SYSTEM FOR DATA RECORDING DURING THE CUTTING PROCESS

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Abstract: The present paper describes the development of the practical system for simulation and representation of the cutting process with milling. The data recording during the cutting process, ensuring reliable identification of the machining process, is effected by means of a measuring system based on the information obtained by means of sensors. The system is based on the knowledge from machines, technological processes, machining and experiments executed. By means of the system for simulation it is possible to forecast the development of events that will take place during the cutting process without executing the tests. It can be used also in the combination for monitoring and optimizing of the machining process - cutting parameters. The measuring system covers on extensive area of machining operations; in addition to milling, it can be extended also to other cutting techniques such as drilling, grinding, turning and high speed cutting.

Keywords: measuring system, cutting, cutting forces, simulation

1   INTRODUCTION

Measuring of forces in production is very important, particularly in cutting. It is used for following up the machining process, supervision of the tool condition and for preventing the tool breakage during machining. Measuring of forces helps us to understand the machining process because the cutting force is one of the most variable factors during machining. The static and dynamic components of the cutting force contain the information related to the process of the chip formation and to the cutting tool. The purpose of the system for simulation of the cutting process and of the system for the force measuring is to forecast and represent the events during the machining process and thus to assure reliability of machining, to increase the machining accuracy, to shorten the time and to reduce the manufacturing costs.

2   PRESENTATION OF THE SYSTEM FOR SIMULATION

The system for simulation of the cutting process (we limited ourselves to the cutting process with milling) consists of the software and measuring equipment; it is mainly divided into:

- simulation based on calculations and measurements,
- simulation with finite element method and
- technological data base

The simulation based on the finite element method is divided into the area of the static and dynamic representation of results. The static simulation is the representation of loadings, stresses, strains and of the temperature of the cutting insert and workpiece by means of the finite element method in a particle of the second. In case of the dynamic simulation the results of loadings in a time interval are represented so that the occurrence of loadings is followed from the very beginning to the end of machining. The results are shown graphically in two and three dimensional method. The static and dynamic simulation are divided into the following areas:

- simulation of stresses,
- simulation of strains and
- simulation of temperature.

The simulation based on calculations and measurements is divided into the following areas:

- simulation of cutting forces,
- simulation of rigidity of the system and
- simulation of roughness of surface.

All parameters required for making calculations, measurements and simulation can be found in the technological data base. The results obtained are recorded into the base of data on the obtained values of the simulation.
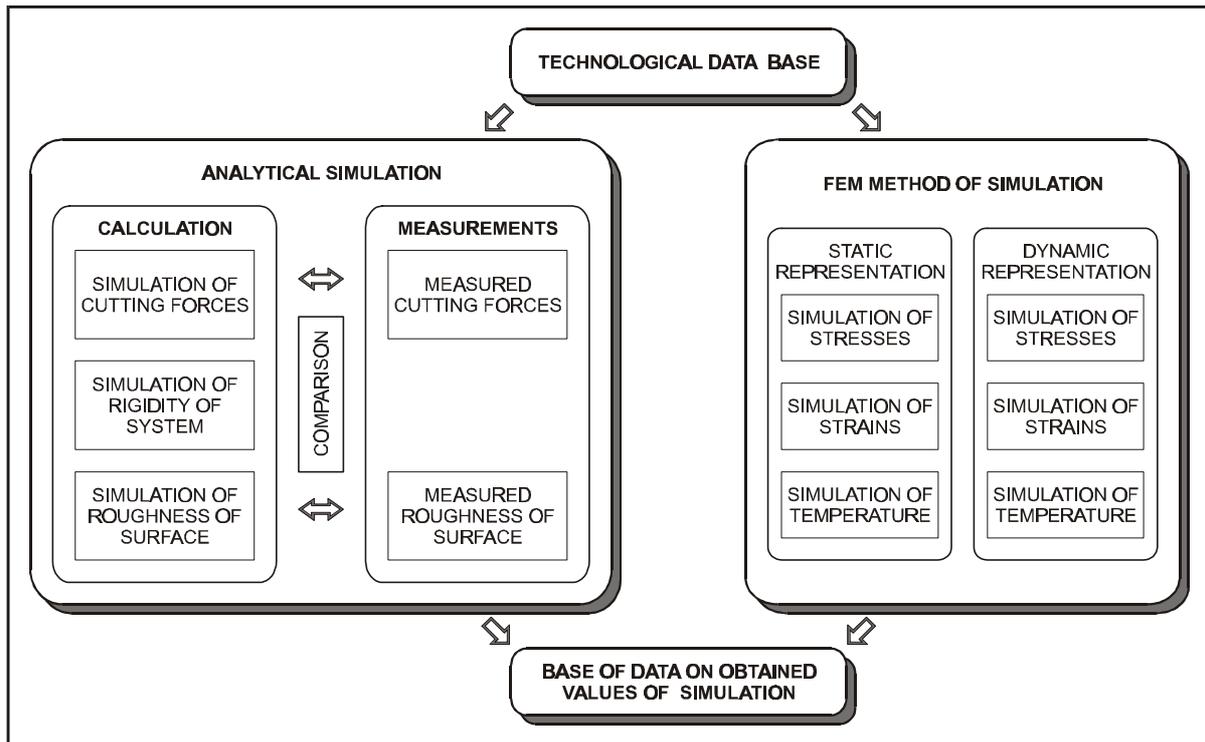
Figure 1. System for simulation of cutting process

3 SIMULATION AND MEASURING OF CUTTING FORCES

The system for simulation and measuring of cutting forces is the analytical and graphical programme for representation and optimization of the machining process.

The system for simulation and measuring cutting forces consists of the following modules:

- technological data base,
- selection of basic data for simulation,
- simulation (cutting forces, vibrations, quality of workpiece surface),
- measuring of cutting forces,
- calculation and representation of simulation results (diagrams, tables) and
- storing of the simulation results into the data base.

The technological data base contains the data on the technological parameters, tool, machine, workpiece, clamping devices and cooling/lubrication means. From it the input data, needed for simulation, are selected. The data base is complemented with data from catalogues and internet.

The input data for the process of simulation can be selected from the data base or we can enter them ourselves. The basic input data, needed for simulation, are:

- Technological parameters (type and method of milling, required quality of workpiece surface, milling depth, width and length, direction of milling, cutting speed, feeding , cutting depth, milling with one or more cutting inserts…),
- Tool (milling cutter type, milling cutter diameter, number of cutting inserts, type of cutting insert, cutting insert material, cutting insert geometry, resistance to wear…),
- Workpiece (workpiece material, workpiece size…),
- Machine (machine type, data on number of revolutions and motions, machine rigidity…),
- Clamping device (type of clamping device, method of clamping, rigidity of clamping device…),
- Cooling and lubricating means (cooling yes/no, type of cooling/lubricating means, viscosity, temperature of the means…).

The simulation can be effected in two ways. The first way is such that the machining process with milling is simulated only by the computer programme. The second way includes in addition to the computer simulation also the measured cutting forces during milling, which are obtained by means of the force measuring instruments on the machine. The results obtained during simulation and measuring, can be represented and compared in diagrams and tables. The results of the simulation and measurements are stored into the base of data on obtained values of the simulation.
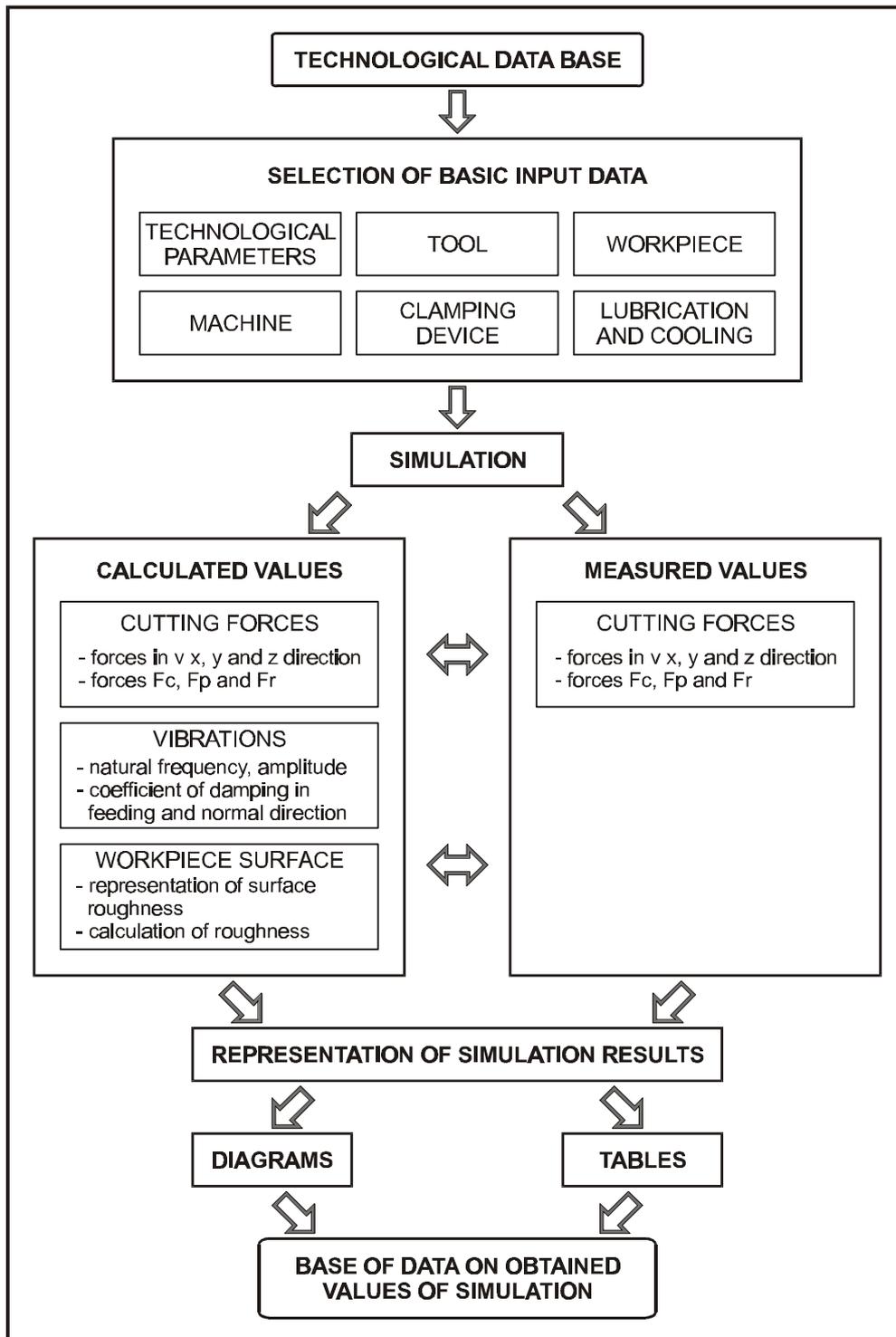
Figure 2. System for simulation and measuring of cutting forces

Simulation of the milling process by the computer programme includes the following calculations:

- Cutting forces (calculation of cutting forces in x, y and z direction, calculation of the main cutting forces F_c, F_p and F_f),
- Vibrations (vibrations on the machine and clamping device, vibrations in the direction of the main and feeding cutting force, natural frequency, amplitude…),
- Workpiece surface (representation of the surface roughness in section or 3D, calculation of roughness…).

The measured values are obtained from the force measuring instrument through the interface for the transfer of the measurement results on the PC. In order to assure accuracy of the measuring system for measuring of forces it is necessary to take into account also the outside influences participating in the cutting process such as the following technological parameters:

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- tool,
- workpiece,
- metal - working machine,
- clamping device and
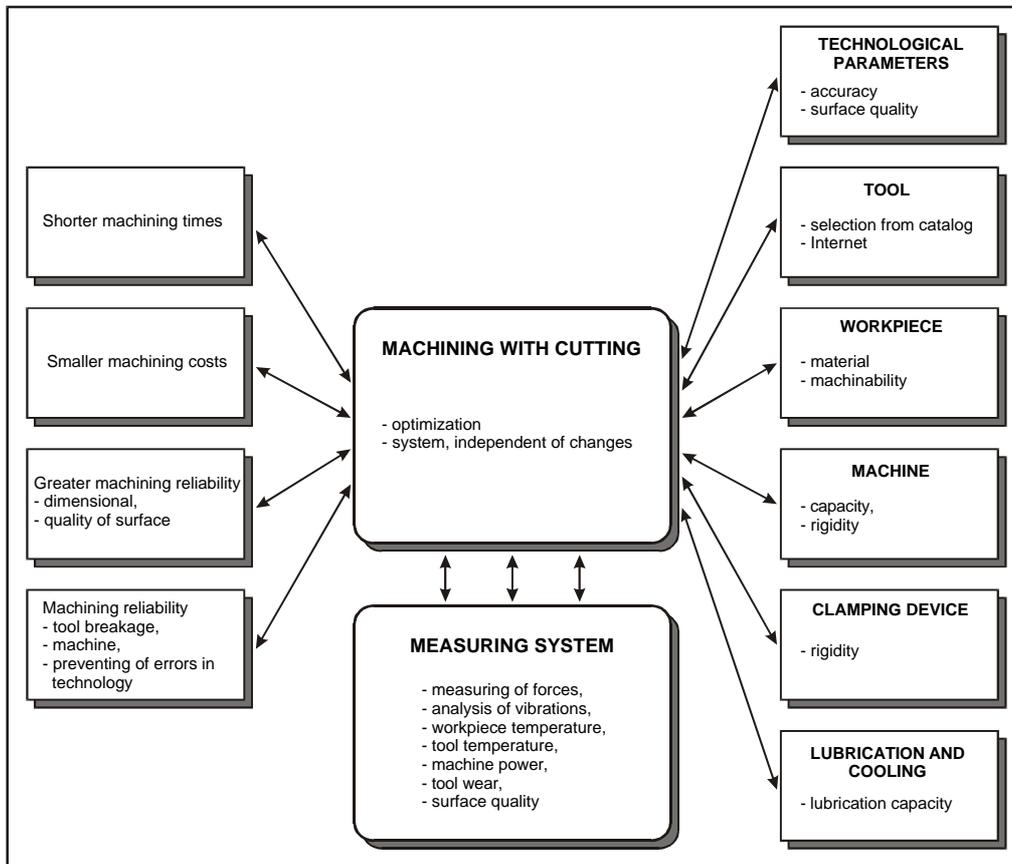- cooling / lubricating means.

Figure 3. Representation of the measuring system for data recording during the cutting process

4   CONCLUSION

By mean of the system for simulation of the cutting process it is possible to simulate the cutting process on the computer. The programme for simulation is an aid enabling us to forecast the course of events during the machining process with given initial conditions such as the technological parameters, tool workpiece and the machine. Thus the cutting tool wear is reduced, the breakage prevented, the number of errors in selection of the cutting technology reduced and greater accuracy and productivity of the machining system reached.

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