

MANUFACTURING SYSTEM FLEXIBILITY VERSUS PRODUCTIVITY

PhD. Assoc. Prof. Daniela Ghelase
PhD. Assoc. Prof. Luiza Daschievici
"Dunarea de Jos" University of Galati,
Romania

ABSTRACT

Flexibility is the system's ability to manage production resources and its ability to react to external and internal changes that occur. The flexible manufacturing system (FMS) generates high costs and investments that must be recovered in the shortest possible time. For a long time, research has focused on increasing productivity by increasing the performance of cutting tools and machine tool performance (cutting speed, power, rigidity, etc.). The results have not confirmed a substantial increase in productivity. The solution to productivity problems should not be sought in the actual machining but in the operations adjacent to machining (fixing, clamping, basing, measuring, transport, feeding tools and devices, adjustments, etc.). Starting with the 90s, flexibility versus productivity has become a challenge for the machining system.

KEYWORDS: Manufacturing System, flexibility, productivity, conventional machine tools, manufacturing cells, transfer lines.

1. INTRODUCTION

The production system is a complex concept that includes people, equipment, materials and consumables, management activities, the manufacturing system, etc. (figure 1). In fact, all economic aspects (production, sales, advertising, profit, and distribution) are involved in a production system.

A production system develops and creates goods, services or both simultaneously.

Manufacturing is an activity that leads to the materialization of goods or services that satisfy people's desires.

A Manufacturing System (MS) can be defined as the totality of machines, integrated equipment, and human resources, which together perform one or more operations of processing and/or assembling parts. MS is an integral part of the production system (PS).

So, the manufacturing system houses all the means of manufacturing and the laws between them that compete to transform raw materials into finished products.

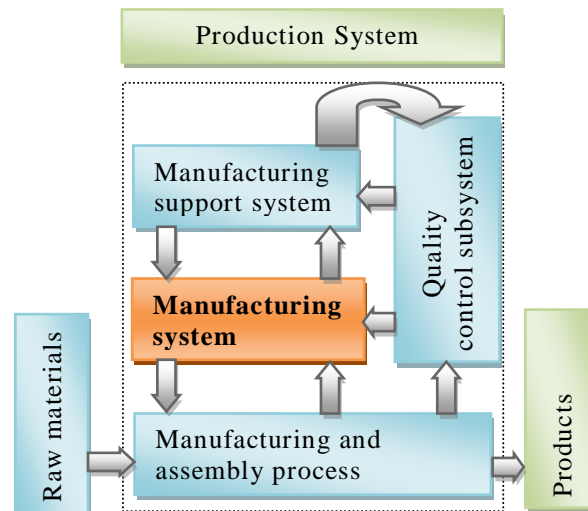


Fig.1 MS- integral part of the production system

2. FLEXIBLE MANUFACTURING SYSTEM (FMS)

The Flexible Manufacturing System is a group of numerically controlled machine tools

(CNC machines) linked together by an automatic transport and handling system for parts and tools, controlled by a computer, which performs automatic machining. The parts are machined in medium series and belong to a family of parts with morphological and/or technological similarities. They are machined within the limits of a predetermined manufacturing capacity and itinerary. In the classic manufacturing system, the manufacturing cost for a large production volume is low, and for a small production volume, it is high. FMS is intended to be able to machine a large number of different parts at the same price as the same large number of identical parts.

• *Manufacturing system flexibility* represents the ability of a system to adapt with minimal expense to variations in production tasks, so that for an extended period it operates economically, with minimal changes in its structure.

• *Production flexibility* represents the substitution of specialized automation (for a type of part/product) with a multipurpose automation (for a family of parts – figure 2) in order to improve the productive mix. The productive mix represents the typology of parts that are processed in the Manufacturing System to satisfy customer requirements.

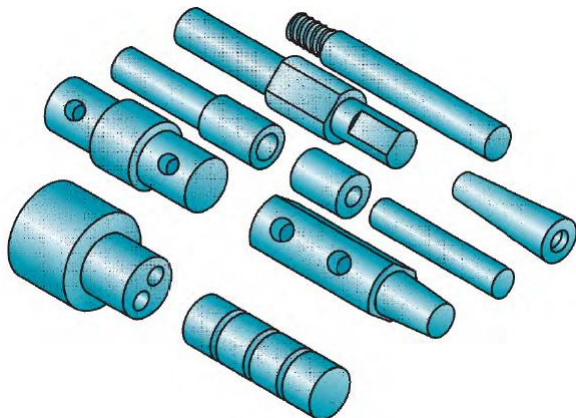


Fig. 2 Family of parts

Depending on the level of automation (figure 3), the manufacturing system can be in one of the following variants:

Conventional Machine Tools

These are machine tools where the operator makes all the adjustments and controls the machining process throughout its duration. They involve a high level of physical labor.

CNC Centers

These are CNC machines that have automatic tool change and their own tool magazines. They are usually operated by an

operator.

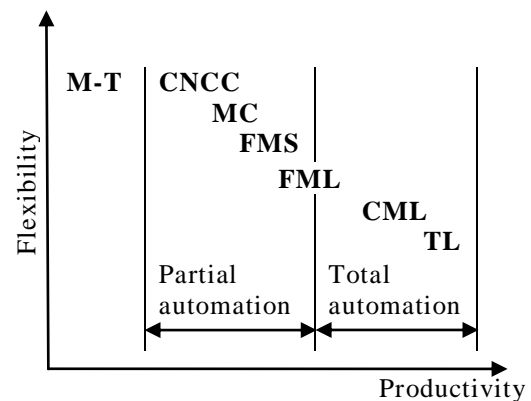


Fig. 3 Flexibility versus productivity depending on the level of automation of the manufacturing process: M-T- conventional machine tools; CNCC- CNC centers; MC- manufacturing cells; FMS- flexible manufacturing system; FML- flexible manufacturing lines; CML- conventional manufacturing lines; TC- transfer lines.

Manufacturing cells

Manufacturing cells are a small number of CNC machines grouped together to process parts. The machines are controlled by a central computer. Cells are usually a family of machines served by one or more industrial robots for handling parts. A small number of CNC machines grouped together to process parts. The machines are controlled by a central computer. Cells are usually a family of machines served by one or more industrial robots for handling the parts.

Flexible Manufacturing System

It consists of a group of manufacturing cells controlled together by a central computer. The handling of parts is mixed or automatic, having an optimal ratio between flexibility and productivity (figure 2). Basically, FMS is that manufacturing system that has the ability to adapt to changes occurring inside and outside the system.

Flexible Manufacturing Lines

These are groups of CNC machines arranged in a line according to the order of operations. They are controlled by a central computer. The handling of parts is fully automated, increasing productivity in the case of mass production, but limiting manufacturing flexibility.

Conventional and Transfer Manufacturing Lines

They are organized groups of machine tools in which material handling is fully automated. The manufacturing line is designed with limited flexibility, the goal is to produce a

single part or a limited number of parts. They are very productive and efficient.

As shown in Figure 3, automation plays an important role in increasing productivity and quality of manufactured products, as well as in increasing flexibility.

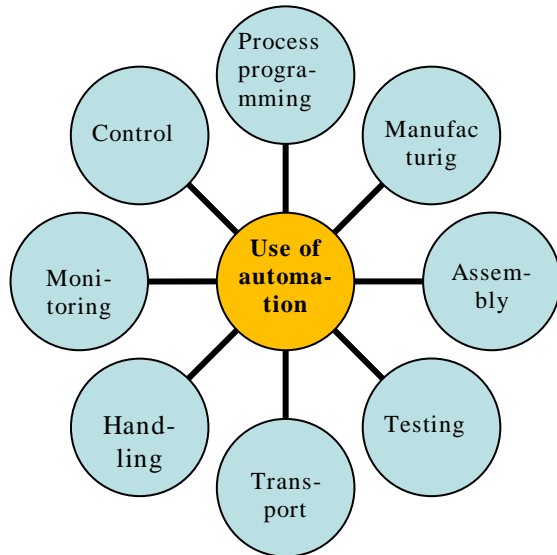


Fig. 4 Using automation to increase flexibility

The structure of a flexible manufacturing system is determined by:

- establishing the machining operations that can be cost-effectively executed on the existing machine tools or equipment in the system;
- the type and number of machines and equipment cost-effectively integrated into the system;
- the characteristics of these machines;
- the machining accuracy that can be achieved;
- the area occupied by the flexible system;
- ensuring the flow of tools, semi-finished products, and information.

2. ADVANTAGES AND DISADVANTAGES OF MANUFACTURING IN FMS

Manufacturing in FMS leads to a variety of advantages, namely:

- ✓ substantial increase in labor productivity;
- ✓ reduction in the number of classic machine tools;
- ✓ reduction in production space and auxiliary spaces;
- ✓ reduction in processing times and parts parking times between work points;
- ✓ reduction in specific consumption;
- ✓ reduction in the number of machines,

equipment, tools, devices, and special testers;

- ✓ reduction in scrap;
- ✓ use of highly qualified personnel;
- ✓ reduction in inventories;
- ✓ reduction in manufacturing preparation time and machine adjustment time;
- ✓ increase in the degree of capitalization of the ton of material;
- ✓ functional autonomy.

Disadvantages of FMS:

- much more expensive;
- requires pre-planning of the entire manufacturing itinerary for the family of finished parts.

3. MAIN COMPONENTS OF FMS

The technological components of the FMS (figure 5) can be grouped into three levels and depend on the manufacturing volume being processed.

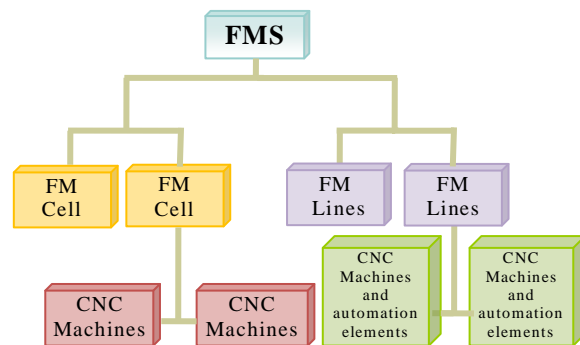


Fig. 5 Technological components of FMS

Flexible Manufacturing Cell (FMC)

The FMC is composed of a small number of CNC centers with pallet changers to which parts are transferred between machines using industrial robots or manually. The FMC has high flexibility, being able to process an entire family of parts, but has an average productivity.

The FMC is arranged according to a process layout.

Components:

- CNC centers;
- pallet magazines;
- automatic parts transfer system;
- robots for loading/unloading pallets from the machine;
- CNC or DNC control.

Use: for medium production runs.

Flexible Manufacturing Line (FML)

FML is composed of "n" CNC machines with pallet and tool changers, and the parts are transferred between the machines automatically in the order of the operations sequence (figure 6).

FML are less flexible than flexible cells, usually being designed for processing 6...11

types of parts in high productivity conditions. FML are arranged according to a technological flow layout.

Components:

- CNC centers;
- pallet magazines;
- automatic parts transfer system;
- robots for loading/unloading pallets from machine tools;
- other process machine tools;
- DNC control.

Use: for large production runs.



Fig. 6 Flexible manufacturing line for assembly

Currently, FMSs have also become efficient when switching from machining one family of parts to another.

6. CONCLUSIONS

Production flexibility represents the substitution of specialized automation (for a type of part/product)

with a multipurpose automation (for a family of parts) in order to improve the productive mix.

In terms of flexibility, for production with a wide variety of the part types, Flexible Manufacturing Systems (FMS), Flexible Manufacturing Cells (FMC), and Numerically Controlled Machine Tools (CNC Machines) are used.

For production characterized by a large number of identical parts in a batch (large-scale and mass production), it is more rational to use automatic machine tools and automated lines (Conventional and Transfer Manufacturing Lines). They are very productive and efficient, but the flexibility is limited.

Automation ensures that the basic machining processes and auxiliary processes (clamping, clamping, transport, storage, control, tool replacement, waste removal, fault identification, and repair) are performed automatically.

REFERENCES

- [1] **Catrina, D., Totu, A.**, *Sisteme flexibile de prelucrare prin aschiere*, Matrix Rom, Bucuresti, 2005.
- [2] **Ghelase, D., Daschievici, L.**, *Flexible manufacturing systems*, The Annals of "Dunarea de Jos" University of Galati, Fascicle XIV Mechanical Engineering, ISSN 1224-5615, Vol. 1, pg. 17-20, 2018.
- [3] **Panc, N. A.**, *Tehnologii si sisteme flexibile de fabricatie*, UTPRESS, Cluj-Napoca, ISBN 978-606-737-487-2, 2020
- [1] **Mazak: Cyber production Center, System fur Integriertes Produktions management, Japonia**, prospectus.
- [2] **Mori Seiki- The Machine Tool Company**, prospectus.