NEW LABORATORY OF FLEXIBLE MANUFACTURING

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Abstract: At the end of 2008 our institute - Institute of Production Systems and Applied Mechanics responded to the challenge number: OPVaV-2008/2.2/01-SORO ASFEU Agency and the Ministry of Education has developed a project called "Laboratory of flexible manufacturing systems with robotic handling for environment without drawing production".
In the final phase of this project in year 2012, the flexible production system will be linked with the CAD laboratory of our institute

Key words: Drawing less production, flexible production, robotized production, material flow

1. Introduction

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 [1.].
The main target of project „**OPVaV-2008/2.2/01-SORO – 26220220055**" is building the laboratory equipped by flexible manufacturing cell and directly connected to our CAD laboratory. The direct connections 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 [2.].
The flexible manufacturing system will contain the two CNC controlled machines (milling and lathe machines). 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 the camera system and shelf storage.
The flexible manufacturing cells are characterized by high level of manufacturing process automation. They are used mainly in middle batch production (500 – 2000 pieces of products) and for middle products range (5 – 100 types of products).
The supplementary devices are used mainly to manipulation with workpieces and tools:

- workpiece storage and device for workpiece changing,
- storage, controlling and changing of tools,
- quality control.

A part of complex automated manufacturing process is an automation of technological process control, automated transportation, handling, feeding, and interchange of workpieces, tools and automated waste cleaner. There are many technological sites existing, which match given requirements. Besides obvious computer techniques for controlling the manufacturing machines, automatically working bins, loaders, conveyors, manipulators and industrial robots are implemented step by step. As industrial production is growing constantly, besides implementing of the classical automated means, which were mentioned above, manufacturing systems with intelligent control are being installed [3.].

Material flow is an integral part of every production system. Material flow is an integral part of every production system. In this paper we will focused to material flow suggestions possibilities in the flexible manufacturing system. The material flow is determined by several variants of system layout.

2. Manufacturing system design

The design of manufacturing system is a part of manufacturing process planning. The main determining factors for the manufacturing system design are: the product, the production volume, the used machines, the disposable manpower, the disposable infrastructure and the legislative frame for the specific cases.

The automation of manufacturing and assembly process can be run in the term of the manufacturing profile, material flow or information flow. These basic elements of the manufacturing process are usually automated together in the praxis, but it is not the condition. The task of the manufacturing and assembly process control is to provide the process running in the status of dynamical stability and the replacement in the equilibrium status on the same or acceptable standard by the deviation of the equilibrium status. The process control is characteristic as the process organization in system that provides the achievement of the required final state; assembly or manufacturing process. The utilization of this information for the manufacturing process control could be only then if it is known the noted model of system behavior by means of that it is possible to create the control algorithm and technical system for its realization by defined aim [4.].

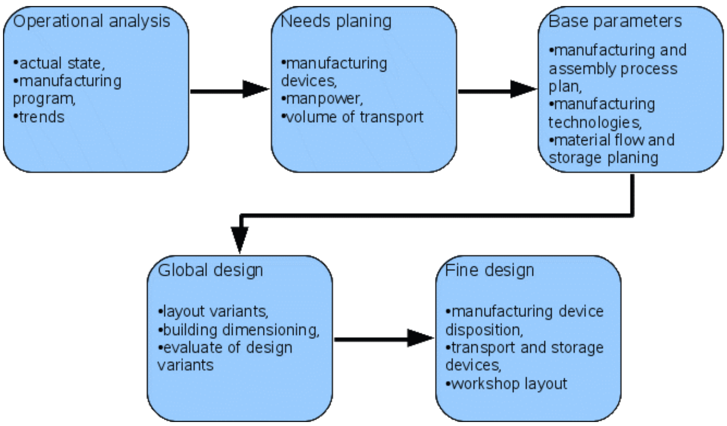

Figure 1. The general sequence of manufacturing system design.

During detailed inspection, it seems advisable to analyze the technological workplaces that are functional and spatial areas:

- Technological area as space where are performed technological operations on workpieces,

- Manipulation area as space where are performed manipulations (operational and intermediate operational) with workpieces, tools and waste,
- Directing area as space in which are performed controlling operations,
- Area of maintenance as space in which is realized set up, maintenance, servicing etc. [5.].

3. Material flow planning

In the process of material flow planning, it is necessary to consider the fact that the aim of the plan is not the transport and storage of material as these activities are expensive and do not improve the material value. Current systems for handling, transport and storage provide a great number of possibilities for the application of expensive and complex systems. The optimal design should contain minimum storages, transport and handling. Hence, the suitable way before the elaboration of detailed system solution is to reduce mentioned activities to a minimum [6.].

All features of manufacturing system must be planned considering mutual interactions and verified by a simulation model before the system realization.

From the point of view of manufacturing and material flow, it is talking about mutual connections and formation of material chain. The main aim is the mutual coordination of all material flows and assurance of the efficiency of material flow between individual segments of a chain.

Material flow analysis is one of the main parts of production process analysis. The type, quantity, volume, mass and dimensions of manipulated material have strong influence to possibilities of manipulation, storage, packaging and transport. In time of material flow analysis we observe the important material movements between a materiel incoming and outgoing stations. The methods used for analysis are similar for production processes and for material flow processes too (Sankey diagrams, CRAFT, coordinate methods, networking methods, linear programming, value analysis, …) [6.].

We want to produce (simulate production) various components of shaft, flange, bracket and box shape in this system. Each component made will represent piece production that means only one piece of this component will be made. Variability (dimensions and shape versions for each component) will be relatively wide. Planning and management of the production process in FMS must be adapted to that fact.

The whole process starting with design up to storage of final component must run automatically without human intervention. That means, material in the FMS storage system will be automatically taken out of store, transported to individual machines according to program, put in operating area by a handling device (industrial robot). Machine will execute individual technological operations to reach final properties (shape and dimension) of the component. Simple components can be worked by one machine only but in case of more complicated 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 realized (sometimes this relocation between individual machines needs to be repeated several times) [7.].

4. The laboratory of flexible manufacturing system

At the fig. 2 and fig. 3 are showed the final variant of flexible manufacturing system layout. This system contains two machining centers (milling and turning), assembly station, shelf storage with the manipulator and industrial robot on the rail. This final variant of a flexible manufacturing system is extended by a transport system in a closed loop, quality control station and by a robotized assembly station.

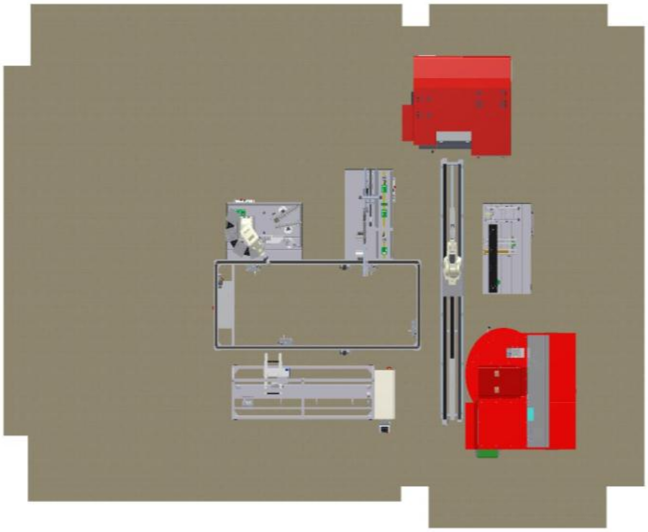

Figure 2. Layout of flexible manufacturing system

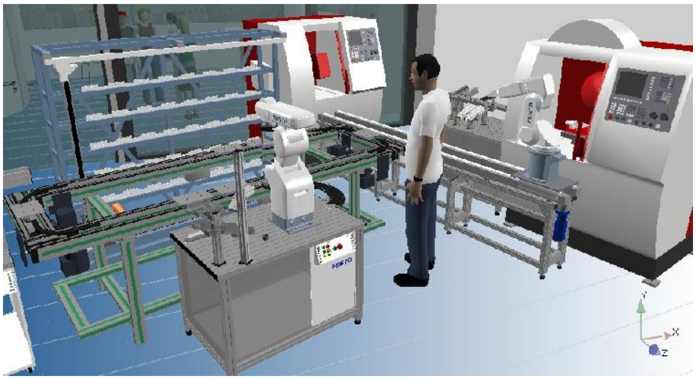

Figure 3. The flexible manufacturing system visualization

5. Conclusion

Flexible manufacturing cells allows manufacturing the small numbers of part from huge range of types and achieve good economical effects near by large batch or mass production. The manufacturing cells structure has connected the machines and save the production time, space and production costs too.

Functions of machines are coordinated and the material flow can be quick Manufacturing process of components, parts or final products usually are not realized at one workplace. The manufacturing logistics solve tasks about organization of material and information flow in manufacturing. The importance of manipulating and transport devices are underlain fact that more than 50% time needed to manufacturing are spent by manipulation and transport and automation level of these processes are smaller than automation level of technological processes [8.].

Our main aim of project is building of laboratory, in which will be located flexible manufacturing system consisting of at least two production machines with NC control (milling machines, lathe). These machines will be linked with transport system and they will be served by industrial robots. Within this flexible manufacturing system will be also station for quality control with camera systems and rack warehouse.

After termination of the project our Institute will have a fully functional prototype of a flexible manufacturing system with robotic operation of individual production facilities, which will be integrated with CAx laboratories [1.].

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