

QUALITY IMPROVEMENT IN MACHINE MANUFACTURING DESIGN PROCESS

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ABSTRACT

The choice of this research topic was made with the purpose of identifying and counteracting the causes that lead to a poor quality in the mechanical design activity in any company that has this field of activity. At the beginning of the paper, the issue of quality and the quality management system according to the standards in force is briefly addressed, followed by a presentation of the policies and objectives defined in such a company. At the same time, the subject of the control activity in design as well as the control methods was debated. The case study considers the proposals to improve the design activity. To achieve this objective, we started from the diagram of the design process, conducting a Failure Model and Effect Analysis and a cause-effect diagram so that finally the quality improvement solutions can be issued.

KEYWORDS: *mechanical design, organization, quality improvement, quality management system.*

1. INTRODUCTION

The competitiveness of a product is largely assured by quality. Quality is itself the cumulative result of objectives carefully pursued by the organization. These objectives are aimed to assure:

- quality services and products;
- a low cost of the production process;
- contractual punctuality.

In order to obtain quality services and products, the process must be coherent, conscious and sustained. The quality of a product or service is determined, in addition to the characteristics and properties it possesses and the way and the degree to which it meets the needs of the customer (Tague's, 2004).

Each organization establishes its priorities in terms of quality through a quality policy of the organization (Țîțu & Oprean, 2015). It also prepares a package of quality procedures in the organization's processes (Masing, 1994).

In order to be able to achieve the organization's policy and objectives, a leadership strategy is required, and at the same time a systemic approach to management according to the ISO 9000 standards package but especially to the reference standard SR EN ISO 9001:2015 towards the concept of Total Quality, with the motivation to be involved the staff on all levels of management and execution.

In order to evaluate the quality, it is necessary to know some quality characteristics within the processes of the organization to which a system of indices, indicators and coefficients is attached (Pop & Țîțu, 2018). The present paper aims to identify solutions for increasing the quality of work submitted in the design activity.

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The company in which the research was conducted permanently carries out quality initiatives based on continuous progress. Therefore, in order to meet this requirement, a quality management system is required, which is verified on each occasion of the certification and supervision audits of the Certification Body. The client plays the most important role.

The quality management system implemented within the company is based on the standards that present the way of organization and functioning in terms of quality (Druker, 1988). Therefore, these standards provide:

- quality manual;
- rules, norms, procedures and instructions;
- forms necessary for registrations (documents of effective planning, operation and control of processes).

Indeed, the objective of the company in which the research was carried out is to realize products and services of design in the mechanical field, based on professionalism and at competitive prices, so as to obtain a high degree of customer satisfaction, as well as ensuring the organization development and profitability.

An essential condition for the fulfilment of this objective materialized in the quality-costs terms, is problem solving. Therefore, identifying and resolving them is a constant concern within the company, because only continuous improvement can be ensured in this way.

In order to solve problems, there are various methods, all of which are based on teamwork, on the grounds that a person can find satisfaction within the group regarding some of his fundamental needs, such as: safety, belonging, esteem and self-realization.

2. POLICY DESIGN IN THE FIELD OF QUALITY

Quality policy refers to the general guidelines and intentions of a quality organization, in the way they are formally formulated by the management of the organization (Țîțu et al., 2011).

The quality policy of the company in which the case study was conducted and then implemented has as main objective: the development of products and services of design in the mechanical field, based on professionalism and at competitive prices, so as to obtain a high degree of customer satisfaction, as well as ensuring the development and profitability of the organization. In other words, it is pursued to the full satisfaction of the client, offering him products and services according to his needs and needs.

The quality policy proposed to be implemented within the organization is expressed specifically on the basis of:

- Standardization of Plan-Do-Check-Act processes;
- Identifying the risks and solving the problems arising;
- Constant and permanent improvement of services and design processes Plan-Do-Check-Act;
- Capitalizing on the experience gained.

Starting from the objectives and programs to achieve them, the management of the organization implements their deployment throughout the entire hierarchical chain within the organization.

3. THE DESIGN PROCESS. CONTRIBUTIONS

Within the organization, all processes have been defined before they are included in the process map, to be measured or improved.

Further attention will be focused on the design process - a process that has been proposed to be improved in order to increase quality.

In this sense, the design process was rethought and defined according to figure 1.

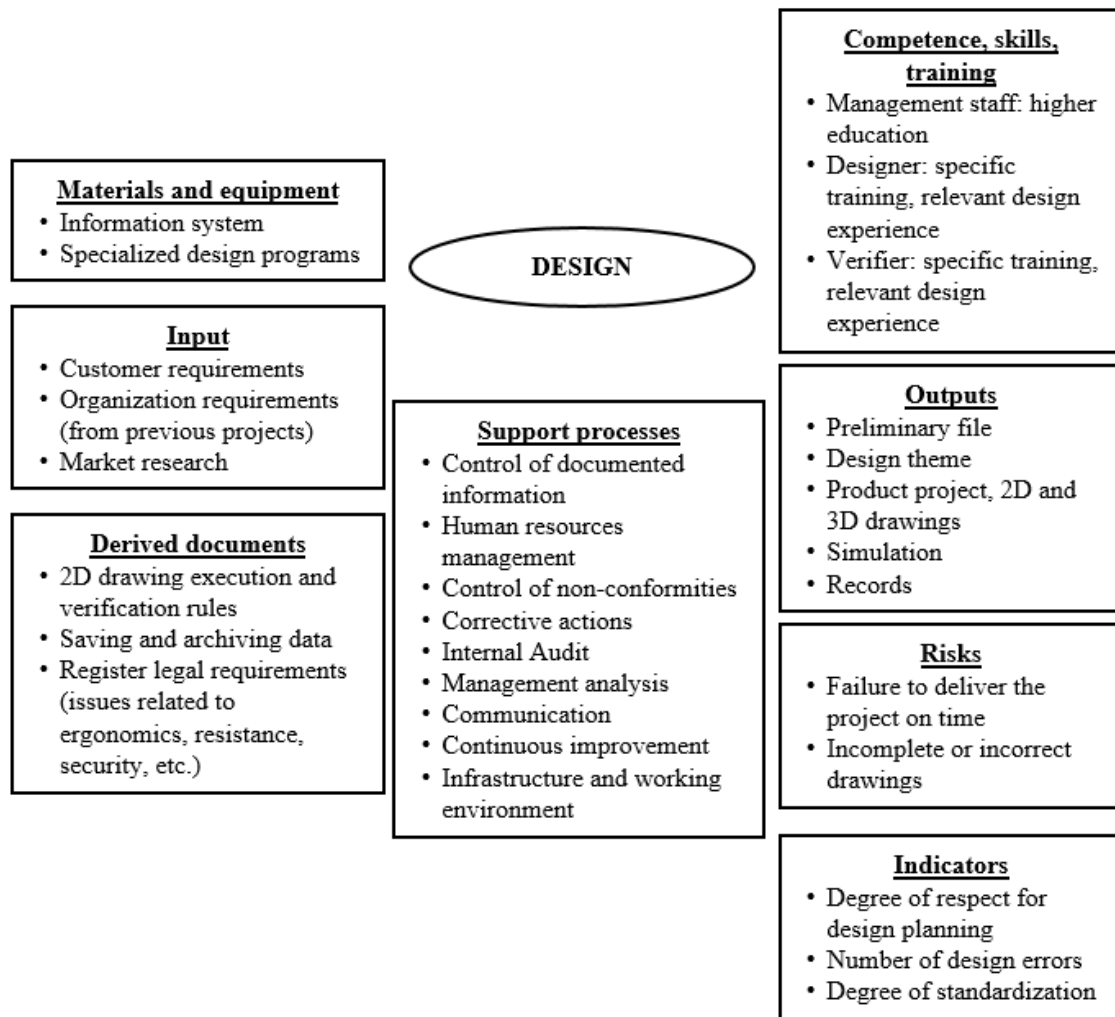


Figure 1. Diagram of the design process

As it can be seen, this diagram includes a series of inputs, outputs and not only:

- The materials and equipment found at the origin of the information entering the process were defined, these being the computer system and the specialized programs for design;
- Entries are related to resources such as: qualified personnel, adequate infrastructure and process documentation that may be in the form of written technologies, procedures, product or service standards, legal regulations, etc.;
- The design process is a basic process that is to be analyzed is represented in the central area;
- The support processes that come to support the design process are represented under the basic process;
- Exits represent data and products resulting from the process;
- The competences, skills and level of training of the persons involved in the process are specified;
- The level of satisfaction of the client's needs are presented in the form of indicators through which is expressed the way in which we ensure that the product / service meets the conditions established at the entry (in the procedure, technology, regulations);
- The risks are also specified.

This diagram was drawn up with the role of understanding very well the purpose of the design process before starting to carry out new management processes or to start an activity to improve existing processes.

Making this chart helps both the process manager and all the people involved to discover the influence of their work on other departments, processes, people, etc. In this way, the information regarding the design process in the organization was structured and everything involved in this process was agreed.

4. RISK ANALYSIS OF THE DESIGN PROCESS. CONTRIBUTIONS

Starting from the design process presented in schematic form in the diagram in figure 1, risk management has been taken into account for the increase of quality in the design activity.

This aspect will be further discussed in terms of the analysis and evaluation of the risk spectrum in terms of severity and probability of occurrence. The measures to mitigate the proposed risks will be analyzed and evaluated from the perspective of their effectiveness, and the results of the performance measurements and the tendency of the risks will be used to optimize the resources allocated, for the proper management of the risks and to maintain them within the tolerance limits assumed by the management of the organization.

The risk analysis we propose helps to identify the risk levels - high, medium or low - considering the probability of occurring and the total impact on the activity or group of activities.

The combinations of risks, in the authors opinion, can be represented as follows:

- Very low impact = insignificant impact, which can be ignored;
- Low impact = a reasonable impact, but it should be noted, that if the probability of the risk occurring, is high or very high, it requires monitoring;
- Medium impact = a significant impact, which could stop the activity, impact that for a low or medium occurrence probability, requires monitoring, and for a high or very high-risk probability, it requires immediate measures;
- High impact = a serious impact, such as stopping the activity, causing damage or non-observance of the legislative regulations with identification and warning, impact that requires monitoring and for a medium, high or very high probability requires immediate measures to reduce the probability by implementing preventive controls;
- Very high impact = a very serious impact, such as stopping the activity, producing major damages impossible to recover, non-observance of the legal regulations without warning, impact that requires monitoring and for a medium, high or very high probability requires immediate measures to reduce the probability by implementation of preventive controls.
- Very low probability = probability of occurrence eliminated by automatic prevention controls;
- Low probability = unlikely to happen during the implementation period of the activity or group of activities;
- Average probability = it can occur at a certain stage of activity;
- High probability = probably it will happen during the duration of the activity;
- Very high probability = surely it will happen during the duration of the activity.

In principle, one risk was proposed to be between values 1 and 25 (1 zero risk - 25 maximum risk).

Depending on the level of risk, the process managers proposed to act as follows:

- For the risks whose level is included in the "Action" area, the measures / opportunities necessary to mitigate the risks are mandatory;
- For the risks included in the "Attention / Monitoring" area, follow-up measures and opportunities for risk mitigation are established.

Once the measures have been taken, the risk level will be updated.

Therefore, after conducting the risk analysis in the organization in which the research was carried out, the risk factors described in the following were identified.

4.1 Risk factor - Defective completion of the project. Proposal implemented

The first risk factor: the faulty completion of the project having as origin the design process has as possible consequences the non-timely delivery of the project having cause - errors and insufficient training of the personnel.

If the probability of occurrence and the impact are scored by 4 - a high score then the risk matrix leads to a level of risk of 16, which requires some measures to be taken (table 1).

results then the risk matrix leads to a level of risk of 15, which in this case also requires mandatory measures (table 3).

Table 3. Risk assessment for insufficient information when taking over the project

Risk evaluation									
Probability of occurrence	Level of impact	The risk matrix			Risk				
Very high	Very high	VH	5	mandatory	12-25				
High	High	H	4	measures					
Medium	Medium	M	3	attention /					
Low	Low	L	2	monitoring					
Very Low	Very Low	VL	1	ignore					
4	4	Probability	VH	H	M	L	VL	15	16
			VH	H	M	L	VL		
			Impact						

The response strategy adopted requires the establishment and observance of the rules, and then the re-verification, with the project coordinator responsible and the deadline not to be 2-3 days. After taking the corrective measure, the monitoring and control was carried out by reevaluating the risks and it was found that the probability of occurrence this time is low - the score given being 2 but the impact remains the same, as high. Table 4 presents the new score obtained by 10 which means that in the future it is also necessary in this case, the increased monitoring and attention to avoid mistakes and to improve the quality of the work performed in the design activity.

Table 4. Monitoring following the risk assessment for the wrong completion of the project

Risk evaluation									
Probability of occurrence	Level of impact	The risk matrix			Risk				
Very high	Very high	VH	5	mandatory	12-25				
High	High	H	4	measures					
Medium	Medium	M	3	attention /					
Low	Low	L	2	monitoring					
Very Low	Very Low	VL	1	ignore					
2	5	Probability	VH	H	M	L	VL	10	10
			VH	H	M	L	VL		
			Impact						

5. IMPROVING THE QUALITY OF THE DESIGN ACTIVITY. CONTRIBUTIONS

Taking as a starting point the major problem identified in the design activity, which concerns the poor quality of the projects, improvement measures are required with the objective of solving the problem identified in order to reduce non-conformities.

The improvement of the quality has the effect of increasing the profit, the revenues of the company. For this purpose, it was used as a quality-specific tool, namely the cause-effect diagram. The diagram was created with the effect of the "poor quality of the project" (figure 2).

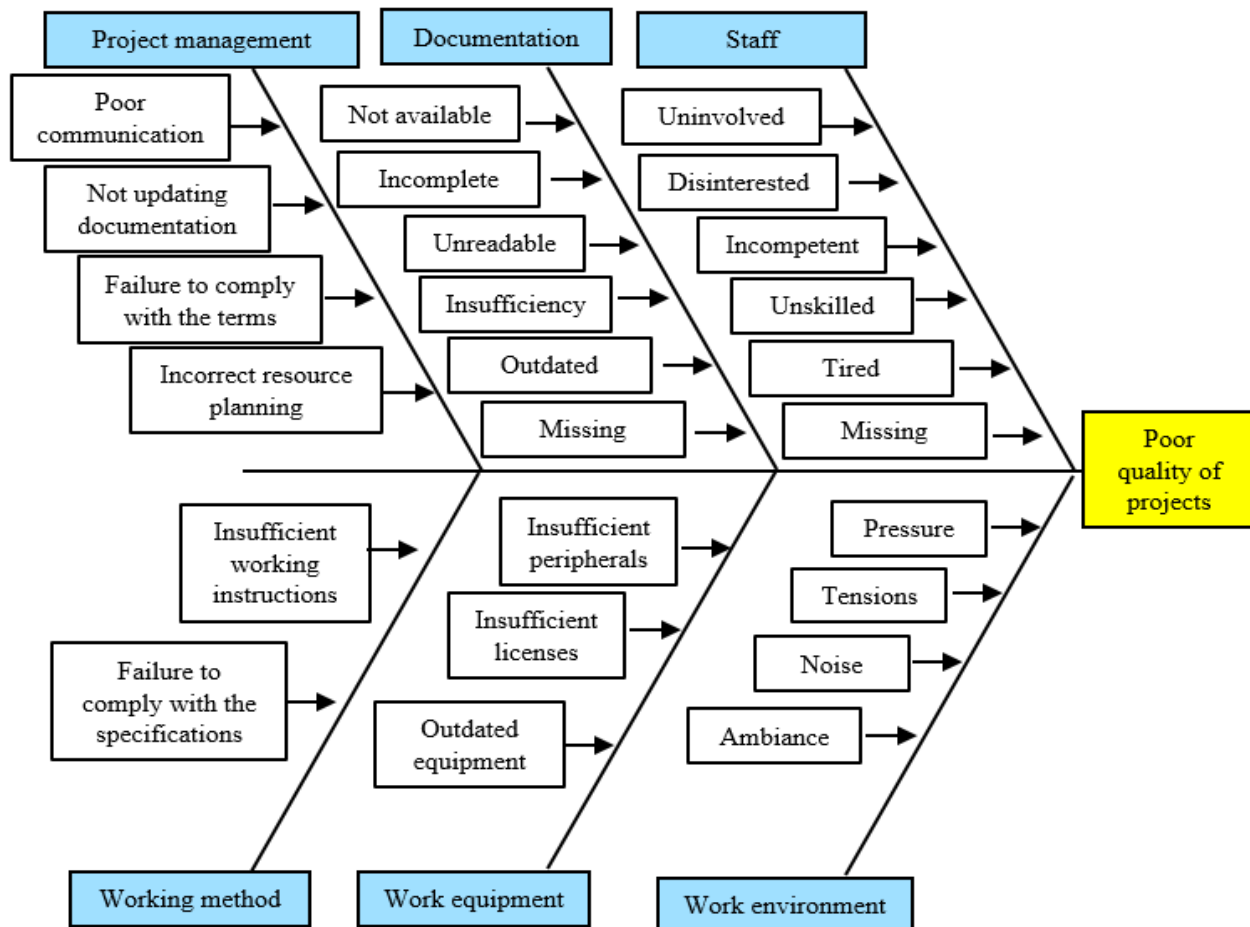


Figure 2. The cause-effect diagram of the problem identified

Therefore, the figure shows the connection between the result and the factors that led to its appearance without resorting to irrelevant complaints and discussions. In this way, the team's attention could be directed to the problem and its causes, as well as to discover the important links between them and the possibility of understanding how the design process works.

In order to improve the quality of the design activity, the following solutions were proposed:

- **Project management:** The proper acquisition of ISO documents, the objective setting of the project managers based on their experience, the correct choice of the team, preliminary meetings for starting the work at each stage of the project, respecting the project times and workload, ensuring the necessary materials the optimal conditions of the project (the corresponding documentation).
- **Documentation:** Ensure and verify from the beginning of the project if there are all the materials needed to carry out the project (specifications, archives, working instructions) and make the documentation available to the project team.
- **Staff:** Motivating staff, proper training of staff.

- Working method: The project manager and each team member will ensure compliance with the client's requirements.
- Work equipment: Providing the work equipment needed to carry out the activity even before the start of the project.
- Working environment: The management of the company will ensure the optimum conditions for carrying out the activity with the support of all the personnel.

As for the clients, in order to avoid the lack of the necessary information to be obtained from them, it was recommended to consider the issues presented below.

The following general data were taken into account:

- Project theme;
- Project Name;
- The program and version of the program to be used;

Production of documentation:

- Task book;
- Example;
- Project specific rules;
- Start the Model
- Work program specific settings;
- Work environment (environment);
- Project location;
- The structure of working folders;
- Libraries trade pieces, standard and assembly elements.

Project delivery:

- Delivery formats (PDF, TIFF, DWG, DXF, CATIA FILES, STP).

As general rules for the execution and verification of 2D drawings, the following were proposed and recommended:

Input elements - according to the specifications contained in the Quality Manual, and in the related working procedures;

Work elements - before the execution of the 2D drawings, the reference drawings and related information regarding the current project are studied. Where there are uncertainties, the project manager is asked questions;

Output element - conforming drawings and non-conforming drawings (returned to the designer with the corresponding observations for correction).

6. FINAL CONCLUSIONS

In the case of the organization providing design services in which the research was carried out, an essential role is played by maintaining and maintaining at the level of the clients' requirements the quality of the services provided, at the requested prices and adhering to the terms agreed upon, but also in terms of efficiency and effectiveness. own maximums.

From the client's point of view, it is oriented in particular towards obtaining design services of maximum quality and minimum rates.

The client seeks to be able to trust the capacity of the organization for the services to which it is calling - at the agreed price, tariff and term - and at the same time seeks to maintain it over time.

The organization must constantly improve its activities in line with the requirements of its customers.

The quality of the design services represents effectively the quality of the work of each employee.

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