

# ЕКОНОМІКА ПРОМИСЛОВОСТІ ТА ОРГАНІЗАЦІЯ ВИРОБНИЦТВА

## INDUSTRIAL ECONOMICS AND ORGANIZATION OF PRODUCTION

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### MODERNIZATION OF MACHINE-BUILDING ENTERPRISES: THE CHOICE OF PARAMETERS AND QUALITY INDICATORS

S.V. Filyppova, DEcon, Professor

V.A. Saadzhan

*Odessa National Polytechnic University, Odessa, Ukraine*

*Філіппова С.В., Сааджан В.А. Модернізація підприємств машинобудівної галузі: вибір параметрів та показників якості.*

Розглянути параметри якості продукції та запропоновані показники, за допомогою яких необхідно проводити оцінку якості проектних робіт по створенню нового продукту, здійснювати впровадження у виробничий процес як нових технологій та обладнання, так і, випуск нових видів продукції машинобудівної галузі.

*Ключові слова:* модернізація, групи параметрів якості, показники якості, вибір, оцінка

*Філіппова С.В., Сааджан В.А. Модернизация предприятий машиностроительной отрасли: выбор параметров и показателей качества.*

Рассмотрены параметры качества продукции и предложены показатели, с помощью которых необходимо проводить оценку качества проектных работ по созданию нового продукта, осуществлять внедрение в производственный процесс как новых технологий и оборудования, так и, выпуск новых видов продукции машиностроительной отрасли.

*Ключевые слова:* модернизация, группы параметров качества, показатели качества, выбор, оценка

*Filyppova S.V., Saadzhan V.A. Modernization of machine-building enterprises: the choice of parameters and quality indicators.*

Discussed the parameters of product quality and performance offered by which it is necessary to assess the quality of design work on a new product, to carry out the implementation of the production process as new technologies and equipment, as well as, new kinds of products for mechanical engineering.

*Keywords:* modernization, a group of quality parameters, quality indicators, selection, appraisal

The development of STP helps reduce the life cycle of most products in various industries, leading to increased competition and, consequently, to accelerate the process either to update the product or production process of its manufacture. It requires businesses modernization. The need for modernization is associated with several factors:

- depreciation of fixed assets of enterprises (industry – 72,7% (including: chemical industry – is 83,8%, automobile industry – 72%, machine building – 57,3%);
- utilization of the energy produced (40,6%);
- significant energy and material production;
- the excess of imports over exports of some products [1, 6].

As world experience shows the development of particular importance in the modernization process is the machine building industry as the leading industry. The state and development of the machine building industry reflects the level of scientific-technical potential of the country because it depends on the level of productivity, development of scientific-technical progress and should provide the material base of modernization processes. In developed countries, the sector of products manufactured by the industry accounts for one-third of the total volume of industrial production. So, this index in Japan is 50%, Germany – 48%, Sweden – 42%, the USA – 40%, France – 38%, UK – 36%, while in Ukraine the level of this index is only 21%.

Machine-building industry can to solve problems associated with: increased technical and organizational level of enterprises in other branches; improving the quality and competitiveness of products; the transition to the production of new generations of machines and mechanisms, capable of

providing multiple productivity growth and the introduction of advanced technologies, primarily energy – saving; the rise of the level of mechanization and automation of all stages of production development from sample to mass production of finished products.

The quality and competitiveness of products manufactured in the sectors depend on technical and organizational level of machine-building enterprises and quality of manufactured products by branches-consumers. To create appropriate conditions for the development of other branches of the machine-building industry requires intensive development based on innovation. In this regard, the main objectives of the modernization process should be design and production of competitive products and expansion of the range and variety of products regardless of its belonging to group A (production) or B (consumption).

Manufacture of products that would meet the best world standards and surpassed them. In view of the current state in the industry to accelerate the modernization process should:

- to identify the need and opportunities for quality improvement renewal and transition to new products (technologies), the expansion of the range and nomenclature;
- identify areas for improvement of the existing technologies, products and development of new types tailored to the needs of the market;
- to explore current and existing research and development to improve, upgrade and design of the products in this specific area, both domestic and foreign markets;
- to optimize decision-making about the need and opportunities to design, create, prototype, testing, or acquisition of domestic (imported) product no similar or superior characteristics of domestic and international samples;
- to create conditions (financial, legal, information) to accelerate the process "research – design – research – test – production-commercial implementation".

The process of modernization in modern conditions of economic development should be based on the following principles:

- development and introduction of new technologies, first of all, energy saving, improving the quality and competitiveness of products;
- ensure high temp of conduct;
- formation of cluster forms of organization to improve financial and economic potential of enterprises;
- putting requirements to fast payback.

Factors leading to the implementation of the modernization process and the principles of its implementation allow to draw a conclusion about one of the main directions of modernization in the machine building industry – the increasing level of product quality. Changes the level of quality of machine building products can be achieved provided:

- production on a new technical basis;

- accounting functional needs of consumers;
- creation of competitive machine building products on such basic indicators as the consumption of materials, energy, performance in comparison the best foreign or domestic samples of the same functional purpose.

The achievement of these goals is possible according to basis of ensuring the appropriate quality of production technologies and products. Therefore, in modern conditions of economic development of particular relevance in the modernization of machine-building enterprises acquires the quality management process, identifying groups of factors and, in particular, performance-characterizing.

#### **Analysis of recent researches and publications**

In Ukraine terminology, metrics and methods of determination the quality level normative-technical documents are accepted as governmental standards and technical requires (GSTR) 2925-94 "Quality products. Assessment of quality. Terms and definitions", GSTR 3230-95 "Quality management and quality assurance. Terms and definitions" [2, 3] and others. Approaches to this problem are covered in the works of such researchers as Brevnov A., Bagiev G., Gurovich A., Deming E., Zakharchenko V., Zahozhay V., Romanov A., Saluhina N., Cherniy A., Yazvinskaya O.

There are different interpretations of quality. In accordance to GSTR 2925-94 "quality is the totality of characteristics of products that relate to its ability to satisfy stated and provided for the needs of consumers [2]. The E. Deming defined quality as customer satisfaction and not only to its expectations, but also foreseeing its future changes [5]. This definition is especially important in modern conditions of accelerating scientific-technical progress.

Recently it was generally accepted when considering the quality of the products was mainly used to evaluate individual characteristics that characterize its quality.

Japanese school of economics and economists in the USA have expanded the concept of quality and established a quality management system based on quality not a single aspect and with a number of different parameters characterizing the quality of the products [7].

K. Isikawa stated: the proper application of CWQC (Company-Wide Quality Control – system quality control) across the organization has a number of positive effects the main are following:

- cost reduction;
- reducing the costs associated with the inspection and testing;
- reducing the number of defects and enhancements;
- increase the volume of production and the possibility of improving its processes;
- development of new and improvement of existing technologies and technological processes;
- execution and implementation of contractual obligations of producers to consumers [7].

The most clear definition of quality and its role on production activities, scientific and technical progress, according to our point of view, was proposed by such Ukrainian researchers as V. Zahozhay, N. Saluhina, A. Cherniy, O. Yazvinskaya, they have summarized the international experience. According to their definition, quality is one of the main indicators of production efficiency, scientific-technical and social progress, representing the totality of characteristics of object that is able to satisfy stated and implied needs and includes technical, economic, operational, social and other properties of products and processes that characterize its usefulness [4].

Despite a significant number of studies according to quality improvement, the selection of groups of quality parameters that have not been fully considered indicators corresponding to these groups in the implementation of streamlined processes for decision-making in the selection and return preferences of a particular process or product in the line extension or modification on the enterprises of machine-building industry, which is the problem of this study. To implement the goal of work the following tasks:

- to identify the characteristics of the products (technologies), which it can be described;
- to determine the group of quality indicators;
- to select group of quality parameters and its corresponding indicators to assess the selection of technologies (equipments) for machine building industry.

### The main part

Products (technology) can be characterized by a sufficiently great number of characteristics which it possesses or should possess. It is well known, the quality must be considered from the point of view:

- functional purpose;
- technological (production, consumption);
- technical mastery;
- reliability;
- security;
- ecologically;
- prestige;
- ergonomics;
- aesthetics;
- guaranty;
- standardization and certification.

There are different approaches to combining of quality to certain groups. Researched and compiled various parameters of quality and approaches according to its groups we have identified the following groups:

- 1) the technical group, which should be considered such factors as:
  - assigning properties of the product, determine its main function);
  - features – the level of mechanization and automation, the level of use of the software, the level of production capacity);
  - reliability (reliability, durability, maintainability and indicators for sustainable development of the

company, which produces these types of products);

- standardization and certification (compliance to standards and unification, the level of unification and other types of products, standardization and unification of normative-technical documentation);
- limiting harmful impacts (safety, environmental friendliness, ergonomics, aesthetics (design)) to ensure: compliance with statutory validity of the protective devices not causing damage to the health of consumers and harm to the environment, convenience when performing work during operation and maintenance process;
- optimizing the use of resources through effective design and technical solutions aimed at reducing the duration of the production cycle, material and financial resources in the design, production and use (consumption) of products;

2) the group patent law – the detection of novelty, patent purity and ensuring patent protection technical design decisions and the availability of know-how in technological solutions, the registration of the industrial marks, trademarks, etc.

3) the group after sales service guarantee, post-guarantee maintenance, transportation, preservation of the quality characteristics of the products during transport, utilization, number of reclamations, number of delivered reclamation, number of claims;

4) the group feeling quality – the image of the manufacturer, clearness of orders, corresponding the particular category of quality;

5) the group of economic indicators – price, costs for design, operation and service. The formation indicators of this group are based on the work of previous groups. This is due to the fact that the price in the design and production must take into account all the parameters, not only the cost but the features and distinctive features in comparison with analogues. For the consumer it is important compliance "price – quality".

For reliable assessment of the quality and determine compliance rates of production it is necessary to investigate a great number of indicators, as the quality of machine building products is an integrated index, the constituent elements of which must be the quality of design, quality and functional properties, quality of raw materials, the quality of intermediate products and components, quality machining, build quality, packaging and transportation, quality of installation and commissioning, operating machines and equipment, quality of design and ergonomics, quality maintenance and disposal.

In the process of modernization the production of machine-building enterprises during pick choice of technologies, technological processes, equipment requires a special approach to the selection of groups of parameters of quality and performance they are relevant. Based on research and review of the quality parameters of the products we proposed indicators which we should assess the quality of design work to

create a new product to introduce into the production process as new technologies and equipment, and the production of new types of products of machine

building industry. For this selected group of quality parameters and the corresponding parameters (table 1).

Table 1. Group quality indicators and characterizing indicators

Group quality parameters	Indicators
1. Technical and technological	<ol style="list-style-type: none"> <li>1) Scope (functionality);</li> <li>2) Constructive-technological complexity;</li> <li>3) The level of mechanization and automation;</li> <li>4) The level of software using;</li> <li>5) The level of production capacity;</li> <li>6) The complexity of assembly and disassembly;</li> <li>7) Easiness of assembly;</li> <li>8) The level of commonality to another types;</li> <li>9) The compatibility level;</li> <li>10) Storage conditions;</li> <li>11) The complexity of identifying the causes of problems;</li> <li>12) The utilization of safety disposal;</li> <li>13) The ability to detect and troubleshoot;</li> <li>14) The possibility of conducting inspections and tests for the purpose of approval of the project, including specific requirements for inspection and testing;</li> <li>15) Technical requirements for materials, spare parts and assembly sites;</li> <li>16) Conditions and operation;</li> <li>17) The permissible level of harmful emissions into the environment;</li> <li>18) Harmful hazardous components to the environment;</li> <li>19) The availability of new technological solutions;</li> <li>20) Utilization of material resources;</li> <li>21) Patent cleanliness and ensuring patent protection technical design decisions;</li> <li>22) The availability of know-how in technological solutions;</li> <li>23) The presence of the registration of an industrial and/or trademarks.</li> </ol>
2. Features (uniqueness)	<ol style="list-style-type: none"> <li>1) Complex of profiles, multifunction;</li> <li>2) The flexibility of modification;</li> <li>3) Adaptation to the operating conditions and environment (temperature changes, etc.);</li> <li>4) Specific requirements for training/</li> </ol>
3. Operation	<ol style="list-style-type: none"> <li>1) Material costs of operation: <ul style="list-style-type: none"> <li>— material;</li> <li>— water, gas consumption;</li> <li>— energy intensity;</li> <li>— the level of production of the marriage;</li> <li>— dimensions (footprint);</li> </ul> </li> <li>2) Expenditure on staff training: <ul style="list-style-type: none"> <li>— productivity;</li> <li>— production capacity;</li> <li>— complexity;</li> <li>— the duration of the production cycle;</li> <li>— maintenance during operation;</li> </ul> </li> <li>3) The availability of the necessary material resources (suppliers, customs obstacles so on): <ul style="list-style-type: none"> <li>— the complexity of the operations (activities) and the need for professional training (user);</li> <li>— the current and capital repair;</li> <li>— maintainability;</li> </ul> </li> <li>4) Repair complexity (parts availability, and others): <ul style="list-style-type: none"> <li>— availability of trained personnel for the repairs and debugging;</li> <li>— the complexity of identifying the causes of problems;</li> <li>— the complexity of the performance;</li> <li>— deadlines;</li> <li>— availability of the service);</li> <li>— the provision of harm limitation;</li> <li>— adherence to the stipulated validity of the protective device;</li> <li>— the level and likelihood of harm consumers and harm to the environment;</li> </ul> </li> <li>5) The level and the probability of emission of harmful substances: <ul style="list-style-type: none"> <li>— ergonomics;</li> <li>— aesthetics.</li> </ul> </li> </ol>

Continue table 1

Group quality parameters	Indicators
4. Dependability	<ul style="list-style-type: none"> <li>— Continuity;</li> <li>— Reliability;</li> <li>— The presence of embedded systems auto shut-off in case of changes in energy, water and gas systems;</li> <li>— Professionalism in the preparation of the instruction manual;</li> <li>— Durability.</li> </ul>
5. Accordance	<ul style="list-style-type: none"> <li>— The expected and received effect by consumer;</li> <li>— Specification and standardization of parts, components, accessories;</li> <li>— Ensuring adequate financial resources;</li> <li>— Products of the project, including requirements for special processes, mechanization, automation, Assembly and installation of components;</li> <li>— The requirements for labeling, warning labels, identification labels, packaging;</li> <li>— Regulatory requirements, national and international standards;</li> <li>— The requirements of the environment;</li> <li>— The level training;</li> <li>— The level of commonality with another products;</li> <li>— The adaptability factor;</li> <li>— The coefficient of repeatability;</li> <li>— The coefficient of mutual unification;</li> <li>— The degree of development and use of normative-technical documentation.</li> </ul>
6. Service life	<ul style="list-style-type: none"> <li>— Life cycle;</li> <li>— Durability;</li> <li>— Useful life.</li> </ul>
7. The sense of quality	<ul style="list-style-type: none"> <li>— The image of producer;</li> <li>— Clearness of processing;</li> <li>— Class;</li> <li>— Compliance with defined quality categories.</li> </ul>
8. After-sales service (service)	<ul style="list-style-type: none"> <li>— Transportation (availability of transport);</li> <li>— Preservation of the quality characteristics of the products during transportation;</li> <li>— The number of reclamations;</li> <li>— The number of accepted reclamations;</li> <li>— The number of claims;</li> <li>— Guarantee;</li> <li>— The presence service;</li> <li>— The security relevant components.</li> </ul>

Technical and technological parameters, the consideration this point of view of functional and possessing certain properties and characteristics, which are a useful effect, as well as patent-low opportunities.

Features or unique settings that may have separately considered the objects (for example: multiprofile, multifunction, modification, adaptation to the operating conditions and environment: temperature and other climatic conditions), requirements to increase the level of qualification and the development of appropriate knowledge, abilities and skills of the personnel.

Operation. Various technologies and equipment have different operating characteristics and therefore the characterizing indicators. It is necessary for a decision to consider the operational characteristics from the point of view:

- saving material costs;
- improve performance;
- supply of the service process with the necessary material resources;
- provision of professional level staff;

- opportunities for current and capital repairs;
- limit the harmful effects of the ergonomics, aesthetics, technical and ecological safety of personnel and the environment.

Proposed indicators for evaluating performance (table 1), according to point of view of costs' minimization (by reducing: material consumption; energy consumption; water and gas; manufacturing defects; space; and do not harm consumers and harm to the environment), will allow to optimize the solution in the choice of technology or equipment for modernization of production. Measurement of ergonomics (the product complies with the properties of the human body during work operations and interaction with the machine, which are hygienic, anthropometric, physiological, psychophysiological, psychological) and aesthetics (simulating the external perception of products through the adoption of design solutions to reflect its properties, and which are essential for the user), are important in the perception and performance of the production process.

The commitment of this group of indicators like reliability with such security as the availability of embedded systems auto shutdown (in case of

disappear the energy, water and gas system), professionalism in the preparation of the manual, will help ensure that, with strict observance of the actions prescribed in the regulations, continuity, reliability, durability, and safe operation, thereby reducing downtime associated with displaced repairs, increased productivity and product quality.

Not less important place group of indicators – compliance is occupied. It is necessary to assess compliance accordance expected and received effect by the consumer, specifications and standardization of parts, assemblies, components, requirements for special processes of mechanization, automation, Assembly and installation of components, packaging, labeling, warning signs, identification signs, regulatory requirements (characterizing the properties of the product which are subject to mandatory norms, standards and legislation in a market where this product is supposed to sell and in the case of non-compliance with applicable standards and regulations, it cannot be used to satisfy existing demand and therefore has no buyer's consumer cost, national and international standards), environment, level of training, level of commonality with the other products. While such indicators are calculated as the ratio of adaptability, the coefficient of repeatability, coefficient of mutual alignment, the degree of development and use of normative-technical documentation.

Service life is characterized by a life cycle assessment of the technology or equipment and plays a special role in the modern rapidly developing scientific and technological progress. Therefore, it is very principally to establish the useful life of the given moral and physical deterioration.

The sense of quality should be viewed through the prism of the image producers, recognition of its market, its high economic indicators, referring to a particular category quality of their products.

To the quality assessment of alternative options for the purchase of specific technologies or equipment should be included after-sales service, so as a follow-up operation after the acquisition depends on the quality of transportation (packaging and the availability of appropriate vehicles, ensuring the preservation of the quality characteristics of products during transportation), the guarantee of the existence of the service, providing the relevant components and repairs, if necessary, which creates conditions for the recovery of the initial properties and maintain the quality, continuity of the production process to the extent possible and likely in the case of modernization

to spend modification technology or equipment due to the standardization and unification of parts, components, accessories.

### Conclusions

The implementation of the modernization process, and the principles of its implementation allow to draw a conclusion about one of the main directions of modernization in the engineering industry is the increasing level of product quality. Changes in the level of quality of engineering products can be achieved, provided that:

- production on a new technical basis;
- accounting functional needs of consumers;
- creation of competitive engineering products on such basic indicators as the consumption of materials, energy, performance in comparison with the best foreign or domestic samples of the same functional purpose.

In modern conditions of economic development of particular relevance in the modernization of machine-building enterprises acquires the quality management process, identifying groups of factors and, in particular, the characterizing indicators.

Quality must be considered from the point of view: functional purposes; technology; technical mastery; reliability; security; eco logical; the prestige; ergonomics; aesthetics; warranty; standardization and certification. Researched and compiled various quality indicators and approaches for its association we have identified the following groups:

- technical and technological;
- patent law;
- after-sales service;
- a sense of quality;
- economic indicators.

Based on research and review of the quality parameters of the products we proposed indicators which we should assess the quality of design work to create a new product to introduce into the production process as new technologies equipment and the production of new types of products at machine building industry.

The theoretical importance of the studies is to control the quality of engineering products at any stage (design, development and implementation).

The prospect of further research is the development of methods of quality assessment regards to the proposed groups of factors and indicators and the practical application them on the machine-building enterprises.

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Філіппова Світлана Валеріївна / Svitlana V. Filyppova  
*jackal@te.net.ua*

Сааджан Валентина Арамівна / Valentina A. Saadzhan  
*pusya54@mail.ru*

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