

## The modern quality control of preproduction sphere in a company

**M. Dudek-Burlikowska\***, **D. Szewieczek**

Division of Materials Processing Technology, Management and Computer Techniques  
in Materials Science, Institute of Engineering Materials and Biomaterials,  
Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, Poland

\* Corresponding author: E-mail address: marta.dudek-burlikowska@polsl.pl

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### Industrial management and organisation

#### ABSTRACT

**Purpose:** A new approach for quality control and improvement of preproduction sphere in organization with usage of chosen quality research methods has been presented.

**Design/methodology/approach:** The possibility of usage of method of product modernity is connected with improvement of preproduction sphere of organization, and the result - improvement the products. Interdependence of the quality control and quality research methods in preproduction sphere and management processes has been taken into account.

**Findings:** At the present time the enterprises should integrate management system in preproduction sphere and their continuous improvement with quality management, knowledge management and intellectual capital. Such kind of strategy will enable to achieve success for these companies.

**Research limitations/implications:** Described a few quality methods in preproduction sphere and quality analysis of product modernity can be employed in companies, in which the modern quality control has been implemented.

**Practical implications:** Averaging Quality Rating method can be used in companies for estimation of quality index of product modernity. Usage of this method can improve functionality of preproduction sphere.

**Originality/value:** Describing and comparing modernity of product inside company with usage of Averaging Quality Rating method has been presented. This method is a propose of new strategy to increase of effectivities and efficiencies activities of preproduction sphere.

**Keywords:** Quality management; Product modernity; Averaging Quality Rating method

### 1. Introduction

Quality engineering which means in practice monitoring and improvement the quality of produced product is the absolute necessity in present day free-market economy. This is a result of synergy interaction between several factors.

First, the most essential for businessmen is possibility of profit increase. Offering the products of higher quality favours logging a new customers and at the same time convince the present customers about good choice of supplier. On the other hand, the profit of company grows up as the result as decreases

the quantity defects and lacks also through using quality estimation methods in each sphere of companies activities [1,2].

The next factor concerned is environmental life cycle of product. Effective quality monitoring and quality control helps companies to fulfill the rigorous requirements connected with on environmental and industrial safety. Products, for which all processes with effect from engineering design, through production and exploitations and utilization finishing, should have implement the suitable monitoring and control. It can be good step for products quality and environmental [3,4].

Another factor, can motivate companies in quality monitoring and quality control, is increase in competitiveness. Such activities

are connected with improvement of prospects of companies, what means possessing a certificates confirming efficiency of quality system management or achieve a quality prizes. At the same time we can mark that the desire of obtainment of certificate or quality prize should be the most important incentive to investing in quality engineering – quality monitoring and quality control [4-6].

In this paper selected problems, connected with quality engineering, quality monitoring and quality control using quality estimation method in company have been presented. Also suitable examples of usage of method of estimation modernity product in Polish companies have been given.

## 2. Connection between standard ISO 9000:2000 and modern quality control conception

Analysing last forty years it is possible to notice, that the applied quality control for many years is not enough for quality assurance of system and processes.

Such situation was the consequence of dynamic technical progress caused by demand on products of larger complexity. Thus customers began paying attention of their suppliers on essential problems of traditional quality control, and among other things [4-6]:

- Defects and discrepancies, which are most often detected in advanced step of productions process, as a consequence of this activities causes expensive repairs.
- So disclosed defects influence on reputations of company.
- It is possible that some products being practically apart from range of final control in supplier's company.

Such opinions caused the need for creating uniform model of organization for all companies - Standards ISO 9000:2000, ISO 9001:2000, ISO 9004:2000- that would create such conditions of confidence of their process and products, that the risk of defects occurring would approach absolute zero – Process approach, Continuous improvement of system and processes. According to standard ISO 9000:2000 process has been defined as set of interrelated or interacting activities which transforms inputs into outputs [7-10].

In present times “process approach” is a basis for creation of Quality Management System according to standard PN-EN ISO 9001:2001. It is also the base for complex quality management conforming with principles Total Quality Management (TQM).

This aspect contains the following elements: the philosophy, strategy and correcting tools as well as the techniques for value creation. To achieve superior values well defined strategies are indispensable: evolutionary improvement (Kaizen) and revolutionary improvement (reengineering).

The suitable quality methods, tools and techniques, quality metrology should be used in companies for their own best.

“Process approach” to management of organization is a field developing dynamically. This concept is very universal, it works for all companies, because it integrates in transparent way all key mechanisms which result from requirements for quality management system and quality processes [4].

In context of a new edition of standards ISO 9000:2000, ISO 9001:2000, ISO 9004:2000 is based on the process approach during preparation implementation and improvement of effectiveness of quality system management aiming at increase of the customer's satisfaction by fulfillment of requirements [4,5,7,8].

Management process according to PN-EN ISO 9001:2001 can be defined therefore as closed chain in aim of qualification of requirements, supplies and processes (Fig. 1) [11].

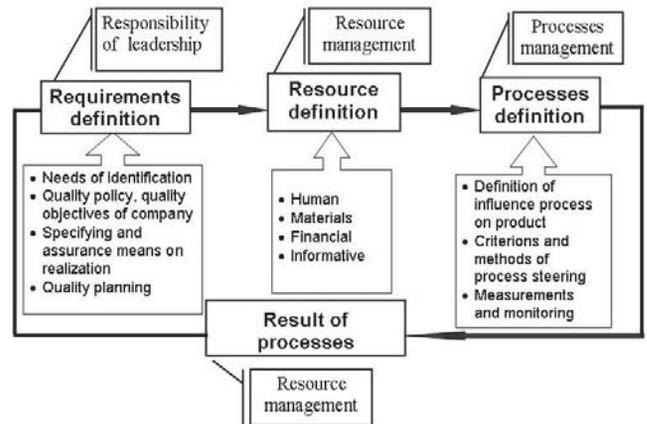


Fig. 1. Management processes chain [11]

The next step after implementation of quality management system is quality continuous improvement according to standard ISO series 9000:2000.

The quality management system in organization should control the quality of every phase of product life cycle – it means all processes in company.

These phases can include (Fig. 2) [12,13]:

- market research and product development,
- process research, planning, and development,
- purchasing,
- production,
- packaging and storage,
- marketing,
- sales,
- distribution and delivery,
- product installation,
- service and support,
- product disposal or recycling

Not all of mentioned activities take place in every company. It depends on area of activity and complexity of offered services. This model needs to use quality management methods and quality estimation methods in preproduction and production sphere of company [13].

Concluding – Information contained in standard ISO series 9000:2000, product life cycle and also rules of Deming confirmed a need creating of modern quality control.

The present definition of quality control is absolutely different from classic definition, which assumed that if the quality products has to be good – the cost of process production has to be high [3,14].

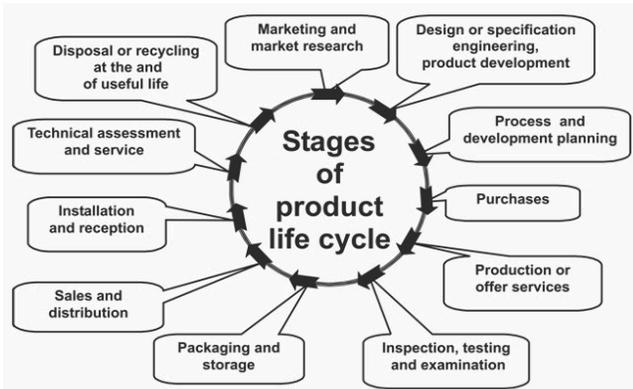


Fig. 2. The acts in product life cycle [13]

According to today's opinions, the good quality can be achieved only by organization, which implemented the Quality Management Systems, which used idea of continuous improvement of all processes and also which used the quality tools and quality methods inside of production process [4,12-17].

The present definition of quality also assumed, the Staff of Organization including highest management should pay more attention to quality of process, through usage of quality estimation methods in preproduction and production sphere [15]. These methods provide a very effective means for development of the new technology and the quality control in manufacturing process [4].

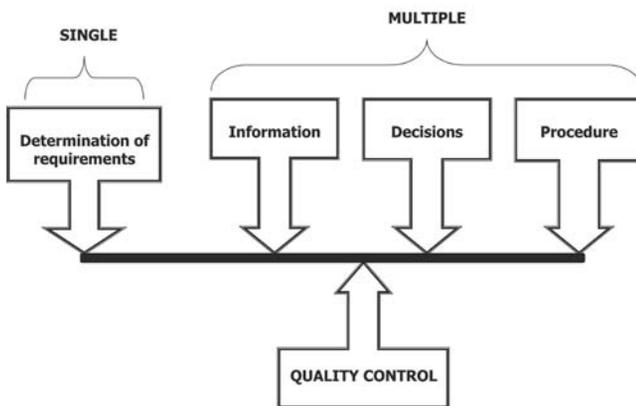


Fig. 3. The idea of modern quality control in organization [4]

In every case of quality control we can distinguish three basic elements, which are (Fig. 3) [4,5,16]:

- Information about quality - in current course of production getting by control states in the exact most way possible,
- Decisions – result from possessed information, they should be: penetrating, univocally and quick,
- Conduct – formative and correcting

So, management in modern world concerns, productiveness, elasticity, as well as creativeness of given companies as well as persons it employs.

The modern quality control approach is connected with "prevention strategy". This strategy is focused on improvement

of each element of quality cycle product- all processes inside. Those processes are understood not only as production process but also as all activities in organization. The task of organization in area of modern quality control is exactly defined by the input and output elements (Fig. 4) [4,5,16].

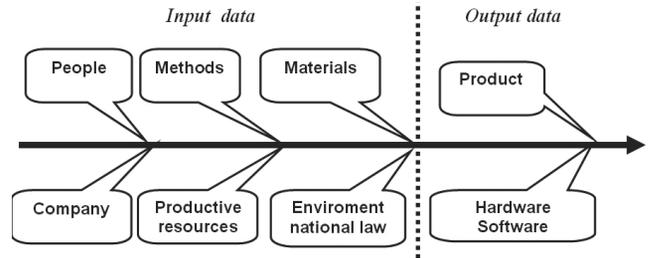


Fig. 4. Organization of process as a transformation of input and output elements [5]

According to the modern quality control – manufacturing processes should be controlled in a number of different ways, quality tools, quality estimation methods and the quality rules for example Deming's Rules, Juran's Rules, Kaizen.

What distinguishes "process control" from automation or machine control is the inclusion of the actual material modification step in the control loop. Also of critical importance is the frequency of control. To achieve high frequency control including the process usually involves difficult sensing and process modeling [18].

### 3. The Modern Quality Control in preproduction sphere of organization

It seems not right to call the preproduction sphere of back-up facilities, because exactly this sphere is beginning of production activities in company.

The confirmation of this opinion is modern quality control process, where the preproduction sphere is treated as initiating sphere of quality program and initiating of general development of organization [18].

The preproduction sphere of product embraces many information which make possible to design of product. This product should fulfill all customer requirements.

The preproduction sphere is main activities of marketing manager, quality manager, production manager, designer, those people decide about different functional, materials solution, technology solution of created product. And also about economical aspects and organization aspects connected with process production of this product [5,13,18].

According to proposition of Prof. R. Kolman the basic aspects of quality in preproduction area are first of all [16]:

- The information system about quality product, relating both the project office and the company, which will produce a final product.
- Competitiveness of own product.
- Organization's structure of company, which will produce a final product.

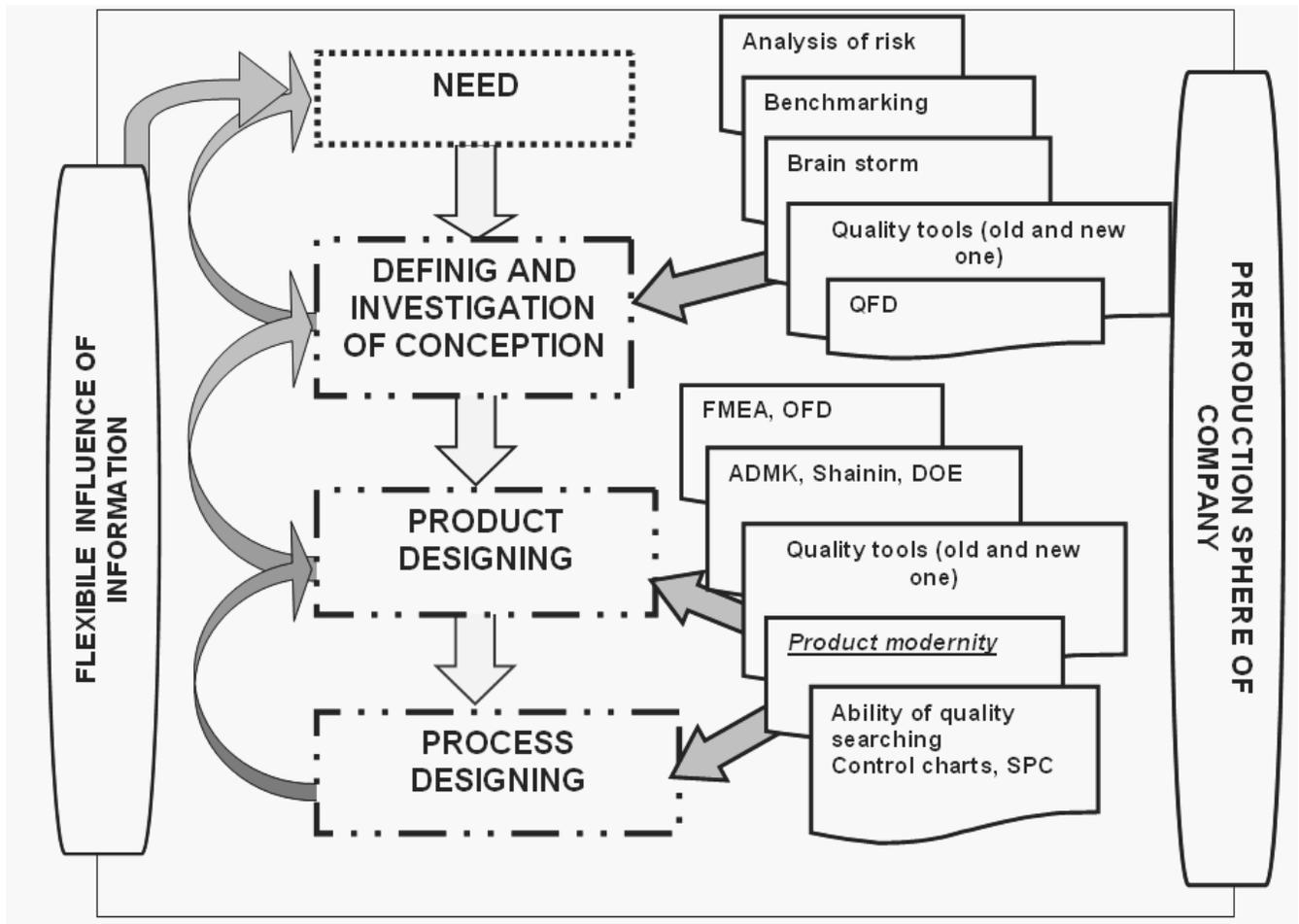


Fig. 5. Usage quality research method in preproduction sphere of company [18]

- Modernity of product.
- Quality investigation of new project design (constructional and technological aspects).
- Purchase, qualified suppliers.

In area of market competition usage of quality research methods are a part of high potential of scientific researching. This potential described relation between problems and reasons. Utilization of quality methods, techniques and tools on the each stage of creating final product, especially in preproduction sphere, is a recipe for company success (Fig. 5) [18].

In practice of quality engineering, many possibilities of presentations of ranges of applicable quality estimation and research methods exist, one of them is introduction of methods on background of existing product cycle [3,13,18].

Then, they are divided into two groups of methods using during phase of product planning, preparation of production and also production sphere. Between those processes and quality monitoring exists and functions the information system, concerning realization of intentional quality operations. So, these methods are used on all stages of product creation starting from development and project, on service finishing. [4,5,18].

In the area of planning and project, such quality tools as benchmarking, brain storming, ADMK (Analytical Choice of Constructional Materials), QFD (Quality Function Deployment) can be use in transformation of customer requirements on technical requirements and preference formulating. FMEA (Failure Mode and Effect Analysis) can be used for estimation of prospective problems related to given project, saving time during product designing, through elimination incorrect approach [5,18].

Quality analysis of product modernity enable company to make repeated identification negative effects, which should be corrected.

#### 4. Quality continuous improvement of process in preproduction sphere

Improvement of company is provided activity, related to all elements of organization with active participation of workers, embracing realization and monitoring all steps out there of processes.

Improvement of processes is continuous activity. Researches in selected polish firms showed, that development of quality should be monitoring road of initiation their in life on every stage of creation of finished product [4].

Thus offers possibility of continuous improvements of quality of processes, and what behind this goes quality of finish product. There should appear suitable and efficient model making possible analysis of their realizations (Fig. 6) [4,15,19].

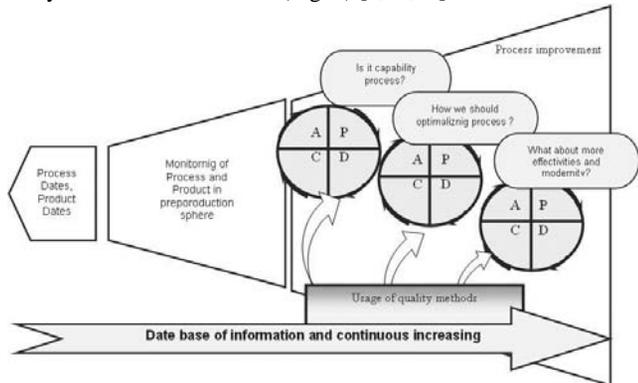


Fig. 6. Continuous improvement of process [4, 15]

Important aspect becomes skill efficient connection of cycle PDCA -Plan- Do - Check – Act- with use of quality methods, techniques and tools.

Suitable selection of tools and methods, orientation in which point of process we are, realization of suitable measurements will make possible analysis and understanding the reasons of errors formation in working processes, and what behind this goes in all firm, and this in turn will permit on identifications and use of correcting activities [16,18].

Correctness of decision, and in this use of suitable quality research and estimation methods will influence on process continuous improvements of quality product.

Passed research permitted to concluded, that there methods are essential contribution in improvement of quality and productiveness in cycle of product life.

## 5. The aspects of product modernity in preproduction sphere in organization – assumption of the method and own research

One of the important quality problems for company is describing the modernity of product and at the same time fulfilling the customer’s requirements. This product modernity should be monitoring the quality of product in preproduction area in company. The modernity is a economic symptom of quality process, product and also symptom of the newest achievements of technical progress and industrial design.

The comparing the modernity of semi-finished product or final product has great meaning on stage of projecting new solution. Designer’s intention is improvement existing product.

### Assumption of the method

For describing and comparing modernity of product inside company use Averaging Quality Rating method, which was found by Romuald Kolman.

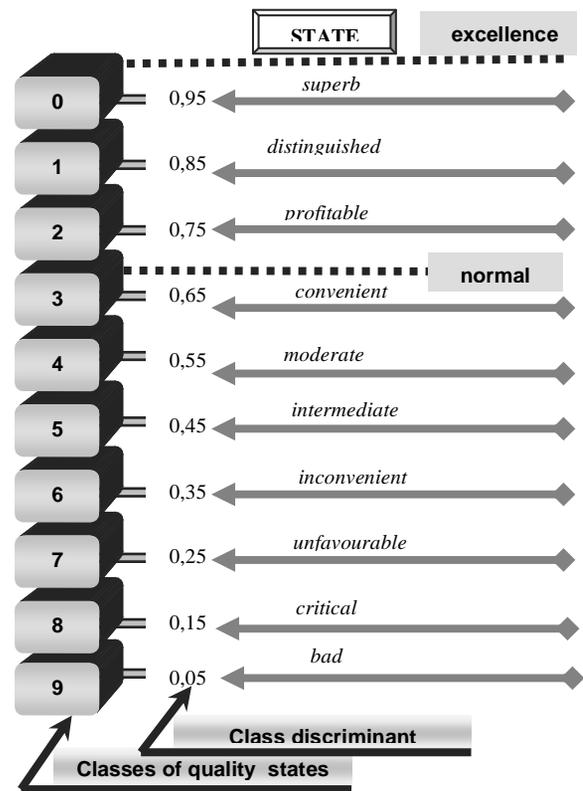


Fig. 7. Universal scale of unity relative states [16]

The stages of quality analysis of product modernity in proposed method are [16]:

- Designing: Quality Standard of Organization System employing universal scale of unity relative states (Fig. 7).
- Calculation: Discriminates of criteria through relativation of absolute states.
- Calculation: Groups discriminates.

For calculation of groups discriminantes Averaging Quality Rating method should be known. The general proceeding in realization of Averaging Quality Rating method has been described in Figure 8 [16].

After achievement of this stages of calculation product modernity depends on search for optimal level of product quality.

### Own research

One of the polish company wanted to estimate the level of modernity of own products. This organization produces e.g. the solenoids. The solenoid valve type 199Z (I) has been estimated of product modernity. This company keeps continuous contact with own customers and collects requirement and opinions about their product. Customers complaints:

- Premature otherheating of coil.
- Core Otherheating.

Related to customers problems - company decided to improve this valve. The solenoid valve type 199Z has been modernized in two groups of problems:

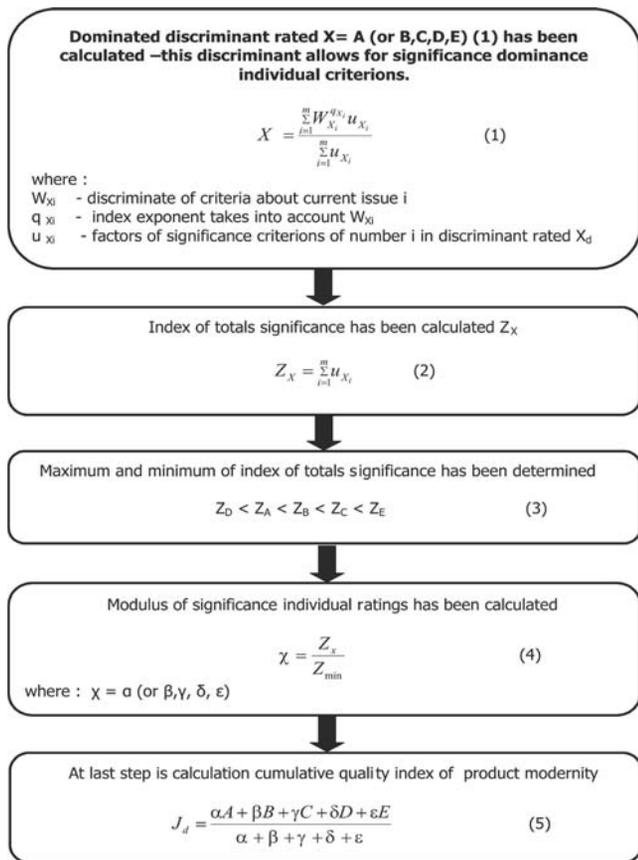


Fig. 8. The general proceeding in realization of Averaging Quality Rating method [16]

Table 1. Steps individual criteria and their quality factors for solenoid valve

Criteria and their quality factors	$W_{X_i}$ - discriminate of criteria		$u_{X_i}$ - factors of significance criterions	
	I - solenoid valve 199Z	II - solenoid valve 199P	I - solenoid valve 199Z	II - solenoid valve 199P
<b>A Modernity of construction solution</b>				
1 safety	0.7	0.75	1.42	1.33
2 efficiency	0.55	0.65	1.82	1.5
3 simplicity	0.5	0.7	2	1.42
		The sum of $u_i$	5.24	4.29
<b>B Production technology</b>				
1 industrial safety	0.6	0.6	1.67	1.67
2 new technology	0.5	0.5	2	2
3 process capacity	0.6	0.65	1.67	1.54
		The sum of $u_i$	5.34	5.21
<b>C Efficiency of utilization</b>				
1 esthetic	0.6	0.6	1.67	1.67
2 functionality	0.45	0.65	2.2	1.54
3 working precision	0.5	0.6	2	1.67
4 stability	0.4	0.5	2.5	2
5 operational reliability	0.5	0.6	2	1.67
		The sum of $u_i$	10.37	8.55
<b>D Product economics</b>				
1 designing cost	0.65	0.7	1.67	1.42
2 producing cost	0.6	0.6	1.54	1.67
		The sum of $u_i$	3.21	3.09

- Construction solution: safety, efficiency, simplicity, ergonomics accommodation.
- Utilization: functionality, esthetic, operational reliability, working precision, stability.

All propositions should be used in a new version of this product. The company has performed many laboratory tests in new one version of solenoid valve; and also superfluous elements has been eliminated. This valve has been called solenoid valve type 199P (II).

This new solenoid valve 199P can be useful for opening/closing flow of oil of kinematic viscosity larger from old one. Maximal temperature of agent has been increased. The other technical data hasn't been changed.

Before introducing a new solenoid valve 199P a test run has been realized in company. In the same time selling department and construction department have been obliged to continuous contact with customers, which bought this product. This contact could help for date acquisition about efficiency and correct functioning of product.

Averaging Quality Rating method has been used for describing and comparing modernity of solenoid valves, that is calculating cumulative quality index of product modernity.

At first steps individual criteria and their quality factors have been given in Table 1. After usage universal scale of unity relative states, in this table  $W_{X_i}$  - discriminate of criteria about current issue  $i$ ,  $u_{X_i}$  - factors of significance criterions of number  $i$  in discriminant rated  $X_d$  also have been given.

After describing these data dominated discriminate rated has been counted for : modernity of construction solution, product economics, production technology, efficiency of utilization; in Table 2. In this step formula number 1 has been used . In this analysis have been taken account the rated : A, B, C, D, importance of criterions has been differentiated. In this case at next step index of totals significance  $Z_X$  (2) has been calculated and shown in Table 3.

Table 2.  
Dominated discriminant rated

Criteria and their quality factors	Dominated discriminant rated X= A (or B,C,D,E)	
	I	II
A Modernity of construction solution	0.57	0.69
B Production technology	0.56	0.58
C Efficiency of utilization	0.48	0.59
D Product economics	0.62	0.65

Table 3.  
Index of significance Z<sub>X</sub>

Criteria and their quality factors	Index of significance Z <sub>X</sub>	
	I	II
A Modernity of construction solution	5.24	4.29
B Production technology	5.34	5.21
C Efficiency of utilization	10.37	8.55
D Product economics	3.09	3.21

It has been supposed that index of significance Z<sub>X</sub> have been created sequence of numbers; so we can define maximum and minimum of index of totals significance for solenoid valve in Table 4. Such activities allowed for calculating modulus of significance individual ratings proper with formula number 4.

Table 4.  
Maximum and minimum of index of totals significance for solenoid valve.

I			
Z <sub>D</sub> < Z <sub>A</sub> < Z <sub>B</sub> < Z <sub>C</sub>			
Z <sub>D</sub> = Z <sub>min</sub> = 3.09	Z <sub>C</sub> = Z <sub>max</sub> = 10.37		
δ = 1	α = 1.63	β = 1.66	γ = 3.23
II			
Z <sub>D</sub> < Z <sub>A</sub> < Z <sub>B</sub> < Z <sub>C</sub>			
Z <sub>D</sub> = Z <sub>min</sub> = 3.21	Z <sub>C</sub> = Z <sub>max</sub> = 8.55		
δ = 1	α = 1.38	β = 1.69	γ = 2.77

This calculation allows for counting cumulative quality index of product modernity J<sub>D</sub>.

The quality index has been presented in Table 5.

Table 5.  
Cumulative quality index of product modernity J<sub>D</sub>

I - solenoid valve 199Z

$$J_D = \frac{1.63 \cdot 0.56 + 1.66 \cdot 0.56 + 3.23 \cdot 0.48 + 0.62}{1.63 + 1.66 + 3.23 + 1} = \frac{4.0291}{7.52} = 0.536$$

II - solenoid valve 199P

$$J_D = \frac{1.38 \cdot 0.69 + 1.69 \cdot 0.58 + 2.77 \cdot 0.59 + 0.65}{1.38 + 1.69 + 2.77 + 1} = \frac{4.2167}{6.84} = 0.616$$

It has been supposed that index of significance Z<sub>X</sub> have been created sequence of numbers; so we can define maximum and minimum of index of totals significance for solenoid valve in Table 4.

Such activities allowed for calculating modulus of significance individual ratings proper with formula number 4.

Cumulative quality index of solenoid valve 199Z modernity, 199P has been presented in percent in Table 6.

Table 6.  
Cumulative quality index of modernity solenoid valve.

quality index of modernity solenoid valve	solenoid valve 199 Z	solenoid valve 199P
J <sub>D</sub> [ 0.00.... ]	0.536	0.616
J <sub>D</sub> [ % ]	53.6 %	61.6 %

This results confirmed, that a new solenoid valve 199P is of high quality and fulfils customers requirements. This features are results of additional criteria, which compare valve modernity. It is a confirmation about need of usage modernity of this product.

## 6. Conclusions

Success of intentional targets can be possible only in such firm, which will be able to take care for one's own constant improvement to realizing customer requirements and customer satisfactions. The main aspect of quality improvement strategy has to be connect with modern idea of quality management. This idea should usage in one's own activities of many quality researching and estimation methods, in sphere: before production and also every stage of creation of final product [4,14-18].

Usage of quality research tools and methods in preproduction sphere in Polish companies permits on avoidance of productive defects already in the first stages of product cycle, which helps in elimination of source their formation. Describing and comparing product modernity inside company and used for it Averaging Quality Rating method making easy planning of product and the same fulfill the customer's requirement. Utilization of modernity of product in economic individuals testifies to orientation of aim and also creation of products quality - qualities controlled by customers. Professor R.Kolman opinion is right [16]: "...It seems not correct to call preproduction sphere "background area", because this is a place when we start to create whole of productive activities."

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