

## THE INTRODUCTION OF SYSTEM APPROACH IN QUALITY MANAGEMENT IN XX CENTURY

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### *Abstract*

*The report is focusing on the development of System Approach in quality management, which development started at the beginning of XX century. It has to be stressed that the System Approach implementation took place first in US. Naturally it was dominated by US representatives such as Walter Andrew Shewhart, William Edwards Deming, Joseph Moses Juran and others. The most important phenomenon which characterized the process of systematization of quality management was the use of statistics. The so called statistical process control (SPC) became the platform of the System Approach in Quality management. Thus is possible to say that SPC created a revolution in quality management in the first half of the XX century.*

**Keywords:** *System Approach in Quality management system, statistical process control (SPC), Walter Andrew Shewhart, William Edwards Deming, Joseph Moses Juran*  
**JEL Codes:** *L15*

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## INTRODUCTION

The summarization of basic knowledge related to quality management such as the dynamics of development of quality management systems is playing an important role in understanding the general logic of quality management as well the systems related to quality. This general understanding is very important from the point of view of designing working models of quality management.

The main goal of the report is precisely creating clear picture of the above mentioned logic of quality management based on the analysis of the dynamics of development of quality management systems. This goal is achieved by the following tasks, which are structured in the main chapters of the report, namely:

1. The connection of the quality function with the statistics as beginning of a new stage in quality management (20-th - 40th year of XX century);

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2. The stage of assault of new ideas related to quality (from the middle 40's to the beginning of the 60's of the XX century).

The used methodological approaches are the following:

1. A System approach that sees organizational and managerial phenomena as complex systems, i.e. as sets of interrelated factors, resources and elements acting as one whole.

2. Structural-functional approach considering the organization, in the case as a structural complex, in which each structural unit fulfills a certain functional role;

3. The Comparative analysis approach, by which on the basis of comparison of the studied phenomenon with other similar, a new knowledge about the above phenomenon, as well as about its functioning, is obtained.

### **THE CONNECTION OF THE QUALITY FUNCTION WITH THE STATISTICS AS BEGINNING OF A NEW STAGE IN QUALITY MANAGEMENT (20-TH - 40TH YEAR OF XX CENTURY)**

The introduction of system approach in the quality function is connected with the statistics implementation. The first steps in this regard happened in the 20s of the 20th century in the United States. Dodge and Romig introduced in US the Sampling Inspection. In other words, not all articles are subject to inspection, but only part of them. It is assumed that this part gives a true picture of the whole set of articles. This rationalizes the work of quality inspectors.

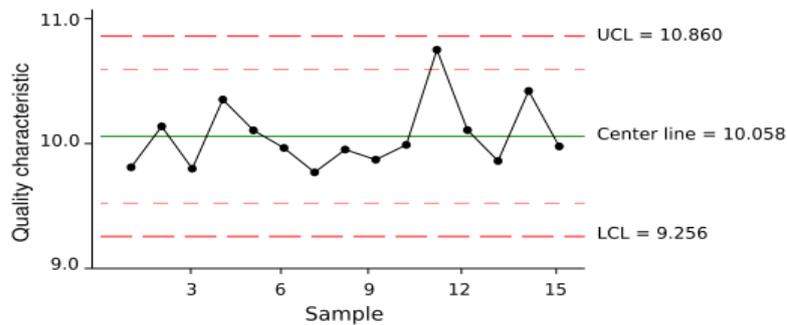
Also, in the 20s of the 20th century, Fisher in Rosamstead Agricultural Experimental Station, UK developed the basic principles of the planned experiment as a way to ensure quality.

The specialist in Bell's telephone company Walter Andrew Shewhart carried out the revolutionary leap. In 1924, he created the so-called "control card" or "Shewhart chart". He is the first in the world to start using statistical methods in quality control. Because that is known as the father of statistical quality control.

Shewhart summarizes his work on introducing the so-called Statistical Process Control (SPC) and Statistical Quality Control (SQC) in the monograph "Economic Control of Quality of the Product" published in 1931. The American Society for Testing and Materials (ASTM) in 1933 adopted the Shewhart card as a quality assurance tool. During the Second World War, Shewhart control cards were included as a model for improving the quality of military production in US military standards Z1.1-1941, Z 1.2-1942, Z1.3-1941 The "Shewhart Control Card" includes:

- Points representing the measurement of the qualitative characteristics of the sample, i.e. the part of the products taken at different times of the production process, these are the data;
- A centerline that describes the average values of a process that a centerline is calculated from the database;
- Upper and lower control limits (sometimes referred to as "natural process boundaries"), which indicate the line behind which the result of the process is considered to be statistically unlikely.

**Figure 1.** An example of a Shewhart control card



**Source:** <https://r-bar.net/xmr-control-chart-tutorial-examples/>

We must say that in 1938, Shewhart work became the focus of the physicists William Edwards Deming and Raymond T. Birge. They deal with the problems of measuring error in research. That is how long-term cooperation begins between Shewhart and Deming. These two, later took the nickname "guru" (in Hindi language means "teacher") of quality. Deming developed and synthesized some of Shewhart methodological proposals in the so-called "Deming Cycle".

All this leads to a revolutionary change in the quality control function in the organization and the creation of a new format for its operation. The new moment that occurs at this stage is the systematic search for the causes of the defects and deviations, i.e., "non-conformities" through "statistical quality control methods".

This happens as the data based on the inspection is processed. In this sense, to the tasks of the quality control function, a very important activity - the analytical activity for identifying the reasons for the non-conformities is added. As a result, the emphasis in the quality function changes. It is not on the result,

but on the process. If somewhere in the process parameters there is a deviation, to ensure high quality, it needs to be adjusted. Then the result will meet the established quality standards. Based on the analytical work, a synthetic result is achieved - the activity concentrates on providing the necessary preliminary conditions to ensure the quality of the product. In other words, the function works in Preventive mode.

However, it is necessary to emphasize that in this activity are "involved" only the specialists of the quality control unit of the organization, i.e. only the quality function. The operators in the manufacturing processes are not "involved" in quality issues, which means that they are not involved in the analytical process of identifying causes and generating ideas for improvement. The fact that the quality problems as well as the improvement of quality are dealt with only by the specialists, defines a serious weakness of this type of quality system functioning. This determines the situation that the quality function is realized only as an operational function dealing with the organization's "narrow" issues.

#### **THE STAGE OF ASSAULT OF NEW IDEAS RELATED TO QUALITY (FROM THE MIDDLE 40'S TO THE BEGINNING OF THE 60'S OF THE XX CENTURY)**

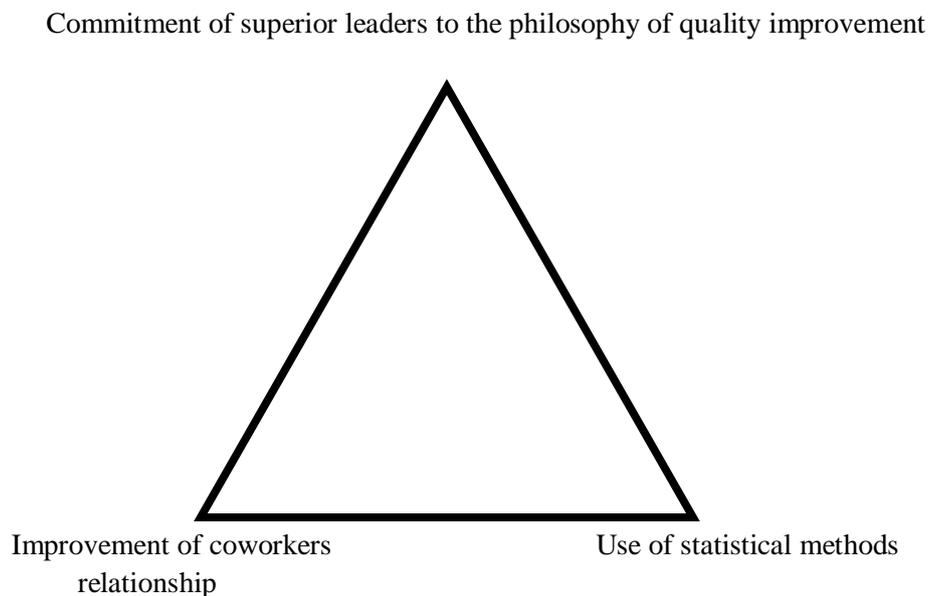
Shewhart's actions gave a good basis for the further work of explorers later called in this text "guru" of quality. Their activity was from the end of WW2 to the 60's of the XX century. This period could undoubtedly be called "American period in quality development" since all of these 'gurus' are of American nationality. All 'guru's ideas actually manage to make a groundbreaking reform in the whole philosophy of quality management and its organizational structure. However, this revolution is not American - a topic that will be later discussed. Now we will have insights into the quality guru's revolutionary ideas.

The first one to be mentioned is without any hesitation William Edwards Deming (14.10.1900- 20.12.1993). Born in Sioux City, Iowa, Deming graduates in mathematical physics. Afterwards, he worked for the Agriculture Department for 11 years which is the place that gave him the basis in statistical methods. From 1939 to 1945 he worked as a consultant for the American statistical bureau and the military USA industry. At this point his colleagues were H. F. Dodge, A. G Ashcroft and others, working on the creation of the American military standards. Another subject that shouldn't be missed is that Deming educated people from the military industry on statistical process control (SPC). It is also important to

mention that statistical methods, widely utilized during WW2, start losing popularity among USA.

Deming wants to put his knowledge into practice and manage to do this far beyond the ocean. In the late 40's he is sent to Japan where is given the task to educate leaders of Japanese companies on working with statistical methods of quality control. Working in close collaboration with the Japanese union of scientists and engineers he manages to educate a respective number of experts.

**Figure 2.** Deming's Quality Management Triangle, which expresses Deming ideas of Quality Improvement



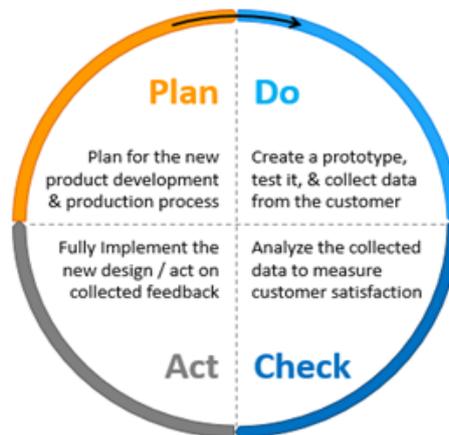
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Deming's ideas, including the one of quality improvement through usage of statistical methods, are more than well received in Japan - a country where at this point products used to have poor quality. Later on, in 1952 in Japan was created a prize for quality named after Deming name, which much later became a measure for quality worldwide.

One of the most popular Deming's concepts is the so called "Deming's cycle". What Deming's cycle represented is that when managing an operative action, the leader should always follow those rules:

1. Every plan should include:
  - Particular aims/final product;
  - A plan how to reach the aim, i.e. how to make the final product;
  - Forming criterion which can evaluate whether the way to the final product is being followed strictly;
2. A realization, which contains:
  - A verification that the employees are aware of the way the realization is going to be achieved;
  - Realization of the planned actions;
3. An obligatory check-up which includes
  - A check-up whether everything has gone as planned;
  - A check-up whether the results\ the final product is as planned in advance;
4. A correction, which means:
  - After taking a look at the final product we make some corrections if necessary;
  - In case there are no errors, it follows to think about how the product can be even more improved.

**Figure 3.** The “Deming’s cycle”  
(This cycle Deming borrowed from Shewhart)



**Source:** <https://curiouscat.com/management/dictionary/pdsa>

Another famous American leader of quality is Joseph Moses Juran (1904 - 2008). Born in Braila, Rumania he worked as an engineer, manager, government

administrator, university academic and consultant in management. Juran also worked as an academic in the International Academy of Quality. His book "Quality Handbook" published in 1951 made him popular. Thus, Juran is invited in the Country of the Rising Sun for seminary in quality control.

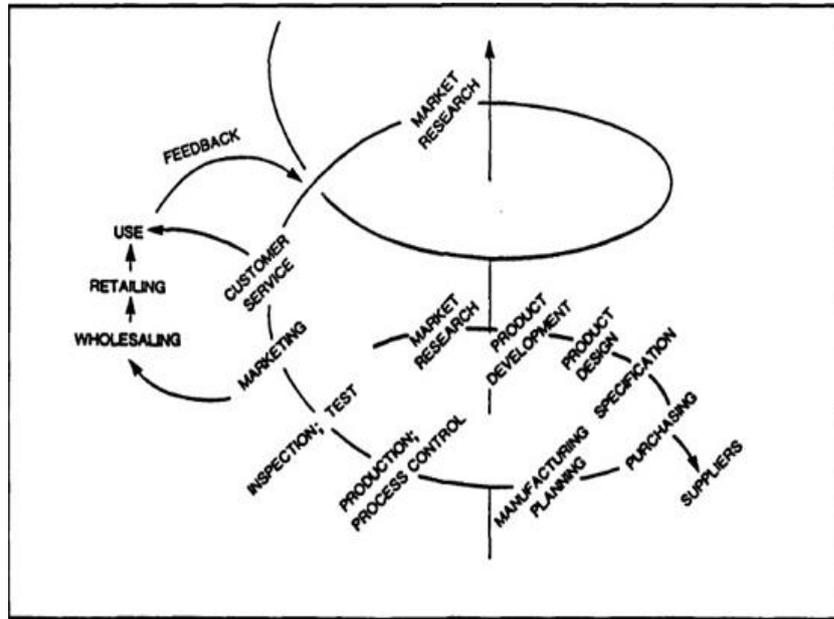
Juran is also famous for his Quality Trilogy, which can be achieved in three main steps:

1. Quality planning/quality planning roadmap which must include
  - Identification of customers and their needs. There are two types of customers – "In house customers", which means the next process in the organization, and "Out of house customers", which means the clients and the consumers of products/services of the organization;
  - A translation of the language of the "Out of house customers" in a language that can be understood by every member of the organization;
  - Optimizing the products/services by improving the processes needed for its creation;
  - The processes must be realized only after formation of the optimal conditions for their realization;
2. Quality control – a process of revealing and corrections of impermissible errors. The goal is to maintain a certain "status quo". Juran agrees with Deming's theory that chronic errors are 80% of all errors and that they can be fully controlled. Given this, we can make a conclusion that issues concerning quality are more likely to be not because of faults of operators at manufacturing line but because bad management.
3. Improving of quality - Juran believes that in production there must be a radical change – a major decrease of errors, which has been expected to lead to unattainable till then levels. Even more, Juran sees the quality system as a long-lasting process with unstoppable and continuous improvement, with flawless communication and coordination between all parts of the organization, as well as with better control product delivery.

Juran is also famous for the "Pareto chart" or "ABC analyze", named after an Italian sociologist - Vilfredo Pareto. The aim of this chart is to identify factors with vital significance for the quality.

J. M. Juran is the first to come up with the idea of transition from quality control to quality management. He developed the conception for AQI (Annual Quality Improvement), which philosophy is based on unlimited continuous improving. Juran is also an author of the "Juran's Quality Spiral", which represents the main stages of the continuous quality management during all processes of product's creation, sell and use.

**Figure 4.** The “Juran’s Quality Spiral”



**Source:** András Hary, Dénes Klujber. Assessment approaches and strategies for the quality system improvement, *Periodica Polytechnic, Ser. soc. man. sci.* vol. 9, no. 2, pp. 127–139

The third American “authority” of quality is Philip or **Phil Bayard Crosby**. He is known as creator of the concept “Zero defects”. His popularity comes from his profession as a manager of quality control and from his business establishment in Orlando, Florida with a company called Martin-Marietta with the program “Zero defects. This program is utilized in manufacturing the ballistic missiles Pershing. In the frame of this program Crosby managed to lower errors with 25% and expenses with 30%. He has written numerous books such as “Quality is Freedom” and “Quality without tears”. He is also famous for his theory “Do it right the first time”, as well as for his “14 steps of quality improvement”.

Philip Crosby (1926 - 2001) before starting as a management consultant worked for „International Telephone and Telegraph/ITT/”, where he managed to get from a minor inspector of quality to manager of the quality department of the ITT corporation. To be mentioned as well, P. Crosby developed the concept of the “Crosby triangle” and “The Four Absolutes of Quality”. The latter includes:

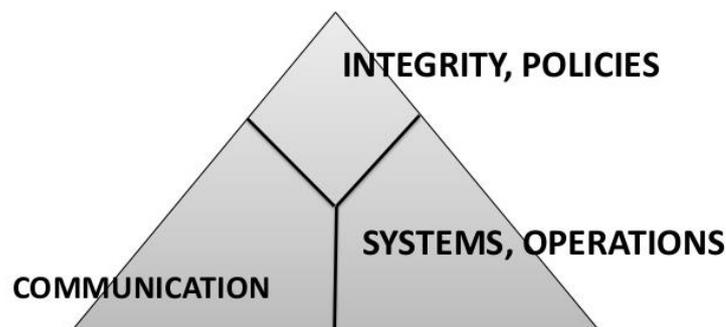
*First*, quality should be equivalent to the requirements, which respectively means that no definition for quality can be correct unless the customer's requirements haven't been settled;

*Second*, the essence of the quality system is in its preventive character. The key to success is in the examination of the processes and identifying the risks for admitting nonconformities;

*Third*, the performance standard is "zero defects" - Resolve, duplicated with a management system that performs the necessary communication and preventive tools, can reach a level of "Zero defects";

*Forth*, Quality measurement is the cost of non-conformity. In order to attract the attention of senior management, quality must be measured in financial terms. This is how quality, from technical point of view, is becoming a management function.

**Figure 5.** The "Crosby triangle"



**Source:** <https://www.slideshare.net/AngelSegovia5/report-tqm>

**Armand Vallin Feigenbaum**, born in 1922 in the United States, is the fourth American "guru" in quality. He received a bachelor's degree from Union College and a Masters and PhD degrees from the Massachusetts Institute of Technology. Between 1958 and 1968, he was a production executive at General Electric. In 1961-1963 he was the president of the American Society for Quality, ASQ, formerly named American Society for Quality Control /ASQC/.

By the time he led the quality control department of "General Electric", he raised the idea that high quality is achieved only through what he called "Total quality control" model. According to this idea, total control requires a new

organizational culture. This vision defines the "zero defects" movement. This is creating a system where each operator in the production itself controls the activity he performs. If a discrepancy is noticed, he immediately communicates this with his direct supervisor. Total quality control is seen as an effective system for integrating quality design, quality assurance, and quality enhancement.

Armand Vallin Feigenbaum, born in 1922 in USA is as well one of the American quality leaders. During his service in the control section in "General Electric " he developed the theory that high quality of products can solely be achieved by the so called "Total Quality control". A. Feigenbaum believed that this total quality control requires brand new "Organizational culture".

This perception initiated the "zero defects" movement. This latter is understood to be the creation of a system where each operator on the production line itself controls the activity he performs. If a nonconformity is noticed, he immediately communicates this with his direct supervisor. Total quality control is seen as an effective system for integrating quality design, quality assurance, and quality improvement.

Another conception of Armand Vallin Feigenbaum is the so called "hidden factory". In other words - the errors sometimes can be in such an enormous quantity that the activity to correct nonconformities is so great that sometimes there are two in one enterprise. Feigenbaum is also an author of the idea of "cost of quality" by which he initiated the "Economy of Quality" model. He is also the author of the idea of the "Four Deadly Sins" in Quality Approaches:

1<sup>st</sup> - Raising slogans and orientation to surface changes;

2<sup>nd</sup> - Introducing of "blue-collar" programs, i.e. oriented to the line operators and ignoring the "white-collar" programs, i.e. that oriented engineering staff;

3<sup>rd</sup> - unwillingness to confess that there doesn't exist a consistent and permanent quality level. Respectively, the quality must always improve and be in a process of improving.

4<sup>th</sup> - the deadliest sin concerns the self-deceiving that the automation in production puts an end to the human factor in quality.

## **CONCLUSION**

The presented dynamic of quality management from non-systematic to systematic approach plays important role not only for understand the logic of the quality management system. Here the most important is the use of this logic for designing a working models of quality management systems. All the "guru's" in

quality management tried exactly this – creation of working models based on SPC in one or another variants as the most demonstrative expression of the implementation of System Approach in quality management.

Practically, all ideas of the “gurus” mentioned above gave a solid basis for the invention of a new philosophy, new methods and new mechanisms for quality development. The nucleus of this new philosophy is in the fact that in the previous non-systematic models of Quality management dominates the Post-factum approach. This approach means that the main instrument of quality control is the quality inspection. The inspection reveals already realized nonconformities. But in the case when SPC is used the Preventive approach becomes a dominant one.

Thanks to SPC the attention in Quality control moved from inspecting the products to monitoring the parameters of production process and keeping this process in parameters which do not allow nonconformities to happen.

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