

TOOL FLOW PROBLEMS WITHIN THE FLEXIBLE MANUFACTURING SYSTEMS

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Abstract: In a flexible manufacturing system (FSM) there are three major flows, mainly the material flow, the energy flow and the informational flow. The paper will make a short analysis of how the tools which are a part of the material flow are handled with an overview of the possibilities for realizing the flow at the TMA55OP system in the University of Oradea.

1. Short description of a flexible manufacturing system.

Flexibility was introduced as the mean to obtain high quality products with minimal cost, but also for reducing the amount of time needed from changing from a product to another. Flexibility is defined as the capacity of the machine tool to adapt to the variations either in quantity or type, influenced by technological diversity with random variations, in conditions of imposed and constant standards of quality and optimal work load. (1)

In order for a system to be considered a flexible manufacture system there is a series of capabilities that must be present, the most important being:

- a) Management function- general coordination of all activities related to the system functions.
- b) Automatic tool change function (ATC).
- c) Automatic tool readjustment function (ATR).
- d) Automatic work pallet change (APC).
- e) Automatic pallet readjustment function (APR).
- f) Automatic work process monitoring function.
- g) Automatic Work piece changing (AWPR).
- h) Automatic determination of work piece and tool offset.
- i) Tool malfunction detection. (2)

All the mentioned functions handle a specific task in a flexible manufacturing system, either regarding the material, informational or energetic flow (the management function). When the material flow is analyzed three major groups are identified: the tool flow, the raw material flow and the finished work pieces. The raw material flow is entering the system, the finished work pieces is exiting the system, but the tools can be considered as a relatively constant resource of the flexible manufacturing systems.

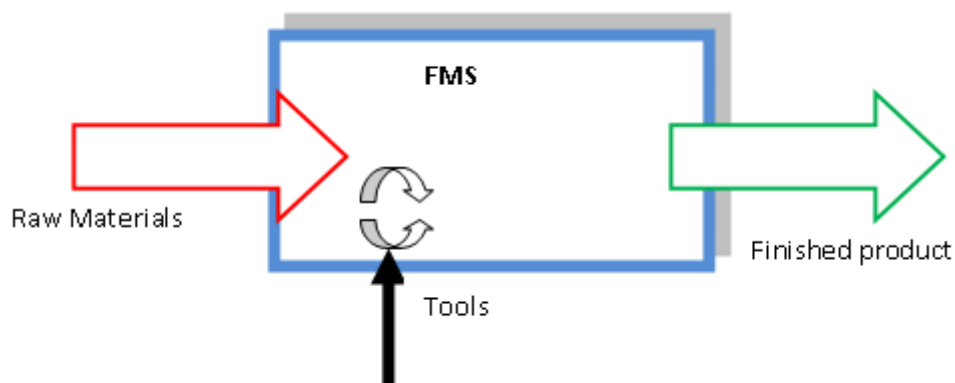


Figure 1 Material flow in a typical FMS

The definition of the tool flow as relatively constant is determined by the fact that the tools in the flexible manufacturing system are only changed in case of excessive damage to the tool or in case the a major change of the type of manufactured piece. As constant as the tools my look from outside the system, in the system the tools are changed between the tool storage station and the machine ATC. The frequency with which the tools are rearranged between the tool storage station and the ATC depends on a series of factors among which the most important are the complexity of the worked piece and the capacity of the machines ATC. The necessity of tool rearrangement rises in direct link with the complexity of the work pieces, being more important for machines with low ATC capacity. Tool magazines are indexable storage units used on machining centers to store tools which are not used. Usually on the market rotary drums station have 12-24 stations and chain type storage units have between 24 and 180 stations. (3).

The tools in a FMS have to be either stored or transported. Depending on the moment of use the storage can be permanent (in the tool storage station), temporary (for example while waiting to be loaded in the machine or waiting to be returned to the storage station). This function is accomplished by the ATR (AUTOMATIC TOOL READJUSTMENT) function of the FMS.

The main methods to realize this function are (2):

- Double tool magazine (active and passive) and an ATR manipulator.
- Readjustment with medium/large flexibility using a tool rack.
- Readjustment with limited flexibility using a monorail manipulator and the double subordination of the tool magazine management.
- Readjustment with medium flexibility using ATR robot behind the machine tools and an ATC tool magazine with double subordination.
- Readjustment with reduced flexibility using a tool rack type pallet that can be accessed by the ATC.

The system handling of tools in a FMS must be able to fulfill several tasks in a certain order: storing the tools, delivering them at the requested moment, returning them to the storage station after use (4).

2. Tool storage system.

As presented above one of the role of the tool handling system is the tool storage. The structural organization of the tool storage function can be centralized, decentralized or mixt. (4)

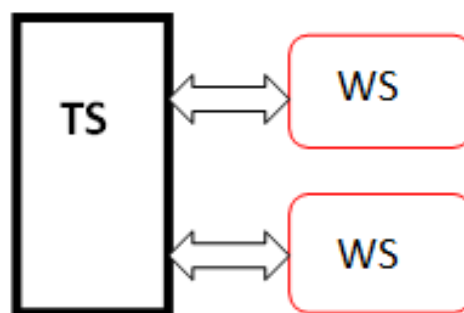


Figure 2 Centralized tool storage system (4)

The figure 2 shows the structure of a centralized tool storage system. The FMS is feed with tools from one TS (tool storage) and each WS (work station-machine tools) has access to it.

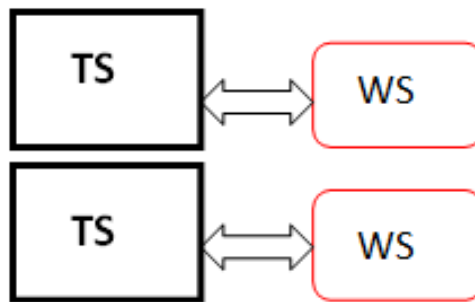


Figure 3 Decentralized tool storage system. (4)

In case of the system presented in figure 3, each WS uses its own TS. The tools are in a decentralized system.

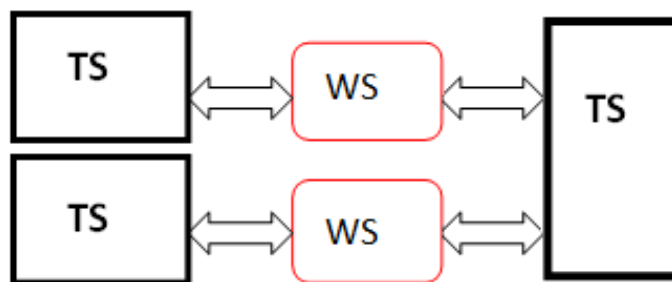


Figure 4 Mixt tool storage system

In this case both methods are used; each WS of the FMS can access the centralized TS but also has its own TS.

There are several types of tool storage system in use. The choice depends on a wide range of factors such as available space, type of management used.

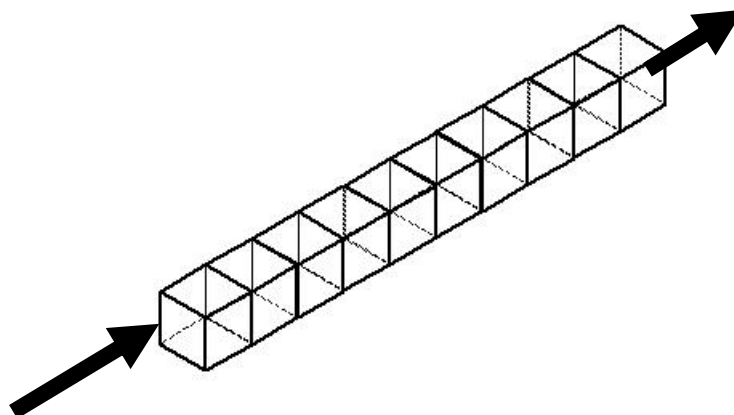


Figure 5 Linear storage (4)

The storage system in figure 5 is suitable for low capacity storages providing a low efficiency regarding the floor space usage. The system is suitable for FIFO (First In First Out) and FILO (First In last Out) management system.

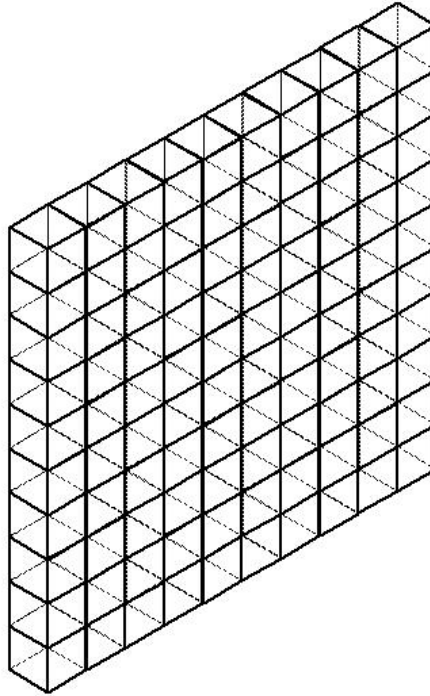


Figure 6 XY coordinates storage system (4)

The system presented in figure 6 is one of the most used systems. Is usable for free access management system providing high efficiency regarding storage capacity.

Other type of used system are rotary storages which can me eater on one or several levels high (figure 7).

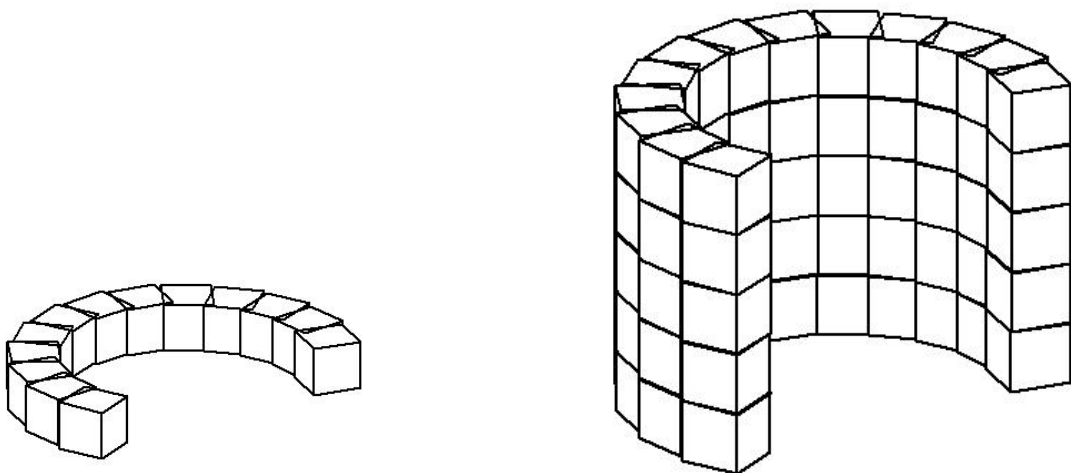


Figure 7 Rotary storage system

Rotary systems are generally used for free access management system. The main advantage by comparison to the XY coordinates storage is the easy accessibility of a robotic arm to each storage station. The cost is higher due to high mechanical complexity.

For the TMA 55Ops FMS system an XY coordinate storage system will be used for both tools and materials. The storage system will be served by the IRB 1600 robot with the help of an additional system that will give access to the robot to all the storage system.

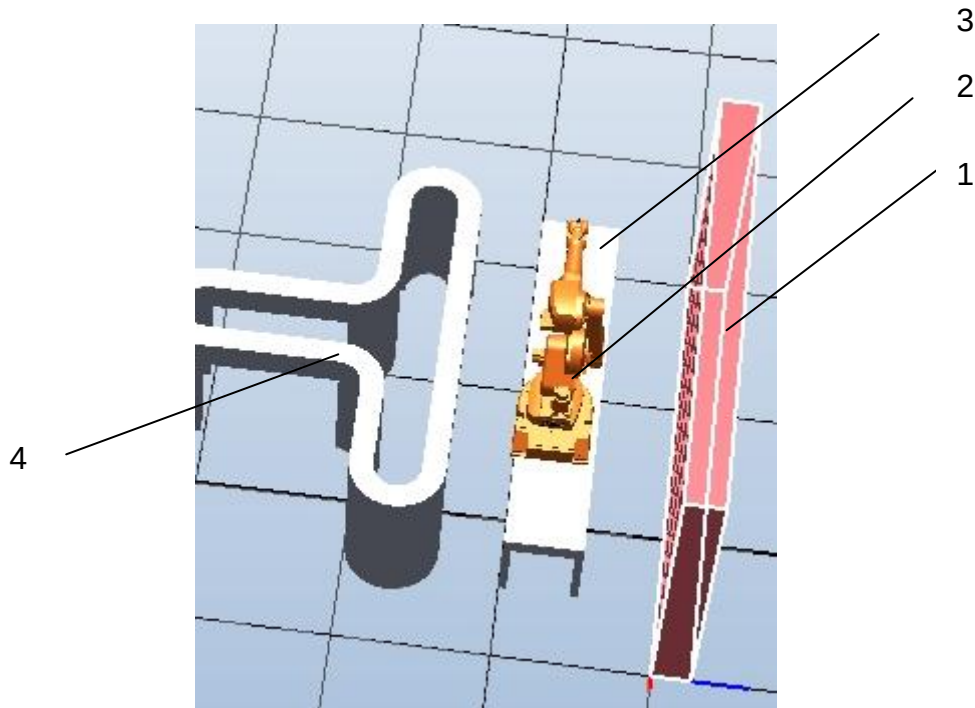


Figure 8 Final layout of the TMA 55 OP FMS, storage system.

- 1- XY coordinates storage system.
- 2- IRB 1600 Robot.
- 3- Linear movement system.
- 4- Conveyor.

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