Towards consistent high quality of engineering products

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Abstract. The low level of competitiveness and the constantly growing requirements of consumers for modern domestic technology indicate an urgent need to improve the quality of technological machinery and equipment produced by engineering. Ensuring a competitive world-class quality of the produced machines and equipment requires innovative development and modernization of the production organizational and technological system of mechanical engineering. Only the association of modern engineering companies is able to unit and direct the efforts of all participants in the process of creating machines towards a stable, continuous improvement in the quality of equipment. Encompassing quality control at all stages of the life cycle of a machine, the company as soon as possible and without any special financial expenses ensures the highest world level of quality of engineering products.

The goal of research is to comprehensively improve the quality of Russian-made machinery and equipment to the level of the best world analogues and higher based on the creation of an innovative production and technological system (complex), ensuring the as great as practicable level of quality of equipment at all stages of its life cycle.

The results of feasibility studies show, that a non-competitive level of quality of domestic equipment has developed and is maintained, despite the efforts of manufacturers, due to the long-term maintenance of the existing manufacturing system and production relations, requiring urgent and accelerated modernization. The main disadvantage of the existing manufacturing system in mechanical engineering is the isolation and fragmentation of enterprises and institutions working on the creation of machinery and equipment, the incompleteness of the production and technological chain, the lack of engineering and technical support of processes at all stages of the life cycle and, first of all, at the stage of operation of equipment. Therefore, in this article, we consider and propose a complex of priority organizational and technological measures providing the accelerated innovative development of the manufacturing system and improve the quality of Russian equipment above the level of the best world analogues.

Introduction
Engineering factories are going through hard times today. They are urgently faced with a huge complex of problems requiring accelerated solution: reestablishment of the high-manufacturing volumes of machinery and equipment for many machine-technological sectors of the economy; elimination of the problems of import independence and import substitution industrialization, other negative consequences of the low competitiveness of domestic engineering companies and equipment; innovative transition and development of energy-efficient machine-building production and providing machine-technological sectors of the economy with high-quality and energy-efficient equipment [1–4].
The solution to these problems involves the maximum use of the possibilities of restructurisation, integration, diversification and technological modernization of almost all types of industries and sectors of the economy - both producing and using machinery and equipment. Each of the above listed areas of innovative development of mechanical engineering and machine-technological sectors of the economy requires a progressive scientific foundation, which should, on the one hand, become the main focus of the development of the country's economy, and on the other, — provide a comprehensive innovative solution to the whole complex of problems [3–8].

The obtained results of inter-industry organizational, technological, organizational and economic analytical studies in the areas of production, usage and technical maintenance of machinery and equipment indicate technological necessity, economic efficiency and the availability of organizational capabilities, providing a packaged solution to these problems. And this is possible only with a systematic approach to the entire complex of problems, and not separately for each, since only in this case the problem of restructurisation the engineering industries and related machine-technological sectors of the economy is automatically solved [6–9].

A comprehensive and systematic approach to a detailed analysis of production and economic conditions and the relationship between manufacturers and consumers of machinery and equipment indicate that the target guidelines and criteria should be comprehensive support for improving the quality of engineering products, not lower than the best foreign analogues. Only improving the quality of engineering products can provide a solution to all the above listed problems of manufacture [10–14].

During the entire life cycle, the quality of engineering products is formed by 75% at the stage of design and construction of machinery and equipment, by 20% — during manufacturing, and only 5% is ensured by proper operation — production (when used for its intended purpose) and technical (while ensuring operational integrity) (Fig. 1) [8, 9, 13].

![Fig.1.formation of quality at various stagesofthemachinelifecycle](image)

At the same time it should be noted that for a high level of quality at the design and construction stage, it is necessary not only to have complete and reliable information about the quality indicators of machines and equipment, but also to have feedback with the structures that service their operation. And this just does not exist in modern system of designing, manufacturing and using machinery and equipment. Each element of this system decides to the detriment of others its own private and narrow company interests, which ultimately result not in a positive but a negative national economic effect. The products manufactured with huge costs of all types of production material and technical resources
are noncompetitive, with an unacceptable price-quality ratio, which requires huge production resources to ensure operability in the form of creating a whole system of powerful technical service enterprises.

All this will continue until the manufacturers of machines and equipment will participate in ensuring the operation processes of their machines and equipment and, first of all, in ensuring their operational integrity during the warranty period of operation, which must be at least not less than presented by technical requirements and established by Russian standards.

**Suggested Solutions**

Therefore, at present, it is necessary in conditions of intense but healthy competition in the technology marketing area to ensure the transition to a full-size proprietary method of technical service of machinery and equipment (Fig. 2). And the need to have their own systems of proprietary technical service should relate, first of all, to foreign manufacturers and suppliers of machinery, machinery and equipment, and not only to Russian manufacturers. The first step in this direction should be done the control by Russian State Technical Authority over the quality of imported machines and equipment in completes, for the presence of visual defects, for time between failures, etc. and if necessary, prevent the sale of obviously faulty equipment to Russian consumers.

![Fig. 2. The organization of the firm and technical support](image)

In the case of failures during the warranty period of operation of machinery and equipment, Russian State Technical Authority services must involve (or provide assistance) and control the elimination of the consequences of machine failures by the forces and means of the manufacturer's warranty service. Besides, the consumer of engineering products has the right to compensation for losses (lost profits) caused by machine downtime for technical reasons. Such claims may be presented either to manufacturers of equipment, or to their technical representatives — dealer structures, depending on who is responsible for the supply of low-quality equipment to the consumer under the supply agreement.

Since in the process of supplying facilities, machinery and equipment to consumers, during the warranty and post-warranty periods of operation, production engineering measures and servicing operations are required, instead of purely intermediary structures — the "dealers" there should be engineering and technical structures — technical representatives of manufacturing. They should have the necessary facilities and finances prepared by experienced personnel for engineering and technical support and monitoring the proper operation of machinery and equipment at the consumer; do the information acquisition on the reliability of the machine, components and assemblies, operating
conditions, requirements by consumers to the technical characteristics and capabilities of the machines, on reliability indicators, etc. Special attention should be paid to the time between failures, appearing failures, research and establishing the causes of their occurrence, the complexity and working time of eliminating them, and not only during the warranty period of operation, but also the after-warranty period.

Regarding the contract for the supply of machinery and equipment, — it should be wholly and completely referred at ensuring the main strategic goal of the branded technical service — comprehensive improvement of the quality of engineering products, ensuring the required level of reliability and efficiency of machinery and equipment delivered to the Russian consumer. Objectives to ensure these goals should be rationally distributed in accordance with organizational, technological and organizational and economic capabilities between the manufacturer of machines and equipment and their engineering and technical representatives. Of course, the agreement having the status of the main legal document, should be reflected the rules and requirements for the level of operation of machinery and equipment.

The main stimulating factor in ensuring consumer rights and the proper construction of relationships in the system of corporate technical service is a specially developed mechanism of organizational and economic relations. It is referred at implementing the above listed goals and objectives of corporate technical service to realistically increase the competitiveness of manufactured machines and equipment, increase their efficiency and ensure the priority of consumer rights, first of all, to purchase high-quality and reliable equipment, and not to constant servicing under warranty and post-warranty periods of operation [14–18].

**Fig. 3.** Improving the quality of technology through the creation of innovative industrial and technological systems (firms)

For the practical implementation of full-scale corporate technical service in the regions in the conditions of unhealthy competition, with an unprecedented level of monopolism of equipment manufacturers and their collusion with trading organizations, with complete disregard for the rights of consumers of machinery, facilities and equipment, management and control of the renovation of machinery and equipment should be taken by territorial oversight organizations (Russian Federal Consumer Rights Protection and Human Health Control Service, Russian State Technical Authority,
etc.). To improve the mechanism of relations between manufacturers and consumers of equipment the «Regulation on the organization of mandatory engineering and technical support service (provision or service) by manufacturers and suppliers to the region of their machinery, machines and equipment throughout their entire life cycle» should be developed. Moreover, they eliminate the consequences of failures that arose not through the fault of the consumer, they eliminate at their own expense, using their own financial resources and means, with the compensatory damages caused to the consumer by simply delivering low-quality equipment. In the future, on this situation, it is advisable to pass two legislative acts, the first - on the mandatory engineering and technical support of engineering products throughout its entire life cycle, the second - on the protection of the rights of consumers of industrial products [18–21].

Conclusion

It is advisable to entrust the formation of technical and technological policies to specialized services of departments of manufacturers and consumers of equipment with the involvement of scientific and educational institutions actively working to solve this problem (project) — the improving the quality of manufacturing and reliability of equipment based on the development and implementation of a proprietary method of technical service.

Currently, a significant scientific groundwork has been created on this issue, the main propositions of which can be put into practice in a short time, both on a state scale and within the framework of regions and individual companies manufacturing machinery and equipment. The final result of the research is a system developed and implemented in real production to improve the quality of manufacturing and reliability of equipment based on the proprietary method of technical service.

The economic efficiency from the introduction of research results has a multidirectional synergistic character and can amount to more than 2.0–2.5 trillion rubles for the national economic complex of the country. A significant part of the economic benefits is the decrease of the need for equipment, material and technical resources for its operation, the decrease of the need for repair, technical facilities and equipment, qualified servicing personnel, the reduction in product losses and its quality during machine and equipment downtime due to technical reasons and etc. Estimated efficiency is so high that, in aggregate, it will allow to reduce the cost of agricultural products, mechanized work and services by 35-50%. And this will positively affect the efficiency of production and economic activity of companies of many machine-technological sectors of the economy.

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