

## **SELECTED QUANTITATIVE METHODS APPLIED IN PRODUCTION ENGINEERING FOR THE IMPROVEMENT OF PRODUCTION PROCESSES**

### **17.1 INTRODUCTION**

In every manufacturing company all the processes in this organisation, starting from production processes, to the machine fleet, infrastructure and managerial process staff should be improved. Activities improving the quality of processes in an enterprise are included in its strategy. Process improvement in an organisation must comply with Deming's principle, the changes introduced owing to the improvement should be measurable and the results tangible; the activities proposed to improve the company's functioning should be continuous and be applied for solving the problems which already exist as well as potential ones, which may occur in the future [3, 4].

Quality management methods are very helpful for the analysis and improvement of goods' quality, as they can be used to analyse the errors and nonconformities, which provides a basis for undertaking improvement actions. All the quality management methods presented in the article are applied in practice in industrial plants and used at various stages of both product and process life cycle [4, 7, 9].

### **17.2 CLASSIFICATION OF SELECTED METHODS IN PRODUCT AND PROCESS LIFE CYCLE**

Improvements in production processes are made at particular stages of product and process life. In this article the most frequently applied quality management methods, such as: FMEA, QFD, SPC, 8D, DOE have been presented, with a division into particular phases of product and process life [4, 6].

#### **17.2.1 Particular phases of product life**

The process of product manufacturing in a production enterprise is connected with a whole complex cycle, which in subject literature is referred to as product life cycle. Production has been divided into many phases, which include [4]:

- idea, inspiration,
- demand for the product,
- analysis of the market and potential customers' needs,
- taking competitors into consideration,
- product design,
- creating necessary assumptions, drawings, selection of a product manufacturing technology, determining all the resources needed for product manufacturing, production and control during and after manufacturing,
- product sale,
- product utilization.

Fig. 17.1 presents a product life cycle from design to utilization [4].

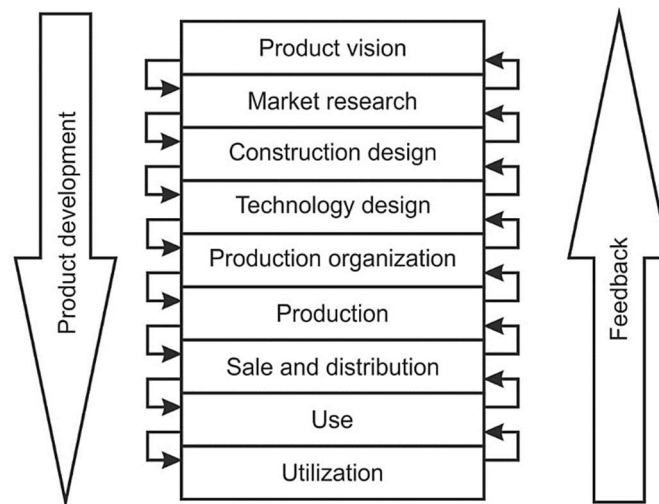


Fig. 17.1 Product life cycle

Source: [4]

### 17.2.2 Particular phases of the process

The process life cycle consists of the following important phases:

- analysis and evaluation of available resources that will be used in the process,
- identification and division of process stages,
- developing parameters to be used in process analysis,
- process implementation and, possibly
- process completion, if it was a one-time action.

Fig. 17.2 illustrates the process life cycle [4].

As opposed to product life cycle, in process life cycle there is no concept phase and product vision related to the producer's ideas and inspirations. However, analysis and improvement at each stage of product manufacturing and in the production process are important in both cycles. Production plants use quantitative quality management methods, by means of which it is possible to evaluate the process functioning, analyse the product failure rate or detect potential errors in the process [4].

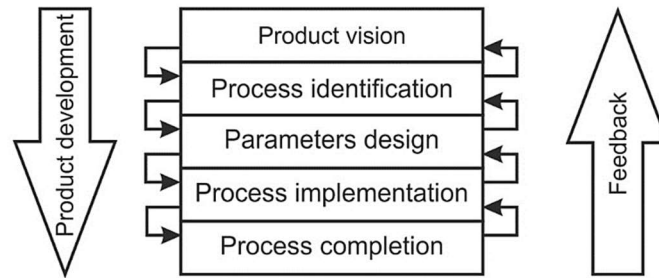


Fig. 17.2 Process life cycle

Source: [4]

### 17.2.3 Selected quantitative methods used in the product and process life cycle

The most frequently used quality management methods which are used at particular stages of the product life cycle include [4]:

- in the product vision phase – QFD and DOE methods,
- in the phase of market research – DOE method,
- in the phase of product construction phase – FMEA, QFD and DOE methods,
- in the organization and preparation of production the most frequently applied method is FMEA,
- in production various methods are used – the most popular ones include: FMEA, QFD, DOE and 8D; apart from these methods one can also use SPC,
- in the sale and distribution phase FEMA is a well-tested method,
- in the last phase of product use all the above mentioned methods – FMEA, QFD, 8D, SPC can be applied [4].

In particular phases of the process life cycle the following quality management methods are used:

- in the phase of resources availability analysis – FMEA, QFD, DOE and SPC,
- in the phase of establishing the degree of process detail the most frequently applied are FMEA, QFD and SPC methods,
- in the phase of designing the parameters which determine process quality ability the methods applied include FMEA and SPC,
- in the process implementation phase – FMEA, QFD, SPC, DOE, 8D report,
- in the process completion phase – FMEA, 8D report [4].

### 17.3 SUMMARY

These methods are helpful in the detection of potential as well as existing defects and nonconformities in both the product and the process [1]. The most frequently applied methods include:

- FMEA, which shows defects in a qualitative way, allows identifying the errors and helps to eliminate them. FEMA in the cycle of both product and process life is used in the majority of phases, except the phase of product vision and market research. This method enables continuous improvement and allows undertaking improvement and corrective actions in the existing products and processes [1, 4].

- QFD, which is used at each stage of product life cycle, as it allows taking into consideration the largest number of factors which might influence its quality in all the phases of product manufacturing. Apart from FMEA, a frequently applied method to solve practical problems in industrial enterprises is QFD, which is extremely helpful when establishing the customer's requirements in relation to the product [5, 8].
- DOE, which helps to identify factors influencing the product at each stage of life cycle. This method is less frequently used in process life cycle – only in the phase of analysis and availability of resources and in the phase of process implementation. DOE, also referred to as an experiment planning method, is less common than the two previously described methods, as it involves big costs and is time-consuming [4].
- SPC, also referred to as statistical control, is very often used in practice for the identification of errors and nonconformities already at the stage of product manufacturing, which is very important in the production process. According to product life phases, SPC is applied at all stages of product manufacturing, except the phase of process completion. The advantage of SPC is the fact that this method provides a possibility of documenting the product manufacturing process on a continuous basis [2].
- The 8D method, also referred to as 8D report, is used for introducing changes in the process and the product. In product life cycle it occurs in the production phase and in the phase of product use, whereas in process life cycle it is most frequently applied at the stage of process implementation [10].

The presented selected methods of quality management have practical applications and are very often used to improve manufacturing processes and products; they are universal and can be applied in various branches of industry as well as in the service sector.

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**dr inż. Bożena Skotnicka-Zasadzień**

Silesian University of Technology

Faculty of Organization and Management

Institute of Production Engineering

ul. Roosevelta 26, 41-800 Zabrze, Poland

tel.: +4832 277 73 51, e-mail: bozena.skotnicka@polsl.pl

**SELECTED QUANTITATIVE METHODS USED IN PRODUCTION ENGINEERING  
FOR THE IMPROVEMENT OF PRODUCTION PROCESSES**

**Abstract:** *In every manufacturing company are analysed and improvement of the life cycle of the process and the product. This is done at the stage of designing, manufacturing and control. The article presents the classification of selected quality management methods, such as QFD, FMEA, SPC, 8D, DOE.*

**Key words:** *quantitative methods, process improvement, production, control*

**WYBRANE METODY ILOŚCIOWE STOSOWNE W INŻYNIERII PRODUKCJI  
DO DOSKONALENIA PROCESÓW PRODUKCYJNYCH**

**Streszczenie:** *W każdym przedsiębiorstwie produkcyjnym dokonuje się analizy i doskonalenia cyklu życia procesu i wyrobu. Dokonuje się tego na etapie projektowania, wytwarzania i kontroli. W artykule przedstawiono klasyfikację wybranych metod zarządzania jakością takich jak: QFD, FMEA, SPC, 8D, DOE.*

**Słowa kluczowe:** *metody ilościowe, doskonalenie procesu, wytwarzanie, kontrola*