1.3 DESIGNING PROCESS

A designing engineer influences almost all processes in an industrial company due to his work. Considering this fact, the designing process is a very specific and important process and no CNC machine tool can come into existence without this process.

The following text describes so-called designing aphorisms which are connected with the designing process and which are related to creation of a CNC machine tool:

- A designing engineer influences 70 % of company's processes due to his work.
- Nothing is possible without the designing office as well as without any other sections.
- You cannot stop making mistakes at designing; however, you can restrict your mistakes by your systematic work.
- Working effort at designing is not proportional to the quantity of money (a salary or a reward), so it is not true that if one is paid more, this one works more.
- Designer's troubles are always repeated with some particular regularity in periods.
- A designing engineer should design in such a way as if it were done for his own home, with such means which he has at home.
- Designing is „a girl with loose manners", all sections turn towards it; therefore, you must become reconciled with this fact or you must make another job.
- It is not difficult to think out anything, it is more difficult to put it in industrial practice.
- It is necessary to develop permanent, kind and systematic pressure on designing engineers, with the target to restrict perfect technical solutions and to apply practical solutions which are feasible in the company in the highest possible degree.
- Let a designing engineer create without supervision and he might create almost a perpetum mobile.
- The chief designing engineer means nothing without his people, he will not draw and develop by his own. He needs his people and his designing office looks like the chief designing engineer himself (as the proverb says „the rot starts at the top").
- The chief designing engineer or the technical director must gain the best conditions for his people in the company as it is possible.

What is necessary to manage the designing process

The designing office is not an isolated elite department. It is a part of a live organism which is called „a company". Considering this fact, it is necessary to manage the designing office and to organize its run. If work is organized well and systematically in the designing office, the chief designing engineer or the technical director will have fewer troubles. The following zones should be considered:

Staffing zone

- to divide engineers to working teams;
- to set salary limits and designers' salary increase;
- a real way how to reward designing engineers;
- a source where to find new people;
- a crisis scenario of the designing run (work organization at a crisis period);
- a plan of designers' education and trips to trade fairs.

Zone of the designing process organization

- workload of designing teams;
- a way how to divide and assign creative and routine work;
- a way how to follow designers' work (e. g. work statements, how much time was necessary for some particular work);
- work organization among executive designing work and:
  1) creation of operating and maintenance instructions,
  2) the commercial department (creation of offers and commercial journeys),
  3) manufacture and assembly;
- a system in drawing documentation (original, copies), storage of drawings;
- a system at disputation of a thesis (regularly, records);
- a designing digital book with proven mechanical and electrical solutions used in the company.

Designing creative work

- classification of changes and their assessment;
- a development plan;
- a method how to assign numbers to drawings and storage methods;
- knowledge which hardware and software means are necessary to perform designing work efficiently;

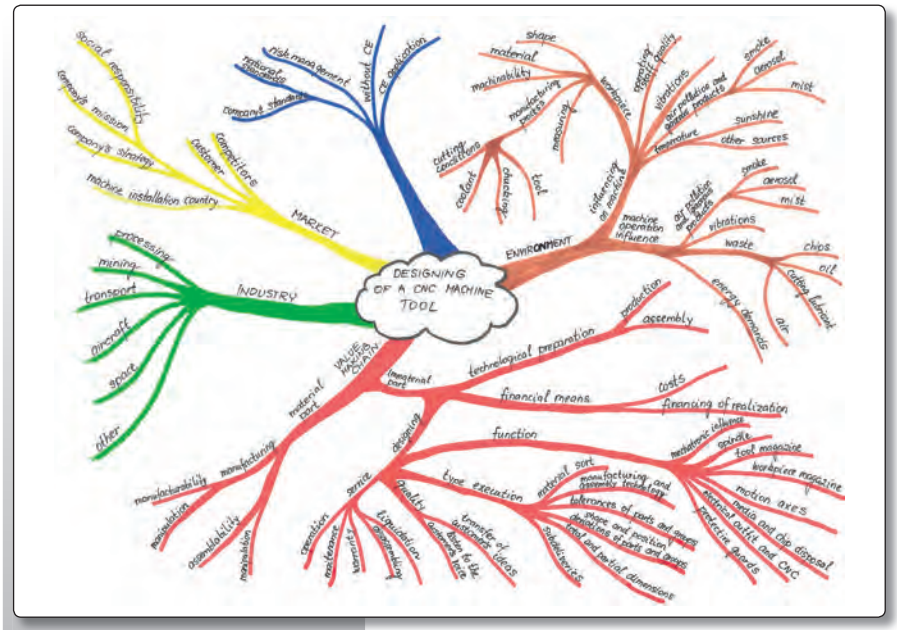

Fig. 1.3.1: Influences acting on designing

- a plan of hardware and software renovation;
- access to standards and law regulations;
- a system how to check the issued documentation;
- a system how to mark machines (products);
- standardization and unification at creation of products (the greatest possible heredity of assembly groups);
- storage of purchase items which can be acquired very easily (reduction of stock);
- a designer's manual with data about machining and measuring possibilities in the company.

Other zones

- protection of spiritual property;
- protection of documentation to prevent its theft;
- management of risks, while an order passes through the company;
- supply of specialized literature and magazines.

Definition of designing

If a designer designs a CNC machine tool, he must take account of the following facts:

- which industry section the machine is specified for;
- how the market influences the prepared machine;
- influence of law regulations;
- how the environment influences the machine;
- how the machine influences the environment;
- to design considering the complete value creating chain.

Then, it is possible to show these influences in Fig. 1.3.1. As it can be seen, there is a great quantity of influences which must be kept in mind by a designer at the same time. It follows from the mentioned facts, that designing is a very demanding process and it requires systematic work to eliminate negligence of some influences.

Considering the above-mentioned facts, it is possible to quote the author's definition of designing:

Designing is a process, where a person uses the system approach to find a technical and economic optimum solution on a technical system with the aim to satisfy own needs or customer's needs. At the same time it is necessary to keep in mind management of the process (risks of the designing process, quality, heredity and innovation) as well as external and internal influences on this process, various standards, CA technology, customer's requirements, subdeliveries, the state of technical development, delivery time and a human factor.

The situation which the designer is exposed to is not simple – due to the solution of a designing job or due to pressure of superordinated restrictions (commercial department, laws, owners, manufacture, particular directors of specialized sections, etc.). The designing course must be divided in partial steps, which follow each other in the logical sequence and which are synoptical. Solution methods must be then prepared for these steps. Designer's work can be divided in three different phases of the design problem solution (Fig. 1.3.2):

- task determination and formulation;
- solution searching using various variants;
- evaluation and decision making which are connected with the determination of the optimum variant.

The particular stages can be proceeded thanks to the support and application of various methods. Doing this, it still depends on the fact, what originality the new originating technical object has regarding to the knowledge, which the designer obtained in the previous time period, e. g. when he created some similar design. The matter is that this designer can create:

- new arrangement or layout;
- adaptation of the existing design;
- modification of the existing design.

The designer must consider technical optimization of some variants of suggested solutions as well as economic optimization of these solution variants – Fig. 1.3.3. The solution variants are chosen from the state scope Quality, Price, Time. Optimization must be performed completely based on technical and economic solutions which are acceptable for the manufacturing company. At the same time, it is necessary to keep in mind customer's criteria – if these have been defined – and then it is necessary to perform the complete assessment. The efficient solution should be suitable for the manufacturing company as well as for the particular customer.

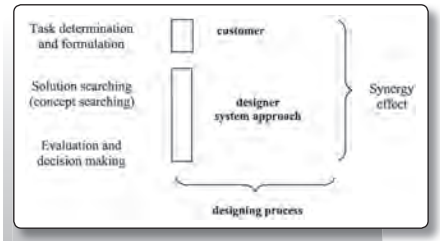

Fig. 1.3.2: Phases of the designing process

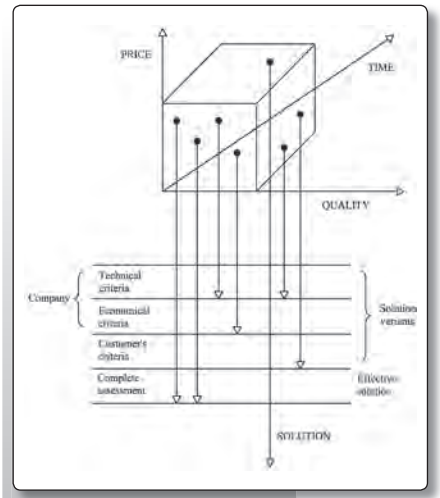

Fig. 1.3.3: Complete assessment of designing variants

Economic optimization connected with the technical aspect of designing is the indispensable part of the complete assessment. It seems very useful to apply methods of value management which includes also value analysis. Considering the methodological approach in value management generally and especially in value analysis, it is always necessary to put five essential questions by L. D. Miles (Fig. 1.3.4):

- What is it?
- What does it make?
- What does it cost?
- What else can provide the function?
- What does something else cost?

Types of designing issues

The technical object must be made in its concept in such a way that its designing elements can provide realization of such processes on this object, which provide the required functions of the object with the required quality, safety and in the

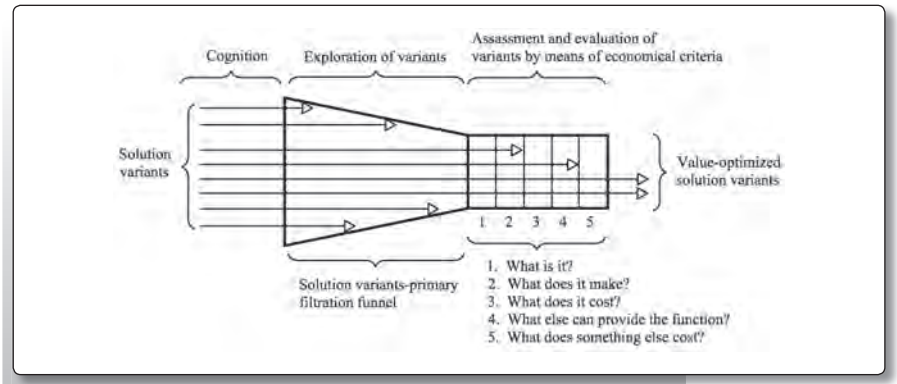

Fig. 1.3.4: Analysis of the designing object by means of five essential questions

risk free way, with observance of social, economic and ecologic requirements. It requires to perform some staffing policy and to provide the adequate degree of work organization; however, this can be also connected with psychological and law aspects [Janíček, Marek 2013].

Conceptual and structural problems are the most important part of designing issues and these problems are solved with the greatest difficulties, because solving these problems, the designer shall also solve the concept (basic approach, idea) of the future product (CNC machine tool) and the object structure corresponding to this concept. This must be done in such a way that the product can fulfil its required function and show required characteristics.

The concept and structure of the designed object must guarantee realization of such processes on the object which provide its functionability (process and functional problems).

Generally, every and each product is required to be in good quality (first class quality) and to be reliable, safe and risk free (quality and safety problems). What this means specifically, how the mentioned terms are defined and how they are provided at products – this is the domain of only some competent people, of those people who participate in creation of products – of designing engineers.

Products start harming the nature at the moment when one starts designing them. During this stage, the designer shall consider the materials which products shall be made from. It is necessary to find raw materials for the products and this is the first impact of the product creation on the nature in the form of raw material mining (economic and ecological problems). Another shock for the nature is manufacture of the product, its operation and its disposal. These are impacts which can be influenced already during designing of the product. These facts underline how it is important to solve conceptual and structural problems with regard to ecological problems of the product.

Every and each company dealing with development and manufacture of machine tools has staffing problems. Integration of human sources at the machine tool creation is one of the most complicated problems of group or team work. Consequences of the fact that the key (fundamental) people grow old in all sections, where the technical object is created, and the fact that younger people leave the company due to bigger competition on the work market –these are factors endangering the company's ability to innovate its products in dependence on customers' wishes (staffing and organization problems). Another staffing problem can be seen in the fact that younger people are not able to adopt experience and knowledge from older employees quickly enough. A great staffing problem can originate, if a key employee leaves for a competitive company with his know-how. These problems can be prevented to a certain extent by motivation of employees.

An unexpected situation can happen during all manufacturing process, at the design creation (designing) beginning, through manufacture and assembly stages and at the final dispatching of the machine tool to its customer finishing. If such a situation occurs, it is necessary to make a decision very quickly, because the manufacturing plan is disturbed. A stress situation originates (psychological problems). The stress situation requires a quick solution to fulfil customers' requirements (delivery time, observance of technical parameters, appearance and functionability).

Computer support of designing

The text has been elaborated with contribution of [Novotný 2011] and [Novotný 2012]. The computer support has been developing very significantly during the recent years. The CAD technology development is shown in Fig. 1.3.5. As dr. Novotný of Toshulin, a. s. company says, common CAD programs based on

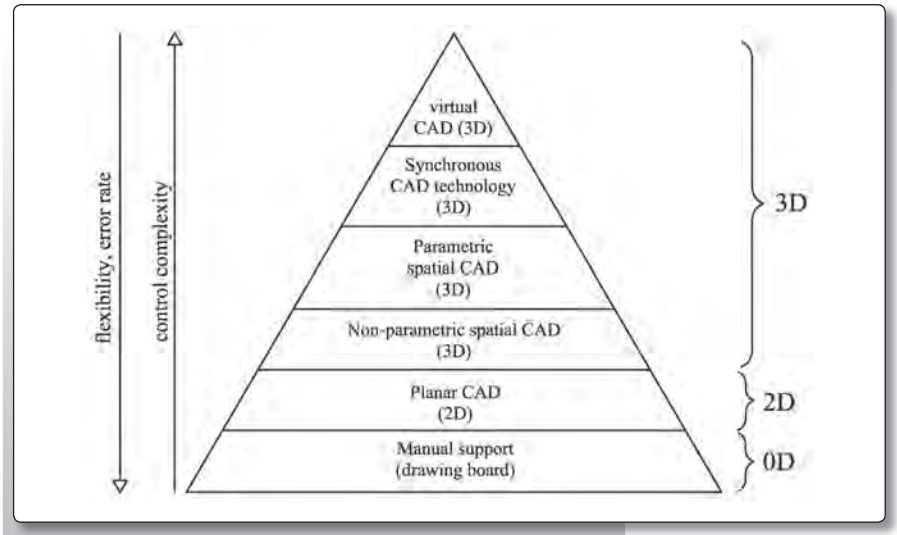

Fig. 1.3.5: Development of CAD technology supporting designer's work