FLEXIBLE MANUFACTURING SYSTEM

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ABSTRACT: A flexible manufacturing system is a system capable of responding to changing conditions. In general, this flexibility is divided into two key categories and several subcategories. The first category is what is called machine flexibility, which allows various products to be produced with the given machines. The second category is routing flexibility that allows different machines to perform the same operation. Flexible manufacturing systems generally consist of three main parts: CNC machine tools, conveyor system, and control system. Smart manufacturing systems represent a higher level of flexible manufacturing systems.

Keywords: drawing-free manufacturing, flexible manufacturing system, industrial robot, material flow

I. INTRODUCTION

The main objective of the project is to build a laboratory with a flexible manufacturing system made up of at least two CNC machines (milling machine, 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 that includes the standard storage and chamber system. [7]

In the final phase of the project in 2012, this flexible manufacturing system will be linked to our institute's CAD laboratory, creating the "Laboratory of Flexible Manufacturing Systems with Robotic Operation for a Drawing-Free Production Environment".

Upon completion of the project, our institute will have a fully functional flexible manufacturing system prototype with robotic operation of individual production machines, integrated with CAx laboratories. However, the ultimate goal is to have a smart manufacturing system. This prototype will allow a deeper exploration of the relationships and properties of the manufacturing process itself but also in its relationship with the production preparation and planning process.

We look forward to several other consecutive projects (including international ones) that should further expand the laboratory's possibilities.

The main advantage of the flexible manufacturing system is its great flexibility in the management of production facilities and resources (time, machines and their use, etc.). The greatest application of these systems is in the field of small series production where their efficiency is close to that of mass production. Its disadvantage is the high cost of implementation.

To achieve the objectives of the project, it is necessary to review the curriculum and use forms and methods of teaching that go beyond the realm of cognitive knowledge of scientific disciplines and professions, which means developing the key skills of students. These acquire extraordinary importance not only for personal development, but also in terms of permanent training and employability of technical university graduates. [8]

PRESENT SITUATION AT SLOVAK INDUSTRY

At present, the structure and management of industrial production in Slovakia predominate, suitable for mass production of a narrow product spectrum. However, this production and management structure is no longer satisfactory because the tendency to individualize users is also increasingly evident among customers of Slovak industrial companies. As a result of the little flexibility to satisfy the demands of the market (clients), the competitiveness of the manufacturers diminishes and they are surpassed by competitors with little or no tradition in the machinery industry but with the capacity to satisfy the demands of the clients. much more flexibly. [9]

Another frequent problem of Slovak industrial companies is high production costs. Many manufacturers try to reduce these costs at the expense of their employees' wages depressing them in various ways (directly or indirectly). However, this attitude towards reducing production costs is less systemic and, in the long term, does not lead to the desired objective which is to increase the demand for Slovak products and thus support the development of individual companies and the increase of the general norm. to live.

The only viable way to achieve this goal (which individual manufacturers can influence directly) is to increase production efficiency by reducing production costs, not at the expense of wages but as a consequence of optimizing the manufacturing process. production by introducing new modern production technologies. modern preparation and management of production methods, increasing the quality and flexibility of production.

The objective of the project is to build a flexible manufacturing system with robotic operation that allows production without drawing. This means that the product will be simulated by PC in an appropriate 3D CAD program, a control program necessary for the production of the component will be generated and this program will be launched in a flexible manufacturing system that will physically produce this component. In this way, it would be possible to produce all the necessary components for a specific product that will be assembled in the final stage.

During production, all manufactured components will be subject to control operations, therefore, during final assembly, the rate of defective parts of finished products will be greatly reduced.

This prototype facility can also examine the impact of various manufacturing strategies on production costs, the time required to produce the required amount of product, and other parameters important to production efficiency. It will then be possible to explore and present the advantages of non-stamping production and the impact of this production method on the efficiency of the entire process before and during production.

All the information and knowledge acquired will be presented nationally and internationally through scientific and technical journals, as well as through scientific conferences and workshops. We will also approach representatives of the peninsular industry and present this prototype to them, demonstrate its potential and ask them to collaborate in other projects so that the results of theoretical and practical research can be integrated into industrial production and used in efforts to maintain the competitiveness of Slovak industry.

DEMANDS ON FLEXIBLE MANUFACTURING SYSTEM WITH

ROBOTIZED OPERATION

A flexible manufacturing system (FMS) is a group of numerically controlled machine tools interconnected by a central control system. The different machining cells are interconnected, through loading and unloading stations, by means of an automated transport system. Operational flexibility is enhanced by the ability to perform all manufacturing tasks on many product designs in small quantities and with faster delivery. It has been described as an automated workshop and a miniature automated factory. Simply put, it is an automated production system that flexibly produces one or more families of parts. Today, this perspective of automation and flexibility offers the possibility of producing non-standard parts to create a competitive advantage. [2]

The concept of flexible manufacturing systems evolved during the 1960s when robots, programmable controllers, and computerized numerical controls brought a controlled environment to the factory in the form of direct CNC and CNC machines.

For the most part, FMS is limited to companies involved in small batch or store production. Typically, small batch producers can choose between two types of equipment: dedicated machines or non-automated general purpose tools. Dedicated machines save money but lack flexibility. General purpose machines such as lathes, mills or drills are expensive and may not reach their full capacity. Flexible manufacturing systems offer small batch maker with another option that can make small batch manufacturing just as efficient and productive as mass production.

The robotically operated flexible manufacturing system for a drawing-free production environment (hereinafter FMS only) will be represented by the CIM (Computer Integrated Manufacturing) model under UVSM MTF conditions. It is a systems approach to planning, management and production itself. The goal is to gain experience in these areas at the level of a manufacturing system as a unit. [1], [3]

In practice, these experiences, if accepted, can considerably increase the competitiveness of industrial companies. This increased competitiveness will result from greater efficiency in planning, management and production. Higher efficiency will mean shorter production time, greater use of machines and tools, greater production flexibility, which together mean savings in production costs.

The introduction of the flexibility of the production and the reduction of the coûts are fortement influenced by the strict respect of the structures of données appliquées dans the communication between the posts of individual travails tout au long de la chaîne de production, de la conception des composants à the conception. and handling devices and finally to the production itself.

Therefore, the entire FMS (all manufacturing and handling devices) must contain a communication structure based on a modern industry standard that is also compatible with other industry facilities to enable transparent data transfer. One of the marginal conditions to define the characteristics of the FMS is the ability to cooperate with the CAD CATIA system available in our institute. In addition, this system must also cooperate with other CAD software systems. This cooperation is extremely important in view of the ultimate goal of the project: "Production without drawing". The functional diagram of this modular system can be found in Fig. 1.

The main philosophy of the system is based on theoretical knowledge and practical experience in the field of production planning, management and implementation of small batch and part manufacturers. Currently, these production areas are developing with the greatest dynamism.

A. FLEXIBILITY OF MANUFACTURING SYSTEMS

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

- Possibility of production program change withoutany 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 level of individual products.[2]

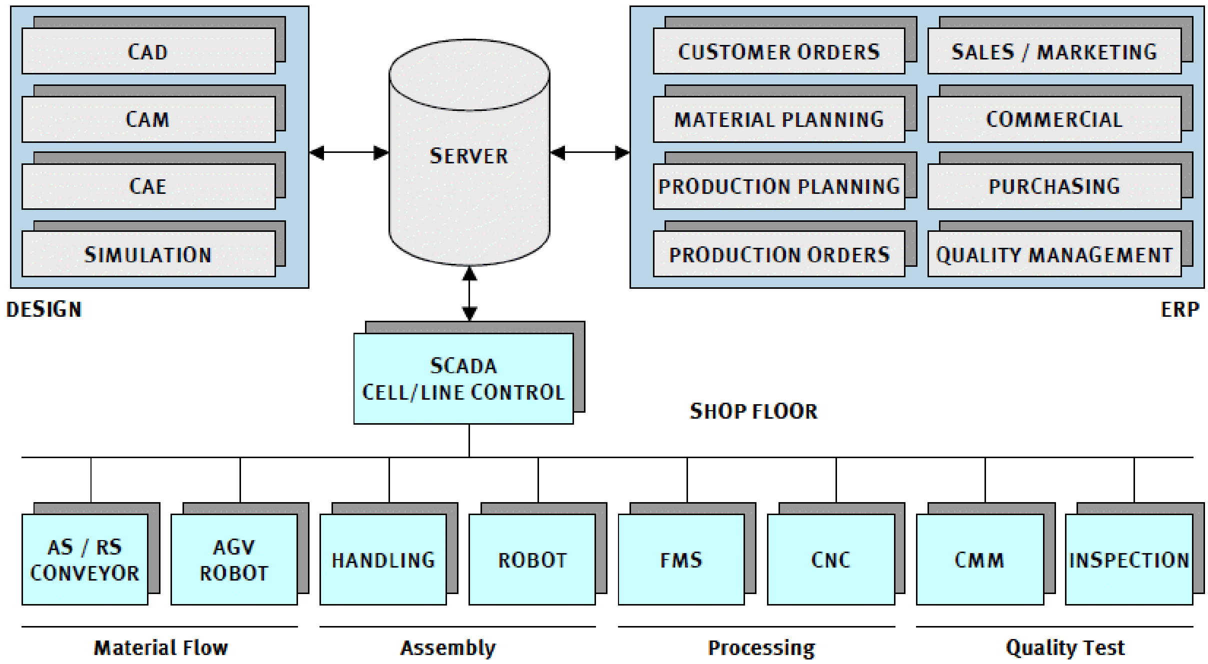

Fig. 1 Modular flexible manufacturing system block diagram

FMS FUNCTION ALGORITHM

We want to produce (simulate production) various shaft, flange, bracket and box shape components in this system. Each component manufactured will represent piece-rate production, which means that only one piece of that component will be manufactured. The variability (dimensions and shape versions of each component) will be relatively large. The planning and management of the production process in FMS must be adapted to this fact. The plant design method is described, p. Eg in references [1], [6], [7].

The entire process, from design to final component storage, should run automatically without human intervention. This means that the material in the FMS storage system will be automatically taken out of the warehouse, transported to individual machines according to the schedule and placed in the operation zone by a handling device (industrial robot). The machine will perform individual technological operations to achieve the final properties (shape and size) of the component. Simple components can be worked with a single machine, but in the case of more complicated parts, the component will have to be manipulated in the machine (for example, rotated to another position) or moved to another machine so that other technological operations are required, performed (sometimes this movement between individual machines has to be repeated several times).

After completing all the necessary technological operations, the manufactured component will be transferred to the control station for quality control, and if the quality control is passed, the finished and verified component will be automatically transferred to the FMS storage system. If the quality control fails, the component is also transferred to the storage system, but to the part where the defective products are stored.

The functional graph of the entire flexible manufacturing system is shown in Fig. 2. The material flow in flexible manufacturing systems is described in [4], [5], [11].

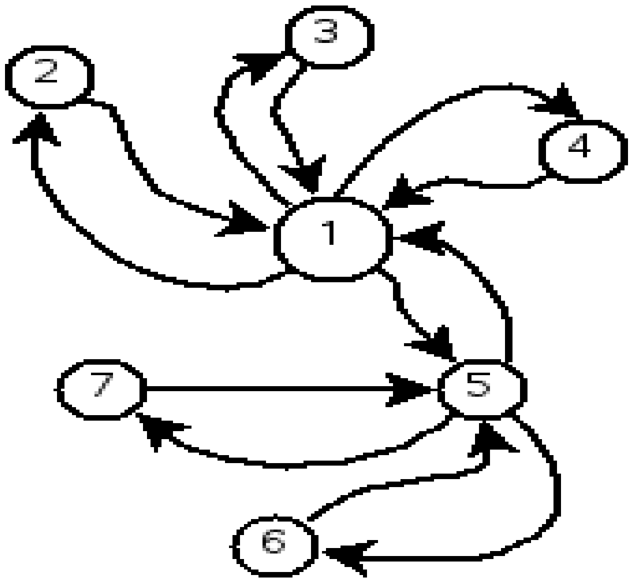

Fig. 2 Function graph of flexible manufacturing system

1 – conveyor, 2 – storage, 3 – pallet handling and quality station, 4 – robot vision and assembly station, 5 – robot feeder of machine tools, 6 – CNC lathe, 7 – CNC milling machine

A. FMS STRUCTURE

Another challenge in micromachining is micromachining. Inaccurate geometry and tool irregularity often negate the benefits of ultra-precise process control, advanced machine tools, and ultra-fine tuning of process parameters.

In a structure term FMS (selection of manufacturing and handling devices), it is necessary to define the general characteristics of the products to be manufactured and of the applied technologies.

Despite a significant expansion in the applications of plastics in the machinery industry, metal remains the basic material. For this reason, we have decided that this FMS will produce (simulate production) components made specifically of metal, possibly another material that can be processed with the same technologies as metal components. The fields of application of flexible manufacturing systems are described in [9] and [10].

Of course, the components must be limited in size and weight. This limitation is necessary for several reasons:

Economical - Larger components consume more material, larger and more expensive machines, higher energy demands, etc.

Space - Larger machines require more space.

Regarding the relatively small space available for the FMS, we have to choose to manufacture and handle devices with small dimensions, which means that the size of the individual components will also be limited.

As an upper limit for the size of the components of the box, we determine 120x120x120 mm.

For cylindrical components, we have defined the maximum size

75x120mm. The maximum weight of the components must be 5 kg.

The technologies that can be used to transform a basic metallic material into a finished component can be divided as follows. The basic division of machine technologies is shown in Fig. 3.

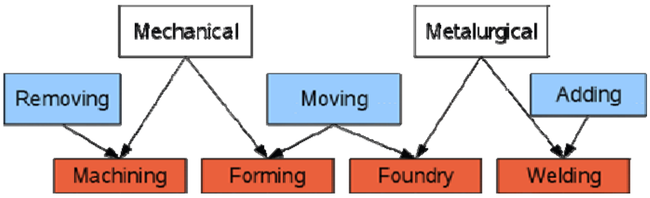

Fig. 3 Basic division of technologies

Both metallurgical and mechanical production technologies are energy intensive, cause environmental pollution and require considerable production facilities. This was one of the reasons for focusing on machining technologies in our FMS. Another reason for choosing machining technology for our FMS was that more than 80% of all components are machined in their final stage and other technologies actually only produce a semi-finished product suitable for machining and are ultimately unsuitable. for the production of parts.

For the production of rotating components, turning operations are used more frequently and milling operations are used more frequently for the production of non-rotating components. As a result, our FMS will also include production facilities capable of performing these technological operations (lathe and milling machine).

As we need a fully automated FMS function, the production facilities (machining devices) have to be controlled by CNC, which allow its integration with other devices of the same system (Fig. 4-6, 7).

The robotic presence within FMS will be ensured by industrial robots that will load the semi-finished product into the area of operation of the individual machining devices or into the area of operation of the control station and will unload any machined components that can be verified. from these devices. (Figure 4-5)

The FMS should also include an automated storage facility where various types of semi-finished products and finished products will be stored. This storage system must be fed by a feeder that will take the individual semi-finished products from the storage system and store them in finished components. (Figure 4-2)

The test station will verify the actual dimensions and shape of the individual manufactured components. This station will also be automated. (Figure 4-4)

All the aforementioned devices must be connected to the transport system that will ensure the transport of semi-finished products and finished components to the place necessary to be in the area of operation of the individual industrial robots. (Figure 4-1)

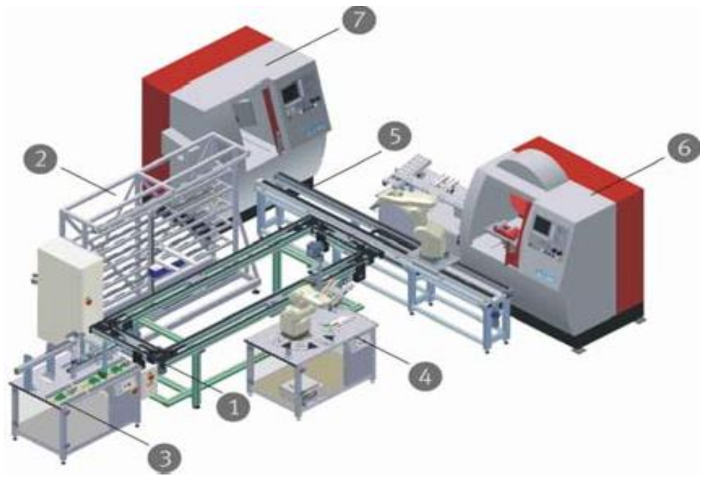

Fig. 4 Flexible manufacturing system

1 – conveyor, 2 – storage, 3 – pallet handling and quality station, 4 – robot vision and assembly station, 5 – robot feeder of machine tools, 6 – CNC lathe, 7 – CNC milling machine

CONCLUSION

Currently, due to the shortening of the product life cycle, market liberalization, strong competitive pressure and constantly changing customer demands, companies are forced to gradually rebuild the nature of their production in mass production and in small series with a wide range of products. This phenomenon is related to many problems, in particular inventory planning, organization of production and rationalization of work. In particular, large companies have adapted the nature of their production to mass production, which creates a huge inventory optimization problem both in warehousing and manufacturing, production optimization problems with frequent machinery changes and lead times. delivery, capacities and associated economic losses. The Institute of Production Systems and Applied Mechanics applies to the design of principles of flexible manufacturing systems, including rational and efficient manufacturing and assembly methods and basic principles of intelligence.

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