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LABORATORY FOR DRAWINGLESS MANUFACTURING

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Abstract

To achieve quick response of production, it is necessary to abandon the traditional form of production process planning. Nowadays, most of the products are designed by using 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. The process plan is important to enter the process of manufacturing of various precision engineering components of complex shape. Using the highest level of programming through graphical engineering system, a 3D model and the ISO programs using CNC machine tools were designed.

Key words

Drawingless manufacturing, flexible manufacturing system, industrial robot, material flow

INTRODUCTION

The flexible approach to production allows to adjust the manufacturing systems capacities to the market requirements. Also, it enables the quick change between several variants of products and fast implementation of new product features into the existing products. (1)

In general, this flexibility is divided into two key categories and several subcategories. The first category is the so called machine flexibility which enables to make various products by the given machinery. The second category is routing flexibility enabling to execute the same operation by various machines. Flexible manufacturing systems usually consist of three main parts: CNC machine tools, transport system and control system. A higher level of flexible of manufacturing systems is represented by so called intelligent manufacturing systems. (9)

In our Institute, we are building a laboratory of flexible production systems for drawingless environment. The main target of the project is to build up a laboratory with a flexible manufacturing system consisting of two NC controlled machines (milling machine and lathe). These machines will be interconnected by a transport system and operated by industrial robots. This flexible manufacturing system will also include a quality control station including a camera system and shelf storage. (2, 3)

The main advantage of the flexible manufacturing system is its high flexibility in management of production facilities and resources (time, machines and their utilization, etc.). The widest application of these systems is in the area of small batch production where its efficiency is getting near the mass production efficiency. Its disadvantage is the high implementation price.

FLEXIBLE MANUFACTURING SYSTEM AT INSTITUTE OF PRODUCTION TECHNOLOGIES

A flexible manufacturing system (FMS) is a group of numerically controlled machine tools, interconnected by a transport system (conveyor or AGV) and controlled by a central control system. The input/output (I/O) point of various machining cells is bonded to transport system via loading and unloading stations. Operational flexibility is enhanced by the ability to execute all manufacturing tasks on numerous product designs in small quantities and with faster delivery. It has been described as an automated job shop and as a miniature automated factory. Simply stated, it is an automated production system that produces one or more families of parts in a flexible manner. Today, this kind of automation and flexibility presents the possibility of producing nonstandard parts to create a competitive advantage. (10)

Flexible manufacturing systems with robotic operation for environment of drawingless production (therein after only FMS) will be represented by the CIM (Computer Integrated Manufacturing) model 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.

FLEXIBILITY OF MANUFACTURING SYSTEMS

There are various approaches to the flexibility of manufacturing systems. The most frequent meaning of this term is described as follows:

- Possibility of production program to change without any significant alteration of machinery (new NC program, eventual tool change),
- Speed of production program change from previous product line to new products,
- Possibility to change production program at the level of individual products.

Fig. 1 presents the flexible manufacturing system in our Institute, which contains the CNC lathe machine and CNC milling machine by EMCO (Figs. positions 1, 3 and 4). These machines are operated by industrial robots. At the left-hand side, the control station (Fig. 1 position 7) and the robotized assembly station (Figs. 1, 6) are placed. The automated storage system (Fig. 1 position 5) contains 50 storage positions for the raw material, semi products and for the finished products. The material flow is provided by the conveyor (Figs. 1 position 2) with 8 pallet holders. The whole system is controlled by the master PC (Fig. 1 position 1).

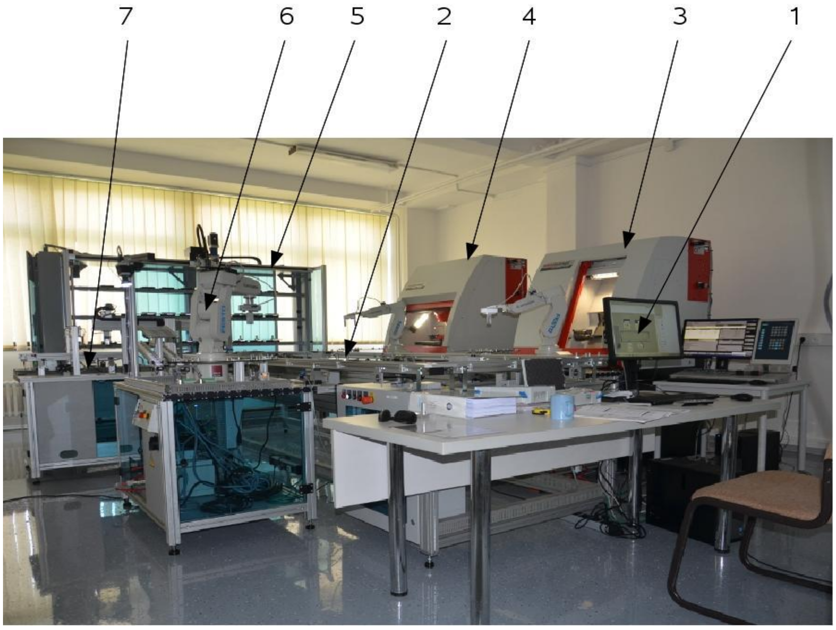

Fig. 1 *iCIM 3000 at the Institute of Production Devices and Applied Mechanics (6)*
1 – Main control PC, 2 – conveyor, 3 – lathe, 4 – mill, 5 – storage, 6 – assembly, 7 – testing

The manufacturing process is based on the orders given from the main control PC. This software contains information about an actual state of storage, about the manufacturing process steps and about the current state of each device. (7, 8)

The manufacturing process for the entire product is described by the process steps. The steps are the basic actions the system performs, for example “load to lathe”, “unload from storage” and others. By using these basic actions, we can make the whole manufacturing process for a product family. (4, 5)

The system remembers the storage status and makes automated changes after all storage operation, but if we perform the storage operation manually, we must update the storage status manually.

The whole process starts with the parts unloading from the storage and finished by the final product store in to storage. The full process runs automatically without human intervention. That means the material in the FMS storage system will be automatically taken out of store, transported to individual machines according to the production program and put in the operating area by a handling device (industrial robot). Machine will execute individual technological operations to reach the final properties (shape and dimensions) of the component. Simple components can be worked by one machine only, but in case of more complex parts, the component will have to be handled in the machine (e.g. turned to another position) or relocated to another machine, so that other necessary technological operations can be performed (sometimes, this relocation between individual machines needs to be repeated several times).

The order system in this flexible production system works on the basis of the status diagram as shown in Fig. 2.

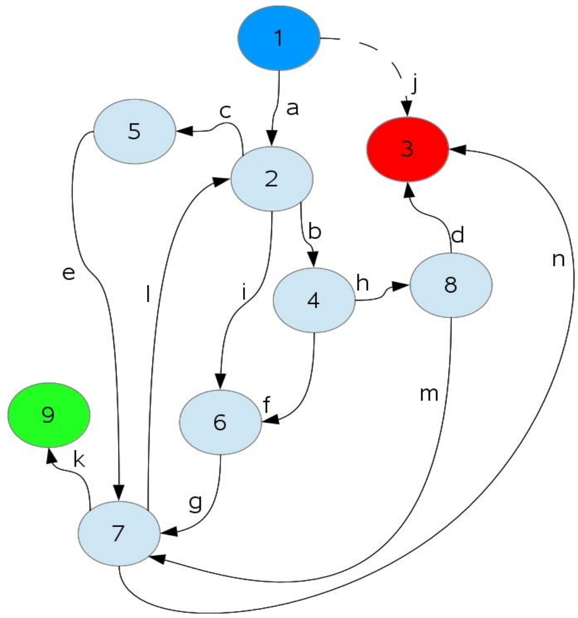

Fig. 2 *Status diagram of order*
1 – order placement, 2 – part/raw material unloaded from storage, 3 – order canceled, 4 – part tested, 5 – part manufactured, 6 – product assembly, 7 – part/product load to storage, 8 – missed part, 9 – order successful

This diagram shows the main principle of the flexible production system operations. The graph shows that the most exhausted part of the system is the storage subsystem. During production of individual parts and their assemblage to a complete product, the storage subsystem loads and unloads the individual parts. This is the reason why the controlling algorithm of a flexible production system is less effective, but, on other hand, it is very flexible and universal.

CONCLUSION

Currently, due to the shortened product life cycle, market liberalization, a great competitive pressures and constantly dynamically changing demands of customers, enterprises are forced to gradually rebuild the nature of its production to mass production and small series with a wide range of products. This phenomenon relates to many problems especially with inventory planning, organization of production, rationalization of work. One of the ways to reduce the production costs is the process plan of time reduction and making a most effective process plan. The possible respond to this challenge is using the latest flexible production system with possibility to use in drawingless environment. (11)

In designing a flexible manufacturing system, the Institute of Production Technologies applies the principles including rational and efficient manufacturing and assembly ways and basic intelligence principles.

In future, we intend to research the effect of different strategies of production control for individual products and manufacture process. Products designed on the basis of classification system will be implemented in digital environment. Along with model of product, NC programs of manufacturing will be developed. The data will be electronically inserted to the manufacturing process. Then, we will research different examples of manufacturing strategies and their impact on production itself. The time needed for manufacturing and specifying the amount of products is a monitored parameter. In this way, we want to optimize the selection of manufacturing strategy for individual types of products and different production amounts.

This research will be carried out in the form of computer simulations and, in some cases, of established manufacturing. In this way, we will be able to compare the results of simulations to those of real production. Based on the comparisons of simulations and real results, we assume the efficiency and accuracy of the used simulation models.

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