

SELECTION OF CUTTING CONDITIONS AND TOOL FLOW IN FLEXIBLE MANUFACTURING SYSTEM

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ABSTRACT:

The contribution presents the determination and selection of optimal conditions reducing the manufacturing costs. The data can be selected from different bases and are optimized with respect to boundary conditions of the own production. By taking into account the simultaneous engineering method it is necessary to carry out integrated and parallel activities of the detail design and production process. For building the tool data bank the “specialties” of the own production are taken into account. For the analysis of the tool and workpiece flow the principle of “virtual production” is considered. Accurate cost analyses are made for planning of the needs. In the processes of simultaneous optimization all requirements and the technology strategy are considered in order to meet the criteria of low costs and maximum quality. The researches and the results were tested in the reel production environment.

1. INTRODUCTION

Today it is of decisive importance for production companies to be and to remain competitive in turbulent market conditions. The increased pressure of the market and the intensive global competition compel the companies to react quickly to the requirements and expectations. To reach successes it is necessary to change the company's strategy so that the development and production processes are adapted and the cost advantages of flexible automation realized [1, 2, 3, 4].

It is established more and more frequently that the product development is decisive for the company's business successfulness. But the leading production companies carry out in parallel the development and the related production processes. It is known that 80 % of production costs occur during the development and that less than 10 % of costs are incurred in production. This fact is often neglected. Many companies still always focus their attention too much to optimization of their production processes, [5].

Herein after the contribution presents the approach with the simultaneous engineering method with the emphasis put on the determination and selection of cutting conditions reducing the total production and after – sales servicing costs.

2. METHODS FOR REACHING OPTIMAL TARGETS

The simultaneous engineering is the integrated and parallel execution of the detail design and production processes, Figure 1.

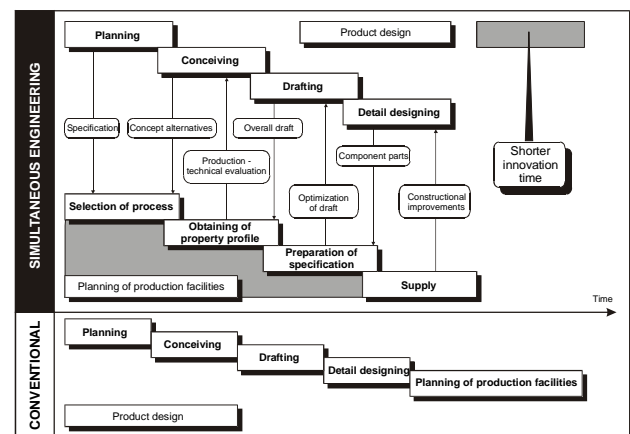


Figure 1: Simultaneous engineering method

The volume and, even more important, the time coordination of technical changes are a key to success. The later the changes in the development and production process, the higher the costs and loss of time for the individual changes. During the development stage, the changes on the CAD monitor are very simple, but when hard tooling follows, they are very expensive and demanding with respect to time. The simultaneous engineering requires the multidisciplinary teams mastering all functions and responsible to ensure that the new product comes onto the market.

Efficiency of the engineering data management “the key to introduction of the simultaneous engineering. The engineering data management” a further step to reducing the time up to placing the product onto the market and preventing the defects and delays. The data are not only the CAD/CAM drawings but also all graphic and textual information, e. g. Reihart [6]. A complete turning point in thinking begins in the area of the production planning, since modern communication technologies ensure production in a virtual factory. Figure 1 confirms the present development where the notions “virtual realities”, “virtual products” or “virtual markets” do not represent anything physical but exist only in the observer’s thinking world as a result of his thinking power.

3. SYSTEMATIC COLLECTION AND DETERMINATION OF CUTTING CONDITIONS

To be able in production to follow up the requirements for smallest possible costs it is urgently necessary to determine the optimal cutting conditions Cus at. al. [7], to select the cutter material, the clamping devices ant to utilize the machine to the greatest possible extent. Figure 2 shows a systematic approach to selection of cutting conditions for a medium-size company. On the basis of the hitherto experience in own production, or on the basis of tests executed in a special experimental department or by direct access through INTERNET, the individual cutting conditions are collected in the Information centre for cutting conditions which is a part of the tool management system. Here the data are collected, verified, processed and organized in suitable bases. The data are accessible to each department within the company according to the open cooperative computing strategy particularly for simulation of machining, simulation of loadings and of clamping the workpiece and tools.

4. BASIC DATA FOR BUILDANG THE TOO DATA BANK

As there are many bidders of cutting tools on the market, it is very hard to remain independent of the individual maker. Many factories do not like the monopoly of a single tool supplier, therefore they combine purchases from

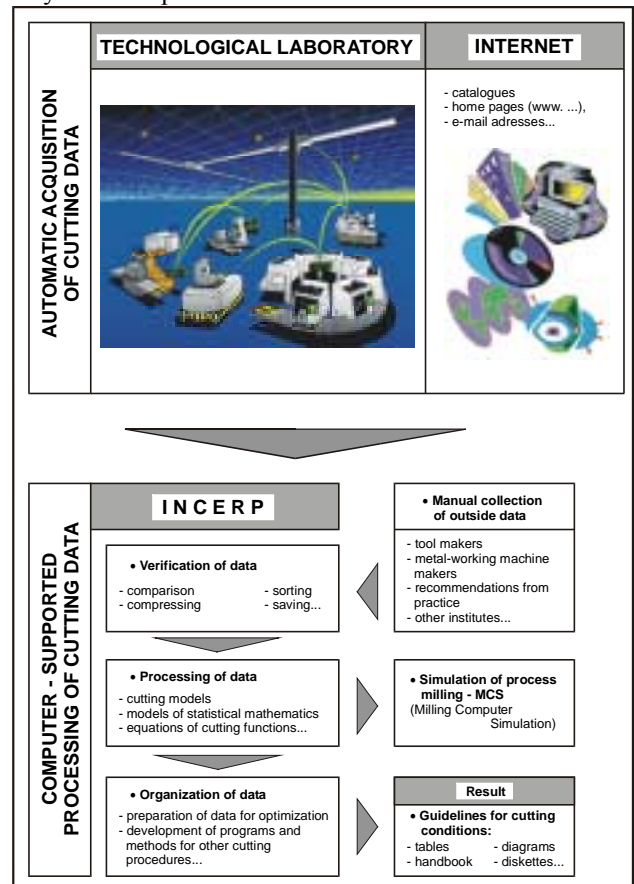


Figure 2: Diagrammatic representation of collection and determination of cutting conditions

several suppliers [8]. In this way they can heat down the price of tools and obtain the best quality.

Of course it is very important to have an own tool data base. This is also a competitive advantage, since some materials have specific features of machining which only we master. In spite of globalization of data some specialities will remain only ones, adapted to our knowledge and production resources. As we do not want to disclose them, we frequently lay the foundations for own tool data base. Figure 3 shows which basic questions we have to answer ourselves. Here it is necessary to include the knowledge of the most experienced technologists carefully following up all

problems in industry. Many data are very precious already in the stage of the detail design of product, therefore in the simultaneous engineering system they are accessible to the people from the design offices [9].

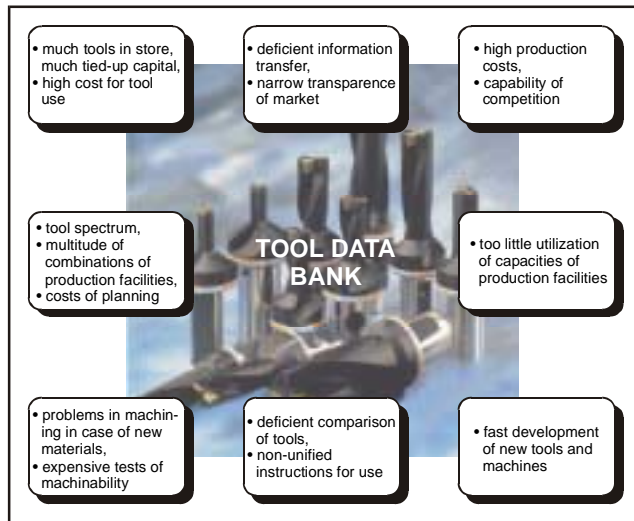


Figure 3: Foundations for building the tool data base

5. TOOL AND WORKPIECE FLOW IN PRODUCTION PROCESS

The term “virtual factory” is no more only the subject of discussions in science and industry but it has become reality for reduction of costs, saving of time, increase of quality and flexibility. It is a fact that there is no production without tools [10]. Today the tool and workpiece flow in production can be simulated by modern information supports.

The “virtual products” can be followed up throughout production up to the final product, Figure 2. At any point of the process they can be simulated in suitable shape and can be logistically followed up. It is also possible to follow up the entire tool flow in the production process the required quantities can be found out, the logistical support for new and used up tools determined and all details for optimal production defined [11, 12]. This is an excellent support of the S. E. system, in particular, when it is necessary to switch over from virtual production to the real product.

In modern flexible systems it is possible to work out several alternatives for production, to select the best alternative or even to combine several alternatives for the optimal solution.

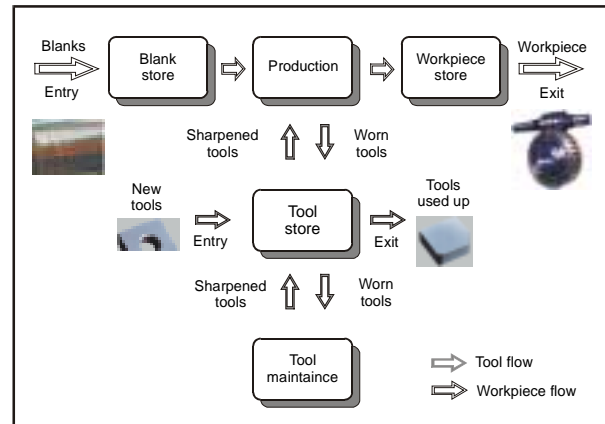


Figure 4: Tool and workpiece flow in production process

6. PLANNING OF PURCHAS OF TOOLS FOR FLEXIBLE MANUFACTURING SYSTEMS

Due to high costs of tools it is necessary to plan rather accurately the purchase and use of tools. Figure 4 diagrammatically shown the basic quantities of tools that have to be available in the company. It is a fact that the tools can roughly be divided into: quantities in circulation, quantities in warehouse and non-usable quantities. As the cost of the working hour in the flexible system is very high, a very good tool planning is necessary to prevent stoppage of the manufacturing system due to shortage or bad quality of tools [13].

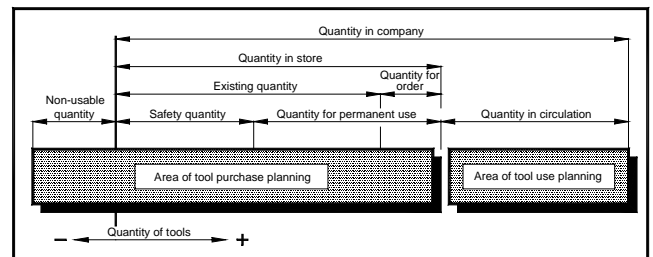


Figure 5: Types of tool quantities and areas of responsibility of tool department

7. INFLUENCE OF TOOLS ON MINIMUM – COST PRODUCTION

The target of the production is the maximum productivity and minimum costs [14]. By selecting the optimal cutting conditions the minimum main manufacturing times and the related auxiliary times and tool replacement times are achieved [15, 16,

17]. Figure 6 diagrammatically shows the dependence of portions of consequences and causes on the minimum cost production. It is a fact that the tool costs influence the entire manufacturing costs. In our researches in companies and particularly, in tool shops we found that these costs are often forget. This is caused by specific features of production, since some tools are used only once and in books they are specified as consumable material, though their purchase price is high. After thorough analyses in some companies the annual tool costs were reduced for 20 – 30 %.

8. OPTIMIZATION PROCEDURES FOR VIRTUAL AND REAL PRODUCTS

In the product design process various aims are pursued: high quality, high physical requirements, small consumption of materials and low costs. Figure 7 shows diagrammatically the principle of the pursuit of largest and other parameters

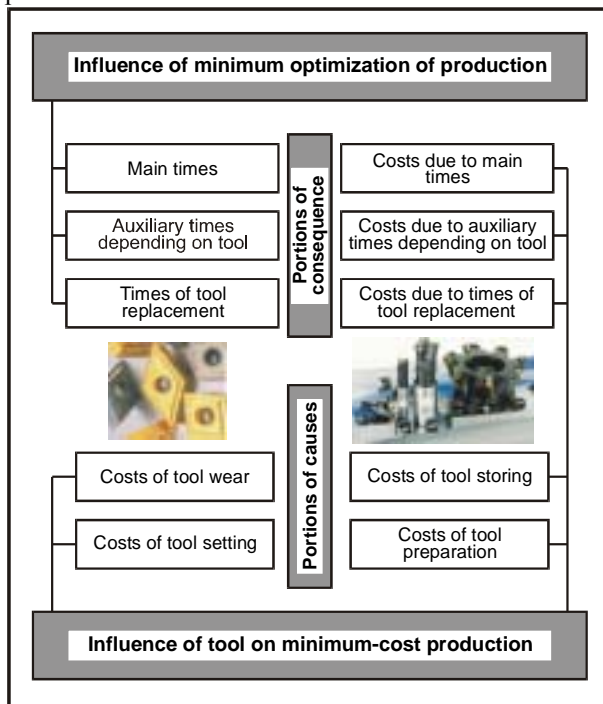


Figure 6: Influence of tools on minimum cost production

required for optimization of procedures. In the S. E. system the optimization parameters are known: these are the minimum costs and the maximum productivity.

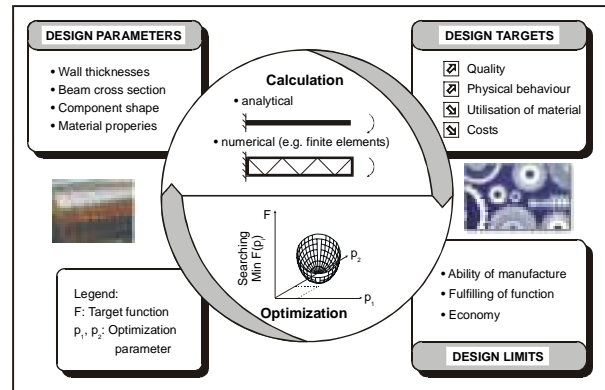


Figure 7: Simultaneous optimization procedures

In the numerical calculations of the product it is important to make simulation calculations because of loadings occurring as a result of clamping and cutting process [18, 19]. Frequently the maximum cutting forces cause the workpiece deformation. In practice this was tested many times and it was found that beval quality of the product is the result of deformations in machining. By suitable corrections and modifications of clamping the specified tolerances were reached. Also the modern cutter materials assure high cutting speeds where high loadings occur and in particular, the old machines are too little rigid for such good cutter materials.

The synergic effect of the S. E. system ensures great reductions in all areas. We reached excellent results on an example of a pilot project of the tool shop making modern tools for cutting plate components for the automobile industry. The costs of the individual parts were reduced for 42 %, the assembly times shortened for 67 %, the product performance was improved the assembly automated and the design efficiency increased for 20 % etc.

9. CONCLUSION

The production companies will have to adapt them selves to the requirement for economical use of time and money [1, 20, 21, 22, 23, 24]. The simultaneous engineering makes possible the shortening of the time necessary to prepare a new product with higher added value for the market. In the contribution we presented the summaries and experience based on our researches in the area of determination of optimum cutting conditions and tool flow in flexible manufacture. It was proved that some radical changes of ways of thinking, some kind of paradigm shift, facilitating the work, are necessary. By analytical work, gradual steps, organizational changes and clearly defined responsibilities we reached excellent results. Only thanks to our activities in companies the synergic effects and the pursuit of joint targets were assured. This was a great encouragement and

satisfaction to us, therefore we continue intensive researches and concrete work in practical.

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