Standardization in the field of design work

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Abstract. The authors take the aviation industry as an example and the positive changes it has undergone since the standardisation reform. The aviation industry standardization programme for 2016 - 2020 is the main prospective standardization programme for the aviation industry. Under the current legislation in the Russian Federation in the field of standardization the creation and maintenance of an up-to-date fund of normative and technical documents is a powerful tool for the development of the aviation industry as one of the key high-tech and most knowledge-intensive sectors of the domestic economy, which is among the priority areas of the state industrial policy and import substitution policy.

1 Introduction

Standardisation and unification in production enables comprehensive quality management at all stages of product development, manufacturing and operation, and accelerates the development of new equipment.

Having consistent practice and experience in the use of standards is one of the basic skills of an engineer, designer or any specialist in the aviation industry, regardless of his or her position [1-3].

Entire units (e.g., communication systems and ejector seats) and systems, processes and even individual activities (management systems) are now subject to standardisation and harmonisation during the life cycle [3-4].

There are noticeable inconsistencies in product quality assurance activities, overlaps or contradictions in research and development and organisational quality assurance activities, also due to differences in the conceptual framework and product nomenclature.

The Aviation Industry Standardisation Programme 2016-2020 was one of the first industry programmes developed, negotiated and approved jointly by industry and authorities after the adoption of the Federal Law "On Standardisation in the Russian Federation".

The need for any technical device arises as a result of the development of society, dictated by socio-economic conditions [5, 6], which in turn are described in the form of standards.

As society has evolved from the earliest times to the present, its needs for various means of transport have also changed, and the standards have changed accordingly. Aircraft can reasonably be regarded as one of the most advanced human creations. Their creation

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requires the expenditure of enormous intellectual and economic resources [7] and often beyond the capacity of some individual states [8].

As already noted, the need for a new aircraft arises objectively from the development of society and is dictated by changing (or the need to change) social, economic, environmental, technical and other conditions.

The aircraft to be created may be required to replace aircraft that are morally, technically and economically obsolete and which perform a certain set of tasks; to ensure transportation of increased cargo and passenger traffic; in case of intensive development of the aerodrome network; to solve transport problems in regions with poorly developed surface transport infrastructure; to study and experimentally test new concepts and technical solutions, etc.

The development of an experimental aircraft usually leads to financial losses in the initial stages, but in the long term the developer may end up with a monopoly on a product that is in high demand. Therefore, it is very important to finance such work and to have methodologies to assess the degree of risk in financing it.

Having a reliable tool at the disposal of designers - a standard for reliable economic evaluation of aircraft in design, series production and operation - enables the creation of highly efficient, competitive aircraft [9].

When selecting an aircraft concept and developing a technical proposal, the generalised efficiency-cost criterion should be developed into a system of economic criteria enabling designers to assess costs at all stages of the aircraft life cycle, compare the economics of competing (alternative) designs and aircraft in service and select rational solutions not only for the aircraft as a whole, but also for its individual components [10].

Let us consider the experience and practice of leading foreign countries in the field of product standardization.

Thus, in the USA, military equipment developed and produced under the state order is regulated by various documents of legislative and regulatory nature, as well as national and voluntary standards.

In NATO, product standardization is given special attention due to the fact that it, on the one hand, ensures the efficient use of NATO member states' economic resources, and, on the other hand, allows maintaining the integrity of NATO as an alliance and its effectiveness as a military structure.

There are two types of standards operating within NATO. The first are the STANAG standardisation agreements, which, as a formal document, formalise the agreements of several or all NATO members to use common weapons, military and special equipment and associated processes.

The second type of standard is represented by NATO publications, ARs, which are a system of documents used by several or all NATO member countries for their application and dissemination to the user level [11].

The EU has a reasonably effective product standardisation system in place, which thereby contributes significantly to the competitiveness of the union as a whole. At the heart of this system is the European Defence Agency (EDA), to which two standardisation committees, CEN and CENELEC, report [12].

The activities of these agencies are aimed at ensuring that product standards within the EU are harmonised to meet the military needs of EU member states.

China's standardisation system for the design and development of equipment is currently undergoing reform. At the core of its transformation is the integration of civilian and military standards, and the development of "packages" of joint standards that focus on regulating the production and operation of large groups of [13].

The CIS countries apply GOST and OST standards; standards establishing uniform requirements for products; various additions to the above standards; standards of special period and additions to them; industry normative documents related to standardization of industries.

All these documents are recognized as inter-State standards. They allow to provide continuity of normative and technical documentation of each individual state in relation to the current system of standards. They do not need to be re-issued or amended [14].

It is important to understand that today, modern Russian civil aviation equipment can be simultaneously covered by national and international standards and regulations of the International Civil Aviation Organisation (ICAO), International Organisation for Standardisation (ISO), International Electrotechnical Commission (IEC), Federal Agency for Technical Regulation and Metrology (GOST R), Interstate Council for Standardisation, Metrology and Certification CIS (GOST), American Society of Automotive Engineers (SAE) and etc. [15].

2 Standardisation methodology

Often the standards of international communities and organisations form an overly broad set of requirements but are mandatory for aircraft manufacturers and carriers, while national standards using specific technical specifications are not internationally recognized [16].

The refusal of Russian aircraft manufacturers to use national standards together with the standards of international communities and organizations at all stages of the life cycle, in favour of only the standards of international communities and organizations leads to a kind of race for "imaginary" competitiveness with significant non-compliance with the requirements reflected in the national standards.

To save the used industry standards in the aviation industry proposed to translate them into the formats of corporate standards or STO, GOST to 2025.

Considering the standardisation process in terms of management and control of its results during the life cycle, several key elements can be highlighted.

First, the nomenclature of characteristics and indicators, which includes both existing indicators (reliability, etc.) and completely new indicators (lifecycle cost, operational and economic efficiency, etc.) [17].

Secondly, a system of methods for rationing and calculating indicators.

Thirdly, the input data required in the indicator calculations, their composition and how they can be obtained.

Fourthly, the procedures related to the development, approval and adjustment of comprehensive programmes to ensure selected parameters during the phases LC. It should be noted that these procedures may also be coordinated with other activities carried out in relation to products and their components [18].

The current trends observed in product standardisation show that the informal system of specified product standards is not effective, but rather has a significant number of shortcomings and is irrelevant. This in turn points to the need for reform [19-22].

As A. Ovchinnikov and A. Topchevsky suggest, the improvement of the product standardisation system in order to improve product quality should be reduced to the implementation of a number of projects to develop standards in terms of design activities and in terms of technological activities [23].

In addition, more work is needed to build on existing civilian know-how in order to further refine it to meet modern requirements and form the basis of innovation [24-39].

In addition, an innovative foundation is being laid for the development of civilian industry as a high-tech and competitive industry. As a result, Russia's dependence on raw materials and its susceptibility to turbulence in the geopolitical and geo-economic space can be levelled.

The national standardisation system of the Russian Federation is based on technical committee standardisation (TC). It is within these elements that plans for the management of standardisation processes are formed, standards are developed and their expertise is carried out. The status of the technical committee is established by Article 11 of the Law "On Standardization in the Russian Federation", and the regulations for establishment and operation are stipulated [39].

The Technical Committee for Standardisation, which is responsible for carrying out work "on national and interstate standardisation in the field of integrated logistics support and lifecycle management of exported products" It comprises leading companies such as Sukhoi Company, Aerospace Equipment Corporation JSC, Irkut Corporation JSC and others, with a total of over 50 organisations.

3 Result

The main message of the technical committee concept is:

The product lifecycle information support technology is positioned as a basic technology. CALS (Continuous Acquisition and Life Cycle Support) technologies originated in the US military-industrial complex and have repeatedly proved their effectiveness by reducing costs and increasing the speed of technological transfer. The Russian analogue of the CALS concept is the acronym IPI (Information Support for Product Life Cycle Processes). The concept of development of CALS (IPI) technologies in Russia has been developed and promoted by the Research Centre "Applied Logistics" [40].

An example of the committee's work is the draft standard "Maintenance Planning for Aircraft Products," which addresses the shortcomings of a similar general technical standard, such as: treating the RCM (Reliability Driven Maintenance) process as isolated; not considering the specifics of maintenance planning within tiered maintenance systems. The standard includes in the form of annexes: "Guidelines for preparing baseline data for maintenance planning" and "Example of presentation of maintenance planning results" [41].

4 Discussion

Thus, the conducted analysis allows us to conclude that Russia has established a system for the formation and improvement of the institutional framework for enhancing the potential of industry on the basis of standardization and product certification methods.

The need for any technical device (in particular, an aircraft) arises as a result of the development of society, dictated by socio-economic conditions, which, in turn, are described in the form of standards.

The names of the products themselves are determined by the essential qualities or established names that are reflected in the basic concepts.

As society has evolved from ancient times to the present day, its needs for various means of transport have also changed, and standards have changed accordingly, and names have changed or become more complex FV and its elements.

FV can rightly be regarded as one of man's most perfect creations.

Creating FV requires the expenditure of enormous intellectual and economic resources. History knows that in the early nineteenth century, the word "aeroplane" was controversial and often frightened people.

As noted above, the need for a new aircraft arises objectively as a result of the development of society and is dictated by changes (or the need to change) in social, economic, environmental, technical and other conditions.

A new aircraft may be required to replace aircraft that are morally, technically and economically obsolete and fulfil a pre-determined number of tasks; to ensure transportation of increased cargo and passenger flow; to develop an intensively operating aerodrome network; to overcome transport problems in regions with a poorly developed surface transport infrastructure; to study and experimentally test new concepts and technical solutions, etc.

The use of terminology standards at the outset provides designers with a reliable tool, a standard for reliable economic evaluation of aircraft in design, serial production and operation, making it possible to create highly efficient, competitive aircraft.

When selecting an aircraft concept and developing a technical proposal, the generalised efficiency-cost criterion should be deployed in system *economic criteria*, allowing designers to estimate costs for all stages of the aircraft life cycle, compare the economics of competing (alternative) designs and aircraft in service, and select rational solutions not only for the aircraft as a whole, but also for its individual components.

Thus, at all stages LC it is essential to use the terminological standards specified in the terms of reference in order to achieve the result - new AT designs.

5 Conclusion

The special infrastructural and climatic conditions of the Russian Federation and the international economic situation force high-tech companies to use fundamentally new approaches to ensure the competitiveness of Russian aircraft.

The use of technical regulations and national standards can play an important role in enhancing the competitiveness of aviation equipment, both at the initial design stages and already at the operational and even disposal stages.

The introduction by the Russian Federation of technical regulation of products and works, the application of standards at all stages of the life cycle of aircraft should ensure the establishment of scientific and technical priority during the entire life cycle of the product.

Using the national and interstate standardization mechanism, the Russian Federation will be able to offer Russian national standards as a legal basis for international standards of the aviation industry.

The competitive environment of the Russian Federation forces high-tech companies to use fundamentally new approaches to ensure the competitiveness of Russian aviation equipment.

The introduction by the Russian Federation of technical regulation of products and works and the application of standards at all stages of the life cycle of aviation equipment should ensure the establishment of a scientific and technical priority.

Using the national and interstate mechanism of standardization, the Russian Federation will be able to offer Russian national standards as a regulatory and legal basis for international standards of the aviation industry in the future.

References

1. Website of the Federal Agency for Technical Regulation and Metrology (2023)
2. https://www.gost.ru/portal/gost/home/activity/standardization
3. Internet site of the Union of Aircraft Manufacturers of Russia (2023)
4. http://www.aviationunion.ru/about.php
5. Aviation. Encyclopaedia. Moscowб The Big Russian Encyclopaedia, TsAGI (1994)
6. S. A. Astakhov, Journal of Academy of Military Sciences **2**, 99-113 (2015)

7. M. V. Kapitonov, AIP Conference Proceedings **2402** (2021) doi:10.1063/5.0071336
8. A. G. Amosov, AIP Conference Proceedings **2467** (2022) doi:10.1063/5.0092787
9. O. S. Dolgov et al., Bulletin of the Academy of Military Sciences **4**, 99-113 (2014)
10. A. G. Amosov, Journal of Physics: Conference Series **1889(4)** doi:10.1088/1742-6596/1889/4/042031
11. M. V. Kapitonov, AIP Conference Proceedings **2402** (2021) doi:10.1063/5.0071308
12. V. A. Golikov, AIP Conference Proceedings **2402** (2021) doi:10.1063/5.0071634
13. M. Y. Kuprikov, Systematization of matrices of design and layout solutions, providing restrictions on basing (MAI, department. 101. Research Report. PB-111. Stage 2, Moscow, 1996)
14. A. G. Amosov, AIP Conference Proceedings **2402** (2021) doi:10.1063/5.0071519
15. E. V. Mikhailova, AIP Conference **Proceedings 2402** (2021) doi:10.1063/5.0071632
16. M. V. Kapitonov, Transportation Research Procedia **61**, 561-566 (2022) doi:10.1016/j.trpro.2022.01.091
17. M.Y. Kuprikov (ed.) Aircraft layout (Edition. MAI, Moscow, 2012)
18. V. A. Golikov, Journal of Physics: Conference Series **1889(4)** (2021) doi:10.1088/1742-6596/1889/4/042069
19. Decree of the Government of the Russian Federation of 30 December 2016 No.1567
20. A. G. Amosov, AIP Conference Proceedings **2402** (2021) doi:10.1063/5.0071513
21. T. S. Karapetyan, Cockpit design for passenger aircraft of transport category (MAI Publishing House, Moscow, 2014)
22. V. V. Malchevsky, Matrix-topological method of the synthesis of the aircraft scheme and layout (experience in the automation of the designer's creative activity) (MAI Publishing House, Moscow, 2011.)
23. M. V. Kapitonov, Transportation Research Procedia **61**, 556-560 (2022) doi:10.1016/j.trpro.2022.01.090
24. V. A. Golikov, AIP Conference Proceedings **2467** (2022) doi:10.1063/5.0092789
25. B. A. Garibyan, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1829-1832 (2020)
26. M. O. Kaptakov, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1821-1824 (2020)
27. O. A. Butusova, International Journal of Pharmaceutical Research **12(4)**, 2292-2296 (2020)
28. A. N. Tarasova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1160-1168 (2020)
29. N. A. Bulychev, Nanoscience and Technology: An International Journal **13(1)**, 55-65 (2022)
30. B. A. Garibyan, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1825-1828 (2020)
31. O.A. Butusova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1147-1151 (2020)
32. V. Goncharenko, Yu. Mikhaylov, N. Kartushina, Neural Computing and Applications **34(5)**, 4033-4045 (2022)
33. A. Yu. Burova, Journal of Physics: Conference Series **2308(1)**, 012006 (2022)

34. O. A. Butusova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1152-1155 (2020)
35. M. O. Kaptakov, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1838-1843 (2020)
36. A. N. Tarasova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1169-1172 (2020)
37. O. A. Butusova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1156-1159 (2020)
38. A. N. Tarasova, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1173-1180 (2020)
39. M. O. Kaptakov, International Journal of Pharmaceutical Research **12(Supplementary Issue 2)**, 1851-1855 (2020)
40. V. M. Rukhlinskiy, Methodology of forming shape operational and technical characteristics of high-performance aircraft of new generation: D. Sci. (Moscow, 2015)
41. A. G. Amosov, Journal of Physics: Conference Series **1889(4)** (2021) doi:10.1088/1742-6596/1889/4/042033
42. M. V. Kapitonov, (2022) IOP Conference Series: Earth and Environmental Science **1112(1)**, 012018 (2022)
43. E. V. Mikhailova, Journal of Physics: Conference Series **1889(4)** (2021) doi:10.1088/1742-6596/1889/4/042063