



TYPES OF FLEXIBLE MANUFACTURING UNITS

Michal ŠULÍK - Mikuláš HAJDUK

Abstract: Flexible manufacturing system is functional grouping of production facilities to a related flow of materials information network, allowing the use of flexible changes in production facilities due to the introduction of new products in a relatively short period of time, effectively producing a small amount.

Keywords: cell, structures, production

Introduction

Though the idea of the group technology formulated by Mitrofanov has revealed the broad possibilities of the mechanization and automation of the technological processes in small and medium size series production, its actual advantages are discovered right at the present time. The reason is quite simple. Increasing the competitiveness was expected from the philosophy JIT. The principal ideas of JIT represent elimination of the non-productive time and improving the continuity of the material flow. JIT was oriented at the problem of reduction of the accession time, pulling systems - pull and application of the statistical control of the process. It was by the end of the seventies. Other direction of the development did not get so much attention. Only Burbidge stressed the significance of the group technology for the successful implementation of JIT when generating the cellular manufacturing.

Almost all definitions of the flexible manufacturing systems are based on the composition for the general definition of the system. In general accepted is the definition that flexible manufacturing system is integrated, by the computer controlled complex consisting of the NC machines and facilities for the automatic manipulation, determined for the production of the parts in small medium size series.

Factors Types of flexible manufacturing units

The procedure of looking for the group of the parts requiring the same machines is described by Burbidge on the base of the production flow analysis – PFA (Production Flow Analysis). Problem is formulated by the binary matrix part - machine, in which are then looked for the suitable clusters for the manufacturing cells generation, Fig.1

In the transformed matrix M' seen may be three principal types of grouping:

- I – closed grouping, i.e. all parts are machined in the same cell
- II – grouping with intercellular transfers, i.e. matrix contains so called extraordinary parts, or machines, which may not be unambiguously allocated to certain cell
- III – grouping of parts requiring only one machine

Based on these grouping it is possible use for the definition of the manufacturing cells the classification of four types of the manufacturing grouping according to B. Maccarthy and J-Liu:

- SFM (Single Flexible Machine)
- MMFMS (Multi-Machine Flexible Manufacturing System)
- FMC (Flexible Manufacturing Cell)
- MCFMS (Multi-Cell Flexible Manufacturing Systems)

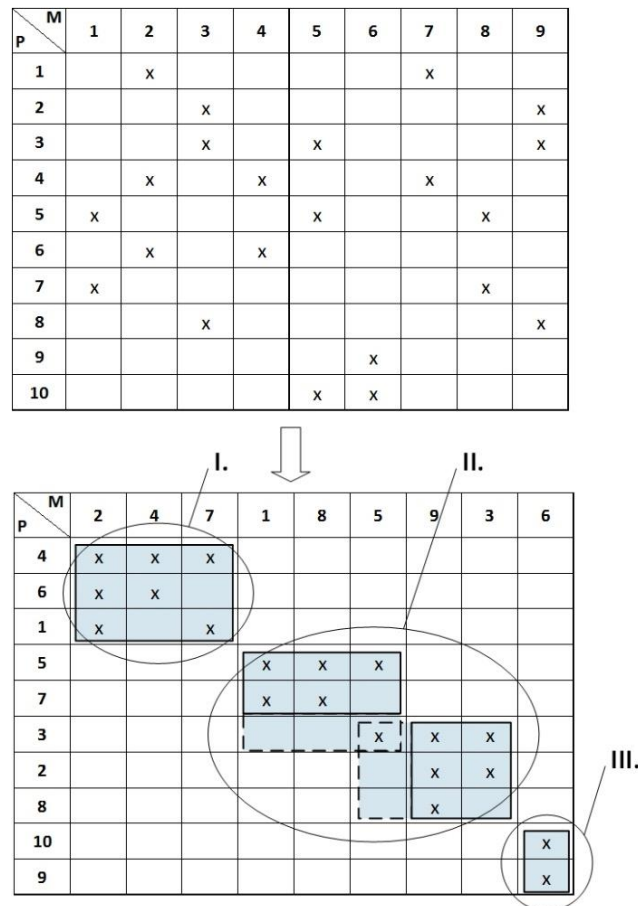


Fig. 1 Three basic types of clusters

Single Flexible Machine (SFM) is defined as the production unit formed by NC machine, completed by the manipulation facility to change the objects of the production.

Multi-Machine Flexible Manufacturing System (MMFMS) is understood as the grouping of several manufacturing machines without mutual dependence of their activity, for example AGV transport system. Machines are autonomous and their activity does not depend on the activity of other machines. These are first of all the machining centres, machines determined for the special operations, as to produce the gearing, grinding operations and so on. Characteristic sign of their activity are the longer operation times.

Flexible Manufacturing Cell (FMC) is the manufacturing system, created by grouping several NC machines, determined for the certain group of parts with the similar sequence of the operations or for the certain type of operations. Characteristic sign of the cell is the mutual material and information interconnection among machines. Usually they apply for the interoperation manipulations the common manipulation facility.



Multi-Cell Flexible Manufacturing System (MCSMS) is formed by the grouping of several manufacturing cells or cells and flexible manufacturing machines. Characteristic sign of this system is the existence of the intercellular transport system as the integrating element.

Difference among so defined manufacturing groupings and the limits among them may be graphically represented according to Fig. 3.2. Based on this scheme, each production system – extended or small, should it meet the requirements of the flexibility, include in the some type. Provided classification scheme provides the unambiguosness of the picture about the discussed manufacturing grouping and creates the fixed base for analysis and design of the flexible manufacture.

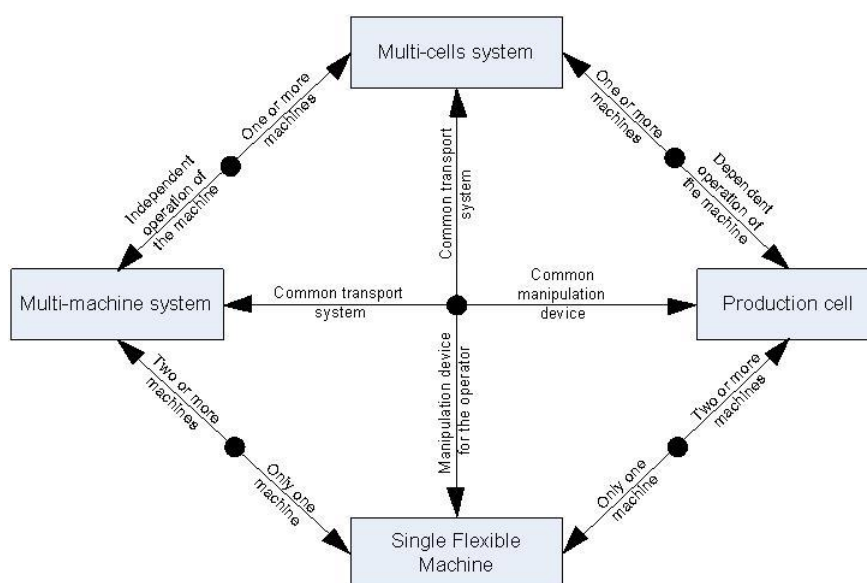


Fig. 2 Graphical interpretation of the definitions of flexible manufacturing systems

Based on the above classification it is obvious that two categories of the production systems: flexible manufacturing machine as the simplest type and flexible manufacturing cell, are the principal production units and the group of machines and multi-cellular grouping are their combination. Another characteristic sign of the flexible machine and cell is also the fact that both have their own autonomous control. For the higher level of grouping, multi-machine and multi-cellular system, characteristic feature is that they have central type of control. The principal distinguishing sign of the cell from the multi-machine system is that the cell machines the specific group of parts requiring the same machines for their machining.

The presented classification scheme of the manufacturing groupings is based on the consistent set of the definitions and determines the relations and limits among the individual systems and with the systems as well. The provided defined relations lead to the useful hierarchical models for the various types of the flexible manufactures and become useful in the solution of the control problems in particular, distribution of the manufacturing tasks, disposition localisation and material and information interconnections.

Category of Flexible Manufacturing Systems/ Cells

There are five categories of flexible manufacturing cells layout; these are discussed in detail:



In-line layout

The machines and handling system are arranged in a straight line. In Fig. 3 parts progress from one workstation to the next in a well-defined sequence with work always moving in one direction and with no back-flow. Similar operation to a transfer line (see unit 13), except the system holds a greater variety of parts. Routing flexibility can be increased by installing a linear transfer system with bi-directional flow, as shown in Fig.4. Here a secondary handling system is provided at each workstation to separate most of the parts from the primary line. Material handling equipment used: in-line transfer system; conveyor system; or rail-guided vehicle system.

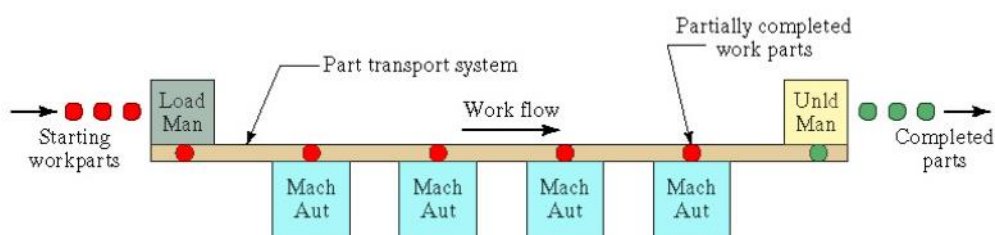


Fig. 3 In-line layout of FMS

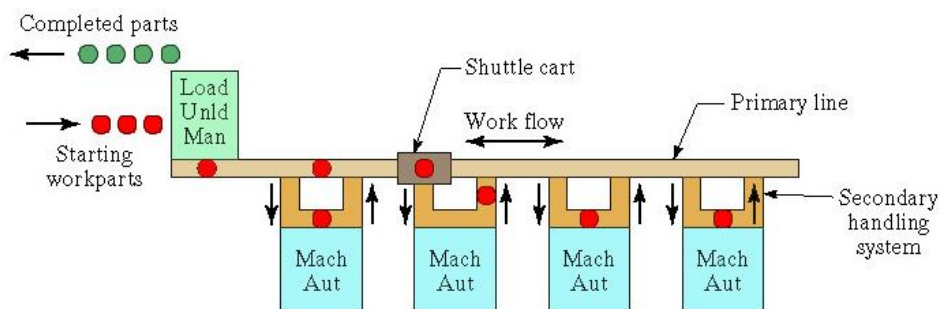


Fig. 4 In-line bi-directional layout of FMS

Loop layout

Workstations are organized in a loop that is served by a looped parts handling system. In Fig.5. parts usually flow in one direction around the loop with the capability to stop and be transferred to any station. Each station has secondary handling equipment so that part can be brought-to and transferred-from the station workhead to the material handling loop. Load/unload stations are usually located at one end of the loop.



An alternative form is the rectangular layout shown in Fig. 6. This arrangement allows for the return of pallets to the starting position in a straight line arrangement.

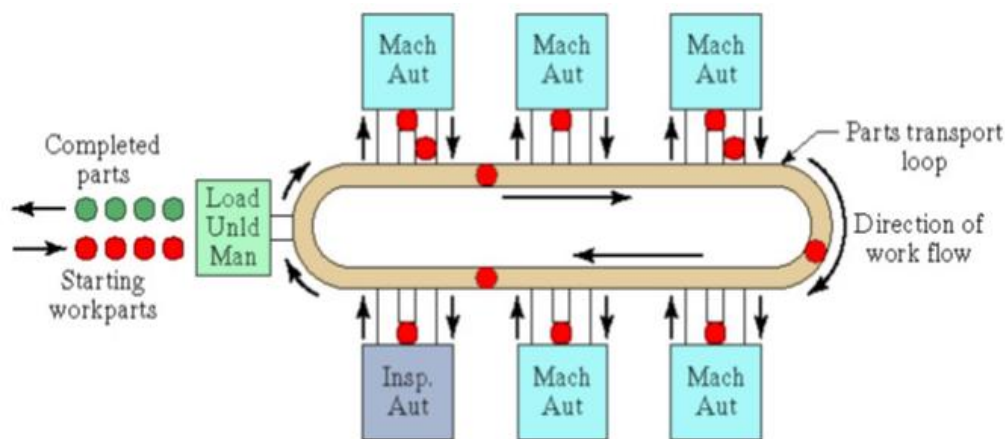


Fig. 5 Loop layout of FMS

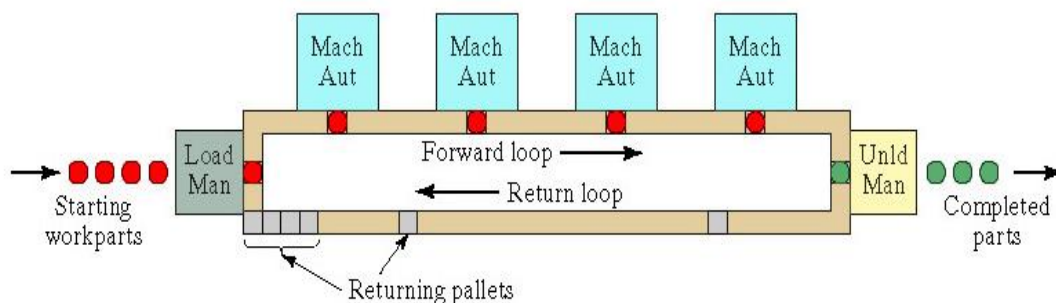


Fig. 6 Loop rectangular layout of FMS

Ladder layout

This consists of a loop with rungs upon which workstations are located. The rungs increase the number of possible ways of getting from one machine to the next, and obviates the need for a secondary material handling system. It reduces average travel distance and minimizes congestion in the handling system, thereby reducing transport time between stations. See Fig. 7.

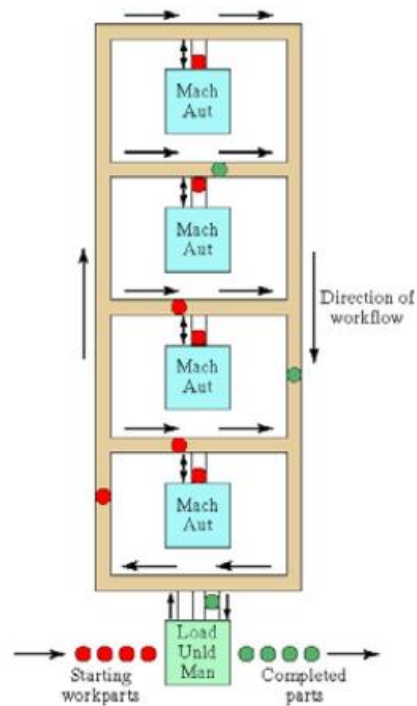


Fig. 7 Ladder layout of FMS

Open field layout

Consists of multiple loops and ladders, and may include sidings also. This layout is generally used to process a large family of parts, although the number of different machine types may be limited, and parts are usually routed to different workstations—depending on which one becomes available first. See Fig.8.

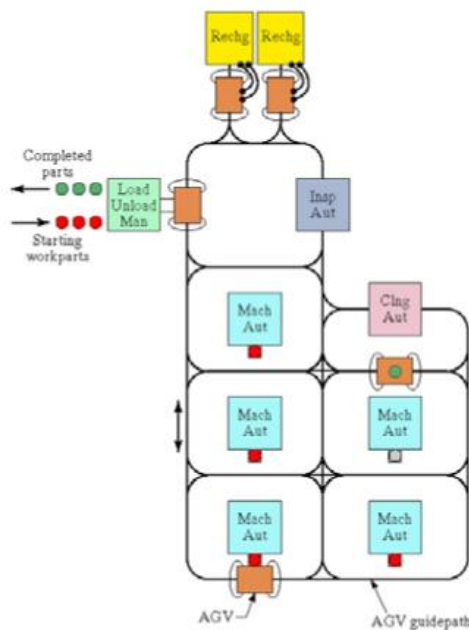


Fig. 8 Ladder layout of FMS



Robot-centred layout

This layout uses one or more robots as the material handling system (see Figure 3.10).

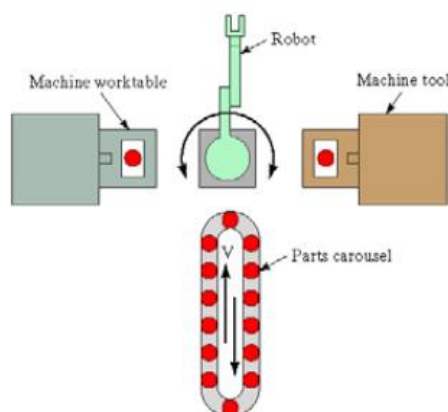


Fig. 9 Robot-centred of FMS

Conclusion

Flexible manufacturing systems (FMS) allows for flexible production of products on a single production system. The flexible technical systems belong to the modular and modular systems. The difference between these systems is mainly the autonomy respectively. the sophistication of basic building blocks. It is integrated and for counter driven complex NC machines, automated handling equipment for materials and tools and complex automated measuring and test equipment, which with minimum manual intervention and with minimal time for adjustment can produce each of the amounts belonging to specific groups of components within the framework of its production capacity and a predetermined plan.

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Contact

Ing. Michal Šulík.
VW Bratislava, Slovensko
e-mail: sulik.michal@gmail.com