DETERMINATION OF TURNING CENTER MANUFACTURING POSSIBILITIES IN THE FLEXIBLE MANUFACTURING SYSTEM

assoc. prof. M.Sc. Kostal P. PhD ¹, M.Sc. Mudrikova A. PhD ¹, M.Sc. Matusova M. PhD ¹, M.Sc. Hruskova E. PhD ¹
Faculty of Materials Science and Technology – Slovak University of Technology, Slovak Republic ¹
peter.kostal@stuba.sk

Abstract: Flexible Manufacturing Systems provide a fast reaction possibility to the changes in production conditions. As production conditions change, other changes in the final product like changes of the product variants, or other unpredictable events may be also expected. Nowadays most of the products are designed by using the CAX software. The product design 3D model contains not only the geometrical data of product, but may contain a part of the process plan and technological data as well. This fact is a reason to quick reaction time possibilities in the manufacturing system settings.

Key words: MANUFACTURING SYSTEM, PROCESS PLAN, CAD MODEL, GROUP TECHNOLOGY

1. Introduction

At our faculty we build the new laboratory of flexible manufacturing system as a part of the project „OPVaV-2008/2.2/01-SORO – 2622020055“. The main target of this project is building the laboratory equipped by flexible manufacturing system and directly interconnect it to our CAD laboratory. The direct connection between these two laboratories enable realization the jointed design and manufacturing system. The main advance of this system is a possibility of manufacturing fast reaction to design changes without a manufacturing documentation on paper form. This is a model of a new „digital“ manufacturing. [1]

Currently is automation very important tools to ensure higher production quality and flexibility. This is the way to improve the manufacturer competitiveness in the globalized market.

A today trend in manufacturing is characterized by production broadening, innovation cycle shortening, and the products have new shape, material and functions. The production strategy focused to time need change from traditional functional production structure to production by flexible manufacturing cells and lines. Production by automated manufacturing system (AMS) is a most important manufacturing philosophy in last years[2]

Improvement of the manufacturing responsibility we can achieve by several ways. One of them is shortening the time needed to preparation of the manufacturing. Important part of manufacturing preparation time is consumed by preparing the drawings and process plans. Integration of design model with production planning and execution is necessary in order to increase product quality, reduce the cost, and shorten the product manufacturing cycle.[3]

Traditionally, drawings are used for communication in industry because they are the clearest way to tell someone what to make and how to make it. They are considered as a graphic universal language. The fundamental purpose of an engineering drawing is to carry, control and maintain a product’s definition in a precise and clear way with no risk of misinterpretation or assumption. Technical drawings provide a means to communicate complexity in a comprehensible and effective manner thanks to visual abstraction. A set or working drawings convey all the facts fully and explicitly. [4]

In base of drawings and knowledge about a manufacturing technologies, manufacturing devices, tools and fixtures, we can do the process plan for the given part manufacturing. The manufacturing process plan creation is so complex task. This complex operation can be realized easier and faster by use of some ideas from field of group technology. The base idea is in preparation of imagined part (most complex part MCP) which contain the all surface what is possible to manufacture by given combination of machine, tools and fixtures. For this MCP we can prepare the process plan template. In this template will by placed the operations, manufacturing conditions and other variables needed to manufacturing each surfaces.

All real part will contain only subset of the MCP surfaces. And all real process plan will be only subset of the MCP process plan.

In this article we subscribe this process for the turning machine from our flexible manufacturing system. (Fig. 1)

2. Turning machine EMCO TURN 105

Turning machine EMCO TURN 105 is a part of flexible manufacturing system (FMS) which is at our laboratory.

Flexible manufacturing systems with robotic operation for environment of drawing less production (therein after only FMS) will be represented by the model CIM (Computer Integrated Manufacturing) in the conditions of our institute. It is a systemic approach to planning, management and production itself. The target is to gain experience in these fields at the level of a manufacturing system as a unit.

The whole FMS (all manufacturing and handling devices) must therefore contain a communication structure based on modern industrial standard that is compatible also with other industrial facilities to enable trouble free data transfer. One of marginal conditions for definition of FMS characteristics is the ability to cooperate with CAD system CATIA available in our institute. In addition, this system will also have to cooperate with other CAD software systems. This cooperation is extremely important in a term of final project objective: „drawing less production“.[1]

The turning machine is operated by industrial robot. As a fixture is used the hydro pneumatic vice with clamping diameter 28-31 mm. This lathe are equipped by 8 position revolver head for tool changing. Maximal turning length is 240 mm, but the real is smaller, only (121 mm) because the revolver head must be able change the axial tools (drills) too. Maximal turning diameter is 140 mm.

We must take a mind for this physical limitations of machine in time of preparing the process plan for real manufactured part. Other limitation are the tools what are equipped in the revolver head.
3. Possibilities to surface creation by cutting

All parts consists of the final number of defined surfaces. In order to produce a specific part, we must take into account the appropriate combination of machine tool - motion and cutting tool. In some cases of surfaces, it is necessary to adjust another surface (such as thread cutting). Therefore, it is essential to pay increased attention to production order of surface in the production process.

The surfaces creation at the part by turning processes are possible three ways [5]:

- Point + movement – usually longitudinal turning the rotational surfaces, transverse turning the heading surfaces
- edge + movement – usually grove turning
- surface + movement – drilling operations in general

In the Table 1 we can see the general cases of surface creation by turning operation by given combination of machine and tools. The first tool able to create the surfaces only as a point (tool tip) + movement. This tool are used for longitudinal turning, or for face turning. The second tool can create the surface usually as a point+movement. This case is usable for longitudinal turning, but this tool can use a grove turning too. This case is the edge+move and final surface are footprint of edge shape, in this case is the V grove. This means, that the tool geometrical characteristics are partially copied into geometrical characteristics of machined part. The third, fourth and fiveth tool are drilling tools, so they create the new surface by method surface+movement. This means that the geometrical characteristics of tool are almost fully copied into geometrical characteristics of created surface.

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<tr>
<th>Tool</th>
<th>Surfaces</th>
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Table 1. Surface creation by several tools at turning machine
By combination of all manufacturable surfaces from table we create the MCP. (Fig. 3) This part contain all of the possible surfaces what we can realize by given machine and given tools. This part is only imaginal, all real part will contain only a subset of surfaces from this imaginal part.

4. **Group technology and MCP process plan**

Group Technology (GT) is a methodology which utilizes the similarity among parts or machine features. As such, the relevant features of the parts have to be considered in order to get the best grouping. In addition, GT methods require that the information is known in advance and remains constant. Contemporary manufacturing, on the other hand, advocates flexibility with less commitment to the features used for clustering. [6]

By using the methods of GT we can prepare the process plan template for manufacturing the all real part on base of the MCP. This template will contain the manufacturing data for all surfaces in the MCP. These data in the template contain specification of the surface, specification of the tool and turning operation.

In case of manufacturing the real part (subset of MCP) we select from this template the appropriate subset of surfaces (subset telling about the surfaces, what are content in our real part) as a raw process plan, and fill the real part specific data.

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**Fig. 3: Model of the most complex part (MCP)**
The raw process plan contain the sequence of operations for creating the real part by a given machine and given tools. But in this raw process plan are not determined the real part specific data. These data such as the cutting conditions or part dimensions will be filled in the next three steps.

In first step we fill the part specific geometrical data such as dimensions and positions of the each surface (type of surfaces are given in the raw process plan).

In second step we give the technological specific data. They are data about part material, cutting material and other technology specific data. These technological data must be chosen carefully. For example see the [7].

In third step are calculated the specific cutting parameters on base of filled data. All of the filled and calculated parameters are filled into the part specific process plan.

5. Conclusion

Currently, due to shortened product life cycle, market liberalization, a great competitive pressures and constantly dynamically changing demands of customers, enterprises are forced to gradually rebuilding the nature of its production to mass production and small series with a wide range of products. This phenomenon relates with many problems especially with inventory planning, organization of production, rationalization of work. This approach corresponding with the idea of lean manufacturing too. [8], [9]

This paper give a very short overview about a possibilities of using the base of theory the surface creation by cutting and the idea of group technology in the modern flexible manufacturing systems.

The paper creates a basis for a broader research project that encompasses the migration to more intelligent manufacturing systems and smarter production preparation in these systems. Further research ideas are related but not limited to the improvement of what was described herein and the use of simulation to explore the different scenarios.

Acknowledgment

References


