option task is intensified by a sufficient vagueness which is characteristic for the initial design stages.The cause is insufficiency of the valid information about the indices of product quality which are supposed to by achieved, about the conditions of exploitation and other product properties which can be defined only at the final stages of product production.In these conditions use of mul-

ticriterion optimization methods based on knowledge of quantity values of the efficiency particular criteria is difficult.Thus development of the method of selecting the efficient variant of designing a system or product from a some number of competition variants in the conditions of vagueness of the initial information is very important.Note, that in the offered method the true critics of purely subjective expert methods of variants analysis is taken into account. It is privided by using of different forms of representation of the initial information about the factors which is at the disposal of the system and expert before starting the examination.

Application of the developed method is expedient in the situation of expert option when the product is characterized by a sufficient number of indices (from 30 and more).And the indices can be as quantitative (that is have physical scales of calculation), so the qualitative ones.Ergonomic, aesthetic and other indices which have not physical units of calculations are refered to the last ones.The qualitation indices,which values are not known for the expert at the stage of expert examination are also refered to them.It is supposed that a set of indices characterizing the product or system can be represented as in the view of a simple non-ordered list so in the view of hierarchical structure and it is assumed,that every index has different degrees of influence on the product efficiency.

2. GENERAL

Quality of products and systems is a set of properties enabling for products and systems to satisfy certain requirements according to their purpose.

Quality level is a relative characteristic based on a comparison of quality indices values of products and systems being evaluated with products-prototypes.In the context of the present paper, quality level is a measure of efficiency of competitive projects.

Evaluation of quality level is a set of operations including a selection of a range of quality indices, determination of values of these indices,determination of significance of individual quality indices, a comparison of values of indices with reference (or required) ones.

A considerable number of quality indices are determined by expert methods. In particular, the expert methods enables one to determine values of the indices, which, at a given moment, cannot be determined by other means due to absence of a physical scale of measurement.

The expert methods are the only possible ones to obtain comparative deductions of experts for many types of products, especially for new ones that are in the stage of design examination.

As noted above, evaluation of quality level is based upon a comparison of a set of quality indices with these of an appropriate product-prototype.

These can be the following ones:
at a design stage - the products which meet practicable promising requirements, products to be produced whose

quality indices are mentioned in requirements for design, competitive variants of a product; at the stage of manufacture - the products which meet the most stringest requirements with respect to operation and maintenance, requirements mentioned in All-Union state standards specifying optimum values of product's quality indices.

The said method of examination is based upon the following principles of qualimetry:

1. Any evaluation of an object's quality depends upon its objectives and conditions.The same object may have several different evaluations performed for different purposes and conditions.Therefore, for quantitative evaluation of quality of an object one should mainly specify conditions and objective of examination.
2. Quality is considered as a hierarchical set of properties, which are at different levels.Each property at one level depends upon a number of other properties lying on more lower levels,i.e. evaluation of each property at any level depends upon a set of evaluations of properties,which are at more lower levels.
3. Evaluation of quality of an object depends upon quality indices of a reference specimen.
4. Each index is characterized by its value and coefficient of significance.
5. An integral index is determined as a result of convolution of appropriate hierarchical structure of complex and single (the simplest) indices of quality.

3. FORMALIZATION OF EVALUATION PROCEDURE

Analysis of indices (properties), which determine quality of products and systems, enables one to class them into quantitative ones, i.e. having objective physical meaning, and qualitative ones, for which physical units of measure don't exist. When evaluating these indices, one can employ expert methods, in which opinion and judgement of a specialist-expert or of a decision -maker has a dominant role. In this case, representation of possible cases of evaluation of quantitative and qualitative properties takes the form:

$$O1 : S \times L \times W \longrightarrow R : W \quad (1)$$

$$O2 : S \times J \times Y \longrightarrow E : Y \quad (2)$$

$$O3 : R \times W \times J \times Y \longrightarrow E : W \times Y \quad (3)$$

$$O4 : F \times Z \times J \times Y \longrightarrow E : Z \times Y \quad (4)$$

where:

S - is a set of quantitative properties;

F - is a set of qualitative properties;

L - is a set of procedures of evaluation based upon quantitative methods;

J - is a set of procedures of evaluation using qualitative methods;

W,Y - are the sets of measures of uncertainty, caused by errors of procedures from L and J respectively;

Z - is a set of measures of uncertainty from F;

R,E - are the sets of values of quality indices obtained through the use

of L and J respectively.

Procedures L,dealing with qualitative scales, have a set of formalization methods of objects from sets S, W, R , and so further we shall dwell mainly upon study of objects from J ,F , and E with regard to Y and Z .

Let Q be a value of an index corresponding to a property h from (S U F). Any procedure evaluation envisages comparison of Q with a meaning of the reference specimen Q1 and establishment of a relation P(Q,Q1) between them.

Then evaluation of a quality index R(s) is defined by a pair (Q,P(Q,Q1)).

Relation P(Q,Q1) can be the relation of equivalence,of proximity or of order, value Q1 and type of relation P must be specified.For all possible cases of relations Q and Q1 with one can formulate the following definitions:

1. Criterion of evaluation is a quantitative (qualitative) characteristic, defined by a pair (Q,P(Q,Q1)) which underlies the evaluation of index value.

2. Index evaluation is characterized by a level of correspondence of index value of examination object to a reference product.

Formalization of index value of R(s) for a reference product is performed employing a linguistic variable "Value" and appropriate modifiers in the form:

$$R(s) := C(k)\ A(j) \qquad (5)$$

where: A(j) is one of the terms:

low, mean, high;

C(k) - is one of modifiers:

<not very>, <more or less>, <sufficient>, <almost>, <inssufficient>, <very>.

Expression (5) shows how high,from an expert's point of view, is the value of s -th index of a product quality, selected as a reference one.

Formalization of a correspondence value of examination object indices and a reference product is performed, using a linguistic variable "Level of correspondence", which has three primary terms D(i) <higher>, <equal>, <lower>, as well as a set of corrective modifiers <B(t)>: <slightly>, <a little> <not much>, <considerably>, <much>, and positioning (ordering) of the above modifiers on a scale is performed by an expert prior to holding a session of examination. Expression for associating value of indices R(s) for examination object with a reference product takes the form [2] :

$$C(k)\ A(j) := B(t)\ D(i) \qquad (6)$$

The left part of the expression (6) shows how high is the value of a product's index being evaluated,i.e. the object of examination, with respect to an appropriate index of a reference product.

S - and Π - functions introduced by L. Zadeh are used for formalization of membership functions of terms [1, 3]. Shift operations are used as modifiers.

Basically,expressions (5),(6) can be used for evaluating both qualitative and quantitative indices. In the later case an expert performs subjective interpretation of quantitative values of appropriate indices.

However,it is possible that an expert may have a set of indices, characteriz-

ing products being compared, in which firstly, quantitative indices prevail and secondly, the values of most indices are calculate by measurement or calculation. The universal convert of index quantitative values and expert evaluations into a dimensionles scale permitting to perform the mathematical operations with evaluation of heterogeneons (qualitative and quantitative) indices is developed for this case.

For an index,whose value is known,an expert proposed to assign a scale having indicated values of an index that,in his opinion, correspond to judgements <high value>, <low value>, <mean value>. Normally, it is a very easy task for a qualified expert. After assigning the scale it is advisable to employ analytical expressions for constructing a Harrington desirability function [4] enabling one to map a real index value on a scale [0,1].Final results obtained by means of expression (5) and the function of Harrington are presented on the scale of the same type. Therefore, one may use expression (6) to perform an expert evaluation of an unknown index for the other product, while qualitative indices in the situation discussed are compared (evaluated) using the above expressions (5) and (6).

Registration of information vagueness degree concerning the quantity index values is carried out of the expense of giving to the expert the possibility of using different methods of index evaluation.In particular, an expert during one session of expert examination may use the following methods of index evaluations: numerical evaluations with physical scale; phrases of limithed natural language; points evaluatons. Expert has the possibility to use a combination of the menthioned evaluation methodes.

In evaluating integral indices it is necessary to select and substantiate a method of convolution that would satisfy the requirement of consistency.

In the context of the given method that would correspond to a maximum value of an integral index.

4. PROGRAM IMPLEMENTATION OF SYSTEM EXAMINATION

The program complex for examination of projects, products and systems has the following blocks:

1. A block of names of types and subtypes of projects.
2. A block of names or code designations of objects of comparison.This block may contain information about a manufacturer, date of manufacture, as well as a brief text characteristic of an object.
3. A block of quality indices. Two types of presentation of a set of quality indices are stipulated: in the form of an hierarchical structure; in the form of a simple enumeration of a list of indices. Different forms of presentation of indices to an expert is proposed according to the specified forms of presentation.
4. A block of indices values input.Performs the function of input, storage and update of values of quantitative indices. The block contains information on units of measure and on a type (complex or single one), on a sign ("the more the better" or "the more the worse").

5. A block of calculation of coefficients of indices importance. Two methods are used: a method of paired comparisons [5] and a rank method.
6. A block of expert evaluation of qualitative indices and of expert evaluation of qualitative indices and expert interpretation of qualitative ones.
7. A block of storage and output of results of examination. The principle of user interaction with a program complex is based upon the system of horisontal and vertical menus, that contain a list of possible actions out of which the action required by a user in a specific situation is selected.

5. CONCLUSIONS

In the author's opinion,the developed system of examination of products and systems can be used for quality control. In this case, a generalized characteristic of a degree of membership developed, manufactured and supplied products to up-to-date scientific and technical trends of development, technological experience, qualifications and organizational skills of a consumer of products is taken to be a criterion of control.

The system of examination and the appropriate program complex are oriented at a verbal form of evaluation of single quality indices, that are more natural for an expert, which enhances adequacy of results of examination. Employment of results of examination in quality control will enable one:
- to ensure rational correspondence between technical and economic parameters, social and consumer's properties and level of competitiveness of products;
- to calculate a set of indices, which exerts the most powerful influence on an integral quality index;
- to ensure flexible change of reference and conceptual notions about quality of products in accordance with tendencies of development in an appropriate subject area of examination objects;
- to ensure high level of quality of products through purposeful quality control at all stages of life cycle.

6. REFERENCES

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