

COMPUTER-AIDED SYSTEM FOR RESULTS PROCESSING OF SPACECRAFT TESTS

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Abstract: *In the paper we consider the requirements to computer-aided system for results processing of spacecraft tests this system has to satisfy and determine the tools for these requirements realization.*

KEYWORDS: COMPUTER-AIDED SYSTEMS, SPACECRAFT TESTS

1. Introduction

A spacecraft consists of many complex technical systems and each of them includes many electronic devices. In turn, the devices consist of electronic components influenced by the challenges associated with spaceflight. The protection means must be foreseen at the stage of spacecraft production and it takes time and additional effort. At the beginning of the spacecraft production, stage of creation of one product took 6-9 years while the term of active existence of such device, i.e. direct operation on its purpose, was 1-3 years. Nowadays, the situation changed cardinally. The term of active existence of the spacecraft increases. For modern spacecrafts, this term is at least 15 years and time needed for their production is 2-3 years. Such terms are set by Customers and it is essential to adhere to such terms in conditions of competitive race. Almost each new project also assigns new functions to the satellite. Its equipment becomes more difficult, increasing number of independent modules arise.

Therefore, there exists a need for a system able to solve the problems below.

- Reduction of spacecraft production time.
- Improvement of quality of operations concerned with the device production.
- Submission of documentation for all phases of creation of the device in a form which includes full information on a product and specifics of its functioning. The documentation must be convenient in use for the spacecraft developer and its Customer.

2. Automation of testing

Testing of the spacecrafts an important, labor-consuming and long phase of its creation. And, first of all, automation has to include the stage of testing documentation development, a stage of carrying out tests and a stage of release of reporting documentation on results of tests [3].

There exists a uniform concept of functioning checks for each module, device or a system of devices. It is possible to allocate the same stages in any cycle of tests, no matter how various they could be. Therefore, having developed testing procedures one of the devices, we can successfully extend them to others. Thus, spacecraft testing process is automatized as a whole.

The stages of this process are listed below.

First of all, we have to define a sequence of operations with the tested object (we will call so an example device or an example module as a part of the spacecraft for developing standard testing procedures). Describing an order of operations, we are supposed to be guided by recommendations of the device (module) developer. However, this order set by the developer is not always mandatory. Some variations are always possible. Upon termination of this stage we have a global algorithm of tests.

The second stage is systematization of the list of control tools for the test object (commands, sets of command and program information). Identification numbers of the commands can change from a product to another product, however, the control system of a commands database includes a structure of inquiries for this purpose. Databases of control signals have to comprise the following information: identification number of the command (an array) or number of functional group of commands; name; action; the hyperlink for starting the small test of the equipment, and the comments / additional information.

The third stage is arranging control data of the tested object and correctness of its functioning. These data include large volume of values of technical characteristics, values of various registers, telemetric parameters of the tested object. Databases of parameters have to comprise the following information: number; name; device

(module); electric connector; chain; cable type; value under normal conditions; value under conditions of increased temperature; value at a lowered temperature; additional information. If it is necessary, the list of fields of the database can be expanded. The modern software market offers a large number of database management systems and tools allowing to input, store and retrieve any volumes of data in the proper order. A number of programming languages which give the chance to construct flexible structure of inquiries to the created database is developed.

Fourthly, it is necessary to establish logical relations of the operations defined at the first stage with the information characterizing tested object (the third stage). I.e. we have to determine the conditions: what parameter must be checked at the specified moment during performing operations with the object and at what moment is appropriate for displaying the check results on the operator's monitor.

Fifthly, the system has to analyze the received measurements values, telemetric sensors values and all other parameters are "normal" or "not normal". This problem requires a database containing values which are demanded according to the Specification of the device (module) which are registered by the customer of the equipment (product).

Sixthly, for the existing stop points of the test procedures (they have to be specified at the stage of definition of distinct operations), we have to determine the directives (messages) for the test operator intended for signaling about "normal" "/not normal" of parameters of the tested object containing the short conclusion concerning the admission of the equipment to further tests and the possible list of further actions of the operator.

Seventhly, all operations must be registered in the document describing the order of works which could be provided to the customer and would be convenient as a guide during the process of carrying out tests.

Eighthly, we have to give the operator a possibility of carrying out any operations repeatedly having registered two options: repetition without loss of available data and repetition with record of the new obtained data.

The reasonable result of work of the computer-based testing system is reporting documentation. This documentation must visually represent operations performed with the tested object, measured characteristics of the equipment and parameters formed by the program, the admission conclusion, other conclusions and recommendations, reports on separate cycles (procedures) and the total test report of the device (module).

From the moment of production till delivery to the Customer, the spacecraft goes through the stages of land and flight tests:

- Development of standard test procedures.
- Performing the tests.
- Verification of test results for compliance of the requirement of the customer.
- Forming test reports.

Thus, the automated system must solve the following problems.

- Automation of test procedures development.
- Optimization of test process with use of the unified set of measuring instruments and test data processing.
- Automation of test results verification process.
- Automation of reporting information forming and test reports writing.

As we already said, tests take place according to the scenario which is uniform for various devices. We develop a number of standard procedures which are borrowed from the previous products

having various modifications of input data when the tested device changes.

For test process optimization, one of our goals is unification a test workplace and measuring instruments. From a product to another product, the workplace must undergo minor changes and the unification must significantly reduce time expense of tests and material inputs.

Having developed criteria of successful/unsuccessful end of each test and values of its normal/not normal parameters, we can quickly easily to observe the result and perform reasonable actions.

The reporting information must sum up all operations with the tested object and form the conclusion concerning the device admission to regular operation or the recommendation concerning performance improvement of its functions.

At the start of the automation problems solving, we must initially distinguish the problem of actual implementing of one or another applications for distinct processes of data processing automation and the problem of implementing of a platform for this automation.

The goal of automation platform implementing is [5]:

- Reduction in cost of developing and implementing of final applications.
- Convenience for the user and unification of the interface of all applications.
- Reduction in cost of operation and maintenance of the program complex.
- Providing the common information space, the possibility of the integrated search and retrieving of the knowledge accumulated in various applications.
- Providing with the unified monitors of processes and execution control.
- Ensuring the collecting of the statistical and analytical information on speed and timeliness of execution of stages.

3. Automation tools.

The success of each test computer-based system depends on proper choose of the automation tools. We must conduct a detailed analysis of the various tools to make the final choice.

Criteria of selecting and choosing the automation tools include [1]:

- License and cost:
 - Cost of the product;
 - Annual maintenance cost;
 - Cost of staff training;
 - (Possibly) Consulting cost;
 - Type of the license (Personal or parallel);
 - Reputation and financial stability of the company that provides the product;
- Technical details:
 - Running in operation systems (compatibility);
 - Compatibility with databases;
 - Integration with the tested system;
 - Need for dedicated servers or computers;
 - Compatibility with the integration tools;
 - Version control;
 - Open source and extensibility of the program code for integration with other tools;
 - Custom reports;
- Developing:
 - Time and money expenses for the developing;
 - Skills and experience of people involved in the project of automation;
 - Coding and recording/playback;
 - The ease of test scripts writing;
 - The ease of test scripts maintenance;
 - Documentation, paperwork.

There are more than 20 technologies of design of organizational and technical systems and hundreds of special tools intended for automation of this process. There are also the similars

which are a part of complex control systems of the companies (SAP/R3, BAAN, Oracle Application, etc.).

Comparing various similars of systems, it is expedient to consider their features in accordance with the following groups of functionality:

- models construction tools;
- models analysis tools;
- tools for optimization of modeled systems in accordance with their models;
- maintenance of libraries of standard models;
- registration of regulations and documentation;
- model development support of databases and software;
- integration into other software products (CASE tools, ERP systems, applied software) [2].

From the point of view of the opportunities of the systems models creation, the following properties of tools and modeling methodologies are usually considered:

- universality (opportunity and ways of representation of various aspects of modeled system for different classes of systems);
- openness (opportunity of modeling of new aspects of the system which have not been considered in the beginning, taking into account the development of modeled system, etc.)/

The universality of similars is a question which demands some specification of this concept. As we mentioned above, in practice of modeling, the main aspects of the system displayed in its models are:

- structural organization of the system;
- functions of the system and its components (for example, its divisions);
- the processes held in system;
- distribution of resources by processes;
- distribution of the responsibility for processes and resources.

Besides, at higher conceptual levels of the system representation, we describe the appointments and organizational and administrative regulations of the system, such as its mission, its purposes, strategy, politics and others.

Realization of all necessary objects and features of the system can be carried out in the following ways:

- at the expense of construction and use of various types of models for illustration of various aspects of the system;
- or with use of the unique type of model allowing various treatment of its component and their links depending on the displayed aspects of the system.

Therefore, we should probably understand the opportunity and ways to vary the display of the representation of various aspects (cuts) of modeled system as the universality [4].

4. Conclusion

The results of our research include developing of a structure of DBMS allowing easy inputting, storing and retrieving data collected in the course of electric tests of an onboard control complex; creating the flexible system of inquiries of DBMS which is suitable for various commercial and military spacecrafts; creating of the system which performs the information analysis and forms the conclusion concerning the degree of compliance of parameters to the Specification requirements.

5. References

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