Proactive management of the design and development processes of interactive electronic maintenance and repair documentation for aircraft

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Abstract. The article deals with the quality management of interactive electronic technical manuals on the operation and repair of aircraft. It has been established that the quality management tools for interactive electronic maintenance and repair documentation for aircraft do not fully satisfy the existing set of specific requirements for the technological process of their design and development, as well as the implementation of proactive quality management procedures in it. This suggests a lack of scientific, methodological and technological security of quality systems in the design and development of interactive electronic maintenance and repair documentation for aircraft. The quality management of interactive electronic technical manuals for the operation and repair of aviation equipment is a sequential process of iterative procedures for evaluating and improving the quality of the specified information and software tools for logistics support.

1. Introduction
The organizational and technological changes that occurred in the system of technical operation of aircraft and other aircraft of industrial production in the 2000s, a qualitative change in the principles of economic and transport construction required new scientifically based approaches, methods of maintenance and current repair of aircraft. Significantly increased requirements for efficiency and comprehensiveness of measures for the regular maintenance of components, assemblies and aircraft equipment, fundamentally changed approaches to undertaking measures for the repair of aircraft, both current and in factory conditions. The constant complication of modern and future avionics on-board means, the development of air navigation systems define new tasks for improving the system of technical operation of aircraft and other aircraft of industrial production, including the widespread use of information and intellectual support tools for specialists in maintenance and repair of aircraft direct activities.

2. Features of quality management of interactive electronic technical manuals on the operation and repair of aviation equipment
Interactive electronic technical manuals (IETM) is a special class of software and information products that implement the concept of a continuous chain “design - create - operate - recycle” and the corresponding CALS technologies, allowing not only to present in electronic form a structured
description of the equipment used and its maintenance, but also with the help of multimedia technologies, visualize its construction and operation.

The process of quality management of IETM for the operation and repair of aircraft consists in consistently carrying out quality assessment procedures for sets of particular and integral indicators in order to identify its shortcomings and anomalies, as well as procedures for eliminating the identified shortcomings and the reasons for their appearance - that is quality improvement procedures. Given the complex, interdependent nature of the connectedness of quality indicators with the quality of IETM for the operation and repair of aviation technology, the process of managing them is proactive, multi-step and iterative.

The essence of the specified IETM quality management procedures for the operation and repair of aviation equipment varies considerably depending on the stage of their life cycle at which this control is exercised. It is obvious that the initial stages of this cycle, namely: design, content development, coding and formation, are the most effective for the quality management of IETM in the operation and repair of aviation equipment. The stages of experimental and basic operation, intermediate improvement, modernization also need to manage the specified quality and provide a fairly effective response to the implementation of the previously described quality management procedures. The final stages of the IETM life cycle for the operation and repair of aviation equipment do not envisage their quality management, as such, within the framework of the previously given definition.

The above-described complexity of quality management of IETM for the operation and repair of aviation equipment is determined by the fact that these software and information products are used on modern computer systems with a distributed network architecture, focused on multi-user access and service-oriented service. For example, the distributed network architecture to provide logistical support for a typical complex for the maintenance and repair of aircraft as part of the airfield base and aircraft maintenance involves the simultaneous support of dozens of professional operators in various buildings of the airfield base and aircraft maintenance.

In turn, the orientation in the creation of modern IETM on continuous chains “design-create-operation of aviation equipment”, i.e. considering them as means of CALS-technologies in automated transport and production systems leads to even more complication of their software implementation, and, consequently, to more complex management of their quality at all stages of the life cycle. Such IETM are focused on the use within the framework of complex cascade design and operation systems of logistic support for the processes of operation and repair of equipment. Accordingly, the multilevel and complexity of the logistics support networks of CALS technologies, the heterogeneity of the information processed in them when deploying IETM for aviation technology objectively leads to the sequential complication of internal telecommunication services and the use of appropriate information exchange protocols.

Thus, proactive quality management of IETM at all stages of the life cycle is an iterative and multifaceted process, based on the appropriate fleet of software and technological tools, as well as relevant regulatory and technical documents defining the content of such management measures, the procedure for regulating standards and technical regulation specified quality.

The quality management of IETM for aviation equipment as an independent class of software and information products is carried out today on the basis of the relevant regulatory and technical base and using the appropriate software and technological tools.

The entire set of specific requirements for the technological process of designing and creating an IETM for the operation and repair of aircraft and the implementation of proactive quality management procedures in it can be grouped as follows (table 1).

**Table 1.** Specific requirements for the technological process of design and creation of IETM for the operation and repair of aircraft.

| Group sign | Requirements |
|------------|--------------|
| 1          | 1.1 Requirements of the content adequacy and relevance of the data provided for the operation (repair) of aircraft. |
1. Requirements for the adequacy of frame-by-frame decomposition of subject content.

2. Requirements for the structured and logical construction of the content of the manuals, the adequacy of frame-by-frame content granulation.

2. Group of software and technology requirements

2.1. Requirements for rationality and conditionality of the software architecture of construction.

2.2. Requirements for an object-oriented IETM model;

2.3. Requirements for the organization of access to remote services and servers.

3. Group of information and resource requirements

3.1. Requirements for the organization of a distributed information database (for building a DBMS, databases, and for building access to remote information resources).

3.2. Requirements for a set of access interfaces and data formats.

4. Group requirements for multimedia visualization

4.1. Requirements for the effectiveness of interactivity.

4.2. Requirements for visualization of multimedia support, conditionality of visualization and representativeness of visual (including audio) images.

These IETM, created as a full-fledged information and software product, must have a given level of quality, which is determined by the relevant state standards [1-3]. The specified quality level, according to these GOST, is achieved by organizing all the procedures of the technological process on the basis of scientifically-based methods (tools), rather than empirical techniques of an experimental nature. That is, the set of requirements of GOST [1-3] provides for the creation of controlled quality conditions for all processes at all stages of the technological chain of development and creation of IETM for aviation equipment [2]. Improving the program-technological quality of these electronic manuals is carried out using well-known qualimetric tools for software and information products [4, 5].

Based on the data obtained using the procedures of qualitative and quantitative analysis, it is possible to solve the problem of determining the degree of compliance with the existing set of standards, as well as methods, models and methods (procedures, algorithms, approaches, techniques and methods) of quality management of IETM at various stages of their design identified special requirements and requirements of regulatory and technical documentation for the operation of aircraft, identifying the security of the various stages of the development of IETM for techniques appropriate quality control methods.

In particular, the indicator of the provision of special requirements for the technological process of design and creation of IETM for the operation and repair of aviation equipment with appropriate means (methodological tools) of quality management for aircraft equipment - \( p \), is defined on the binary set:

\[
p \in \{0,1\}.
\]

Accepting one of the discrete values is determined according to the relation:

\[
p_{ij} = B_{ij} G_i S_j
\]

Where \( B_{ij} \) - predicate that determines the compliance of the prescribed level of development of IETM for \( j \) requirements for the application of \( i \) method of quality management;
\( G_i \) - predicate that determines the limitation of the i-th method of quality management for use in the technological process of developing IETM operational (repair) purposes;

\( S_j \) - predicate that determines the degree of indicative of the results of quality management of IETM according to the j-th requirement at the current stage of the technological process of their development.

Then the provision of means (methodological tools) of proactive quality management of IETM for aviation technology of the j-th special requirement to the technological process of their creation is defined as:

\[
P_j = \sum_{i=1}^{K} P_{ij}
\]

(3)

Where K - the number of considered means of proactive quality management IETR for aircraft.

The degree of satisfaction with the i-th tool (methodological tools) of proactive quality management of the entire set of special requirements for the technological process of development and creation of IETM for aircraft in general is determined by:

\[
P_i = \sum_{j=1}^{D} P_{ij},
\]

(4)

where D - the total number of special requirements for the technological process of development and creation of IETM for aircraft.

The analysis data presented in table 2 are substantiated by examination; The working examination materials are presented in [6-7]. Due to the objectively limited number of potential experts on the subject of the studied subject, the results of the examination were not analyzed for statistical stability (risk).

**Table 2.** Results of qualitative and quantitative analysis.

| № | Requirements for technological development for IETR | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 4.1 | 4.2 |
|---|------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | Methodology of formalized software evaluation; Implementing regulatory technical and technological tools | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 0   | 0   |
| 2 | A method for evaluating custom software properties. Implementing regulatory technical and technological tools | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 0   | 1   | 6   |
3. Methodology of engineering and economic software design. Implementing regulatory technical and technological tools.

4. Theory of expert statistical evaluation of properties, methods for testing statistical hypotheses and statistical significance. Implementing regulatory technical and technological tools.

5. Qualimetric theory of the sample. Implementing regulatory technical and technological tools.

6. Engineering quality, the theory of complete quality control in the organization. Implementing regulatory technical and technological tools.

7. Total quality management TQM. Implementing regulatory technical and technological tools.

These analysis results show that all the IETM quality controls for aviation equipment under consideration do not fully satisfy the existing set of specific requirements for the design process and the creation of IETM for the operation and maintenance of aeronautical engineering and the implementation of proactive quality management procedures.

3. Results

Thus, we can come to the conclusion: the specifics of the requirements for the technological process of design and creation of IETM for operation and repair of aviation equipment, and the implementation of quality management procedures in it determines the need to take into account in their design and development of appropriate proactive quality assurance procedures: and software implementation.

However, the existing set of applied tools (methods, models, methods, procedures, algorithms, approaches, techniques, methods, standards) of IETM quality management for aircraft, do not fully take into account the above requirements.

Consequently, it can be stated that an experimental method establishes an objective contradiction between the existing need for methodological and scientific-methodological tools of IETM quality management in the operation and maintenance of aircraft and the insufficient level of development of these tools at the moment.

References

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