Improving the competitive abilities of mechanical engineering

L I Kushnarev
Bauman Moscow State Technical University, 5, Baumanskaya 2-ya Street, 105005, Moscow, Russian Federation
E-mail: kusharevl@mail.ru

Abstract. In the conditions of market relations, the demand for machines and equipment determines the level of their competitive abilities, which directly depends on the quality of these products. In this paper, the results of organizational and technological research on this issue are described. Their practical implementation will allow national engineering in a relatively short period of time to reach the world quality level for the production of highly competitive products, restore consumer demand in the technology market. This will also allow ensuring the stabilization and growth in production volumes at factories, increasing the economic efficiency of their activities, creating conditions for restructuring, diversification and technological modernization of manufacturing processes.

1. Introduction
In order to increase the level of competitive abilities of national high-tech industrial products, first of all, it is necessary to restore demand for it and increase production volumes, as well as to modernize production and technological processes not only at the factories of the machine-technological industry, but also in mechanical engineering in general.

Despite the tremendous demand for technological machines and equipment in almost all sectors of the economy, engineering enterprises do not have a stable demand for their products. And their production capacities are inefficiently filled. In a real economic situation, there is a constant decrease in production volumes and the quality of engineering products, its cost increases and competitiveness decreases. Own funds for innovative development of production, as a rule, are absent. This makes it difficult to restore the technological potential of engineering enterprises to a technical level that meets the requirements of the present days. In order to increase the demand for manufactured machines and equipment, enterprises, primarily in the engineering industry, face the challenge of rapidly improving the quality of manufactured products, machinery and equipment, which should be characterized by significantly higher rates than being produced up to the present moment [1,2].

The aim of the work is to raise the quality level of technological machines and equipment to the level of the best world analogues on the basis of the innovative development of existing factories and their reorganization into large engineering companies with a full technological cycle, covering all stages of the machine life cycle.

2. Research methods
The work uses statistical data and analytical reviews of the phased development of engineering and technology in mechanical engineering and the engineering-technological sector of the economy. It also includes the forms and methods of organizing production, production and service systems and
complexes, and systems for ensuring the required level of quality. The technology in the Russian Federation and in the technologically advanced countries of the West has become the informational basis for organizational-technological and technical-economic research.

The paper uses abstract, logical, monographic, statistical analysis including comparative assessments, which is the main method of the research.

3. Research results
An integrated approach to the study of the phased development of engineering and technology has made it possible to establish that machines and equipment produced by large machine-building enterprises with a higher level of centralization, specialization, and production cooperation belong to higher quality equipment.

With the development of centralization and specialization of production, more favorable conditions are being formed. They aim at increasing labor productivity, automation, robotization and computerization of production. Introducing advanced technologies and technical means allows one to ensure the development of manufacturing and improving the quality of details, machine components, units and machines [2-4,7].

Along with the consolidation of production plants in order to improve the quality of the manufactured equipment, it is necessary to reorganize enterprises into branded production and technological systems and complexes – firms. A special feature of such reorganization is the unification of all business units of an enterprise engaged in the creation and use of machines. This proceeds from idea to implementation, aimed at the highest possible quality improvement at all stages of a machine’s life cycle, which ensures an unprecedented level of its competitiveness.

The quality level of technological machines and equipment is laid at the stages of their design and engineering. It is very important to substantiate correctly the technical characteristics of the machine, which ensure its effective use during the real operating conditions.

The improvement of the production quality and reliability indicators of manufactured machines and equipment is impossible without the introduction of corporate technical service. This is shown by the results of organizational and technological research and advanced experience of the leading machine-building firms in the world. Corporate technical service is a powerful lever that stimulates the manufacturer to improve product quality constantly at all stages of the machine life cycle [5,6].

The implementation of such high-quality equipment should be followed by the development and organization of corporate technical service in relation to the proposed machines and equipment, primarily during the warranty period of operation, as well as a broad advertising campaign. Taking into account price competition and ensuring a high level of machinery and equipment efficiency during the warranty period, this will allow promoting highly competitive foreign products on the world market. That may contribute to a further increase in the native technology turnover and a significant increase in profits from its production and sale. The additional incoming from the product creation of a technical service product by a company at the initial stage of reorganization should be directed to investment in innovative production development.

The organization of branded production and technological systems allows determining the direction and degree of diversification - further deepening of the subject specialization of existing production. That will contribute to mass production of machinery and equipment, creating conditions for the production of high-quality engineering products. Thus, it is possible to conduct an organizational and technological modernization of production on the basis of the branded production and technological systems creation [7,8].

Special attention of equipment manufacturers should be focused on ensuring a high level of efficiency of machinery and equipment during the warranty period of operation including the study of failures and their causes to prevent them. The required level of machine and equipment operability during operation by the consumer will allow reducing the number of unplanned failures, machine downtime for technical reasons and avoiding economic sanctions during the warranty period for the low-quality equipment delivery. The study of failures and the reasons for their occurrence will make it
possible to establish unreliable units, assemblies, connections. In the process of designing and engineering, it lays down new technical and technological solutions leading to an increase in the quality of their manufacture and an improvement in the parameters of operational reliability.

Diversification of machinery production in improving the quality of machinery and equipment requires a deeper study of all the capabilities and quality characteristics of machines and their components. This will affect the quality of their manufacture and reliability parameters very positively in the future. Furthermore, it does not require the development of an absolutely new product. Additionally there will be the possibility of its constant modification, development and improvement of the production quality, enhancement of the operational reliability parameters. In this case, the production diversification in the machine builders will expand their production sphere, including the operation (using for business purposes and technical service) of machines and equipment. Thus it deepens the subject specialization and integrates it into the subject-technological specialization. With such diversification, there is no need to master the production of completely new machines and equipment, and the entire production potential and resources of the industry can be focused on solving organizational and technological problems of product quality, equipment performance and production efficiency [7-9].

Technological modernization of the main machine-building production should provide the necessary level of technical equipment of production, accuracy and efficiency of process equipment, quality of manufacturing and reliability of units, connections, components and assemblies of the machine. Technological processes of machine units and equipment production should tighten the tolerance bands and reduce undulation (micro-roughness) of the processed surfaces, first of all, heavy duty compounds and intensive wearing parts. To this end, it is reasonable to provide additional finishing operations (of processing) during manufacturing.

In addition, it is appropriate to make high-loaded quickly-wearing parts from more wear-resistant materials, and, if necessary, to harden surfaces. When constructing machine elements, it is important to proceed from the fact that the element must be in good condition and not require replacement or repair during the entire specified service life of the machine in actual operating conditions. Otherwise, one should provide redundancy of such elements of the machine and increase the repairability of the machine or unit for emergency replacement in actual operating conditions when carrying out planned preventive measures of the technical service system [8–10].

Technological modernization of production in the conditions of an acute shortage of funds for technical re-equipment should be based on a thorough technical and technological feasibility and on a technical and economic assessment of the effectiveness of technical and made technological decisions. The choice of the most rational solution begins with an assessment of the state and technological capabilities to ensure the highest quality products. If there are opportunities for refinement, modernization of the design of technological equipment at the same time, they should also be taken into account. After that, a technical and economic evaluation of the effectiveness of all considered solutions is carried out and the best option is determined.

From the perspective of a systematic approach and in order to compound all issues on technological modernization of production, even before it starts, it is planned to develop a special project for technological development of production. At the same time, the problem solution should be carried out simultaneously for both the engineering and the technical service industry [10].

Thus, to increase output, the following arrangements are needed.

1. Ensuring the world prestige of Russia in the field of mechanical engineering, solving the problem of import substitution on the basis of Russian production of competitive native brands of machines and equipment which are highly competitive with manufacturing quality and reliability indicators to the best world standards and analogues.

2. Improving the quality level and demand for domestic machinery and equipment. Full capacity utilization of enterprises for the production of complete machines and equipment and spare parts for them. Ensuring the growth of production in the first year of the project at least 2.5 times, margin - 5-10 times.
3. Solving the problem of improving the quality of engineering products through the introduction of a proprietary method of technical service (without alternative options), since such method has the potential for a stable and rapid improvement of the production quality and reliability indicators of manufactured machines and equipment.

4. Development and implementation of a proprietary technical service system in order to improve the quality of produced machinery and equipment and proprietary engineering and technical support for engineering products throughout its life cycle.

5. Formation of the organizational and economic mechanism of the system, stimulating the activities of all structures that provide proprietary engineering and technical support for engineering products, in improving the manufacturing quality and reliability factors.

6. Diversification of activities and development of engineering enterprises, based on the optimal combination of product and technological specialization of production and the principles of the complete technological production cycle, on the fulfilment and use of machinery and equipment in conditions of tough market rivalry based on the creation of firms – machinery manufacturers and the introduction of branded technical services for machines and equipment.

7. Diversification of enterprises activity in the direction of the corporate technical services system development for narrowing the nomenclature of subject specialization objects and concentration of limited production, technical and financial resources on technological modernization and development of production in order to improve product quality and introduce a system of branded technical services.

8. Carrying out technological modernization, accompanied necessarily by a constant and stable increase in the production of machinery and equipment, spare and component parts for them, high quality indicators of products (significantly higher than the previous ones), even before the start of the project.

9. Integrated implementation of the project tasks, providing quality improvement of machinery and equipment during operation, and first of all, about sudden unplanned failures, the reasons for their occurrence and the elimination of consequences. The analysis of these will allow taking measures and excluding their appearance in the future, using proprietary technical service (maintenance) of machinery and equipment.

10. Aggregation of all necessary information about the reliability of machines and equipment during operation, and first of all, about sudden unplanned failures, the reasons for their occurrence and the elimination of consequences. The analysis of these will allow taking measures and excluding their appearance in the future, using proprietary technical service (maintenance) of machinery and equipment.

11. Development of a modernized preventive system for maintenance and repair of machinery and equipment using modern means of monitoring, diagnosing and forecasting the technical condition as the basis for ensuring a high level of performance of operable machines and equipment. This will drastically reduce the costs of all types of logistical, labor and financial resources for carrying out planned repair and maintenance work, prevent a significant part of unplanned failure, substantiate the feasibility of carrying out complex repairs.

12. Reducing the technical service costs of machines and equipment by diagnosing the technical condition and forecasting the residual life time of machines, units, assemblies and connections due to the operator’s monitoring of a significant part of indicators characterizing the state of object reliability, directly during the operation of the machines and equipment according to indications of stationary computers on the control panel. (In case of critical deviations of indicators, the panel (the computer) should display relevant information about the occurrence or possible occurrence of a failure and instructions with recommendations about the necessary actions of the operator for its elimination.)

13. Mainstreaming the revision and justification of the types, frequency and composition of planned (regulation) operations - periodic maintenance, while avoiding sudden unplanned failures, especially during the warranty period of operation, into the work plan to improve the reliability of machinery and equipment. It is probable when taking all possible measures to increase significantly
the frequency of such regulation work by improving the quality of manufacturing elements, assemblies, machines and the use of effective lubricants and other operating materials.

14. Carrying out planned regulation repairs to ensure the required high level of machine and equipment operability during operation, partially or fully recovery of technical characteristics and operational parameters by the technical service system. They are advisable to build on the basis of an aggregate-nodal repair method when replacing failed or spare elements and assemblies for new or thoroughly repaired at the factory or a specialized repair company. In some cases it happens with technologically simple repair of components and assemblies, the presence of replaceable parts, the replacement of failed elements directly in the use of machinery and equipment.

15. The resource restoration of the long-term and intensively used machinery and equipment is due to physical deterioration of critical parts, components, assemblies or machines as a whole, to the limit state by carrying out general maintenance or general and repair maintenance as complete and carried out at the enterprises - manufacturers of machines and equipment, and assembly-unit repair. Units and assemblies requiring restoration of a full resource are repaired at manufacturing enterprises, and dismantling and assembly works are performed in the repair shops of an equipment consumer or technical service enterprise.

16. Ensuring the transition to the corporate method of technical service and the introduction of a stimulating organizational and economic mechanism in the design, planning and organization of current and capital repairs of components, assemblies and complete machines and equipment. This is based on the improvement of their manufacturing quality and reliability at the initial stage of the project. That will serve as a condition for an immeasurable reduction in the number of such works in comparison with the existing nowadays - this will be the first positive result.

The positive effect will increase when whole complex of measures will be taken to improve the quality of workmanship and the reliability of machines and equipment and the organization of company technical service. The repeated reduction in the intensity of the requirements flow for maintenance and repair will completely change the entire existing system of technical maintenance of machinery and equipment, the forms and methods of its organization, production and technological parameters and organizational and technological structure [11,22].

The data obtained as a result of the operation of an innovative system of proprietary technical service on the wear rates of all critical connections, components and assemblies would effectively manage the performance of machines and equipment.

The project implementation would fundamentally change the conceptual approaches to the renovation technologies development and application for manufacturing new and restoration worn-out machinery and equipment parts to improve the quality (accuracy) of manufacturing elements and interfaces, wear resistance of working surfaces and reliability of components and assemblies.

The main advantage of the implementation of the proposed system for improving the quality of Russian equipment based on the implementation of branded technical services is the struggle for quality at all stages of the life cycle of machinery and equipment by all structures involved in the process of their creation, usage and recovery. This stimulates the search for the best design and technological solutions, tightens the requirements for quality manufacturing, improves reliability in the ensuring of a high level of reliability of machines and equipment. As a result, new modern materials, high-precision methods of processing and hardening surfaces will be used in the manufacturing, and in combination with the use of high-performance lubricants, it will be possible to multiply the life of the manufactured elements of machines and equipment [13].

Only by this way, an accelerated solution of organizational and technological problems facing the state and Russian mechanic engineering is possible. Not only enterprises of mechanical engineering and machine-technological industries, but science and education will rise to a higher technological and cultural-technical level. Improving the quality will increase the efficiency of using substantially all types of resources in mechanical engineering and the machine-technological sector of the economy 2.0–2.5 times. The expected annual national economic effect will exceed 1.5 trillion rubles.
4. Conclusion
The following ideas can be proposed.
1. To implement measures for restoring the demand for domestic equipment on the basis of improving its quality.
2. To improve the quality of machinery and equipment based on the corporate technical service introduction.
3. To direct the restructuring, diversification and technological modernization of manufacturing to ensure the world level of quality technology.
4. To ensure not only the operability of the equipment during its operation, but also to eliminate the causes of failures at all stages of the life cycle of the machine on the basis of the organization of the company technical service system.

References
[1] Edwards D 2011 Exit from the crisis. New paradigm of managing people, systems and processes (Moscow: Alpina Publisher) p 400
[2] Ford G 2014 My life (Moscow: AST) p 352
[3] Kiselev M I, Pronyakin V I and Tulekbaeva A K 2018 Technical diagnostics functioning machines and mechanisms IOP Conf. Ser.: Mater. Sci. and Eng. 312(1) 152
[4] Gubaydulina R H, Gruby S V and Davlatov G D 2016 Analysis of the Lifecycle of Mechanical Engineering Products IOP Conf. Ser.: Mater. Sci. and Eng. 142(1) 129–133
[5] Vasiliev A S 2016 Controlled Forming of Machine Components Operating Characteristics Procedia Eng. 150 975–979
[6] Nikolaev A B, Prikhodko V M, Stroganov Y V, Tregubov P G 2014 Tools of production and logistics support life cycle of high-tech products Life Science J. 11 238–242
[7] Aleshin N P, Grigorev M V, Shchipakov N A, Priluts’kii M A, Murashov V V 2016 Using nondestructive testing methods for in-production quality control of additive manufactured parts Russian J. of Nondestructive Testing 9 64–71
[8] Chernoivanov V I, Severny A E, Kushnarev L I 2000 Problems of technical service in the Russian agricultural sector (Moscow GOSNITI) p 309
[9] Kanchevli A D, Kolobov A A, Omelchenko I N 2001 Strategic management of the organizational and economic sustainability of the firm: logistics-oriented business design, ed. by A Kolobov, I N Omelchenko (Moscow, Publishing House of Moscow State Technical University n. a. N E Bauman) p 600
[10] Chepurina E L 2013 State of organization of technical service of livestock machinery and equipment Int. Techn. and Econ. J. 4 61–66
[11] Chepurina E L and Kushnaryov S L 2013 Organization of company technical service of agricultural equipment Tractors and Agricultural Machines 10 3–4
[12] Chepurina E L 2017 Directions for improving the competitiveness of domestic machinery and equipment for livestock farm Repair. Recovery. Modernization 7 3-7
[13] Kushnarev L I 2014 Company technical service of machinery and equipment Problems. Search. Solutions (Saarbrucken Deutschland Palmarium, Academic publishing) p 210