AUTOMATED SYSTEM FOR MULTIVERSION SETTING AND SOLUTION OF DESIGN PROBLEMS

A.N.Kirilin[1], R.N. Akhmetov[1], V.I. Kurenkov[2], N.R. Stratilatov[1], V.I. Abrashkin[1], A.S. Kucherov[2], S.L.Safronov[1], A.A. Yakischik[2]

[1]JSC "Space-Rocket Centre "Progress", Samara, Russia

[2]Samara State Aerospace University, Samara, Russia

kvi.48@mail.ru, alexandersk@mail.ru

In the course of land remote sensing satellites (LRSS) initial design phase, design engineer encounters a lot of problems concerning updating and linking the design parameters, which should implement LRSS mission (among those parameters are monitoring frequency, ground resolution, swath width, productivity, operational efficiency, operating lifetime, etc.).

LRSS design parameters updating and matching are related to changes of characteristics of some on-board systems elements with regard to the spacecraft under design, with account of new elements development.

While the project updating and matching, there exist two problems, which may lead to delay in spacecraft conceptual design formation.

First, after each design update it is necessary to check the impact of altered design parameters on target characteristics of LRSS, as well as mutual influence of all the changes.

The design process sometimes calls for use of the borrowed, proven spacecraft elements. In other words, there appear a lot of new design tasks, that cannot be foreseen and, in this regard, there are difficulties in formalizing design solutions and process automation choose.

Secondly, the process of design clarifying and matching is carried out by means of numerous iterations. Practically it is done by passing the modified project through departments specialized in distinct areas of activity. At that, an analysis of each modification calls for solving of numerous subproblems.

The paper proposes the approach that enables to rectify these problems at early stage of LRSS design characteristics chose. The essence of the approach is as the follows.

First, it is necessary to develop an automated system that will allow to diversify interactively the design problems, update the design parameters and to obtain data for LRSS design parameters formation.

Secondly, program units used by various departments are proposed to be integrated into a single system in order to run in-process evaluations. This eliminates the need to develop base data for each case of the project updating, as all the data automatically vary within the system during each change.

To automate design tasks, one needs appropriate equations, base data, algorithm and software. In the case of large number of parameters (like a hundred or more), it would be very difficult to form beforehand numerous algorithms, each of which is intended to solve the problem in the specific statement. Such an approach to automation is based on procedural programming.

There exists different approach based on nonprocedural programming. It affords an opportunity to develop problem-oriented designing system (PODS) [1]. PODS advantages are as the follows:

1. PODS allow to check whether a designing task is correct (the task is correct if the number of connection operators does not exceed the number of parameters) and tractable (the task is tractable if there exists a mapping of input parameters set into output parameters set). For correct and tractable task, PODS offer the sequence of solution and find adjusted mass-dimensional, resource, energy and other characteristics of AS.

2. PODS do not necessitate interrupting iterative process of design objectives determination in order to check whether the requirements regarding the target efficiency indices are satisfied.

3. Obtained values of mass-dimensional, inertial, energy and other design parameters provide for development of devises that allow obtaining target characteristics, which are neither excessive, nor insufficient. In practical terms, it means that PODS realize implicit optimization of AS design objectives without formal setting of mathematical programming problems.

4. A great number of problems may be set with the same set of parameters, by extracting subsets of input (acquainted) and output (required) parameters.

5. PODS can be used not only for designing original spacecraft but also in situations when a designer has to "borrow" some of the already existing, job-proved elements, units and aggregates of the on-board systems used in spacecraft of other types. Those elements tend not to fit ideally into the optimal structure of the spacecraft under design; nevertheless, they are used to minimize costs and to save time. Characteristics of such elements are fixed and are thus excluded from the pool number of variables.

6. PODS can be integrated with 3D design systems for the purpose of quick comparative analysis of alternative design versions variants of spacecraft.

Precision of solutions performed with the help of PODS, depends on the accuracy of equations (models). If the last are absolutely adequate, then the solution precision depends upon the computer accuracy.

As the models used in PODS are job-proved and they are being improved permanently, one ought to expect adequate results when using such the system.

In the paper the proposed approach implementation is demonstrated with the help of simple example. Two alternative problems are considered:

- determination the mass of loaded vehicle needed for start from the Earth orbit to Mars when the payload mass is given;
- determination the maximum payload mass when the mass of loaded vehicle is given.

Formalization of the above problems with the help of graph theory is discussed and the software for solving arbitrary multidimensional design problems is described.

The significance of this new research direction for science is that optimization of LRSS basic design parameters is carried out in implicit form, without setting the mathematical programming problem, which requires formulation of objective functions and limitations.

Here we have exact approximation concept.

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References

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