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AREAS IN FLEXIBLE MANUFACTURING-ASSEMBLY CELL

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ABSTRACT: Present development of automation leads to useful grouping of manufacturing machines with automated material and information flows. Through it the directing is realized by computer techniques (computer). One of possibility is the flexible manufacturing – assembly cell connected with automatized directing system with transport – shelf storage system that is realised in our Institute of Manufacturing System and Applied Mechanics.

KEYWORDS: Automation, cell, production, system

1. INTRODUCTION

Subsystem of production and assembly are output elements named manufacturing – assembly cells. Manufacturing- assembly cell of cybernetics aspect means the black box. Fig. Every one black box has own input, inside and output elements. Input units in the manufacturing – assembly cells describing workpieces, components, machine tools and etc. (K1, K2.... Kn). Output elements presented by products (P) and inside elements characterizing the function of black box. From the surrounding information (I) are compiled and they influenced the black box function.

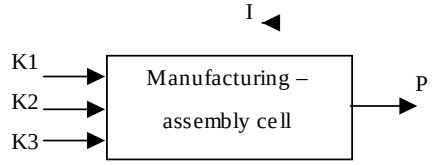


FIG. 1. MANUFACTURING – ASSEMBLY CELL AS BLACK BOX

Base output elements in flexible manufacturing – assembly cells are machines with variable program and with flexible adaptation to this program. These manufacturing – assembly machines are named robotized assembly cells with their base element that is production robot with 4, 5 till 6 degree of freedom realised three base functions:

- Maintenance of assembly devices in the cell – simply operation using by modular robot and manipulators,
- Assembly systems are building the assembly centres with high concentration of technological, manipulation, assembly and accessory functions in a place,
- Assembly systems - where the operations as technological, manipulation and assembly are realised by manufacturing robot of higher generation.

2. TYPES OF AREAS IN FLEXIBLE MANUFACTURING-ASSEMBLY CELL

Through the area aspect in the manufacturing – assembly cells can be divided into three kinds of spaces:

- storage areas,
- utility area,
- operating area.

Storage areas

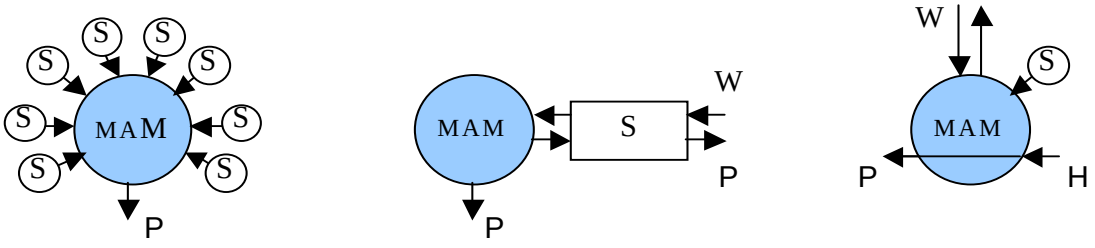
Inseparable parts of manufacturing – assembly cell are storages. Storage devices and storage subsystems have important position in the manufacturing – assembly system structures. There are influenced by technological, technical and economical characteristics. Their important position is developed by their approximately 80% of assembly process time is used for manipulation and transportation processes. Storage devices and subsystems guarded several functions:

- Created operational storage of machined and assembled workpieces,
- Oriented machined and assembled workpieces in the area and in the cycle according to reguests of manufacturing – assembly operations,
- If it is necessary they perform manufacturing – assembly workpieces separating from workpiece flow, in other way connecting to the flow,
- Semi-automatic, in other way automatic they fill manufacturing and assembly units with assembly elements,
- They realised control and control – locking functions,
- They influence the dependability of manufacturing – assembly systems.

Storages and their organisation influence to material flow in the complex system. If the semioperational storages are positioned near the manufacturing – assembly machine, they are named "cells" in special terminology.

There are three base kinds of the manufacturing – assembly cells divided by the structure of storages positioning:

- Storages positioned around manufacturing – assembly machine (Fig. 1a) – this structure of manufacturing – assembly cells is suitable for the frequently innovation of manufacturing – assembly process. Disadvantage of it is that this organisation is used in the more special area. It ii used in the limited number of assortment. In other way, productions or assembly is more effective. It means that in the storages can be organisationed or hurl about workpieces (components). For no - organisation workpieces is necessary to applied storages with positioned device or used particularly positioned devices.
- Self – storage as semi operation storage positioned in front of manufacturing – assembly machine (MAM) (Fig. 1b) – this organisation makes to possible high flexibility of production and assembly although at the expense of manufacturing – assembly process speed. In this case the kind of final workpiece output can be in two ways. First one is through the self – storage and second one is from manufacturing – assembly machine straight to system.
- Cell with several lines of material flow (Fig. 1c). Technological pallette with base component enters into manufacturing – assembly machine in the mainline (H). Then, after manufacturing – assembly operations, the technological pallette with final component leaves the machine at line end. According to the assembly process the components with technological palette enter on the next line and from the second one technological pallettes are coming back into system. Storages around machine officiate mainly for connecting parts providing fe. additional material, screws, plates and etc.



a) b) c)

FIG. 1 BASE ORGANISATIONS OF MANUFACTURING – ASSEMBLY CELLS

a) storages positioned around manufacturing – assembly machine, b) shelf – storage as storage between operations positioned in front of manufacturing – assembly machine, c) cell with several sides of material flow, MAM – manufacturing – assembly machine, S – storages, W – workpiece or component, H – main side, P - product

Utility area

Utility area is characterized by two various spaces. Generally, it means one is for manipulating and utilization of the machine and second is the necessary area reserved for maintenance and operating personnel.

Operation area

Operation area is characterized by realisation of manufacturing – assembly operations. Belonging to this area are positioning and clamping devices, fixtures and etc. Presumption in the flexible manufacturing – assembly systems is high flexibility of production program and whereupon solution of systems develops to use intelligent positioning and fixture devices. Basis of these intelligent positioning and fixture devices is in planning of the every manufacturing – assembly cell. It means that complex manufacturing – assembly cell is designed for production of particular component kind with flexible production program. Generally, each component kind manufactured or assembled in the cell has appertaining jigs for positioning and fixturing. After automatic change of positioning and fixture device, the direct system has to remember by which force and by which requirements the workpiece be fixtured.

3. DESIGNED AREAS IN FLEXIBLE MANUFACTURING-ASSEMBLY CELL IN INSTITUTE OF MANUFACTURING SYSTEMS AND APPLIED MECHANICS

Generally, flexible manufacturing cell contains technological device with program directing with automation accessories of technological process operated autonomous. Flexible manufacturing cell is connected with production robot and that develop robotized technological complex. Laboratory systems of Institute of Manufacturing Systems and Applied Mechanics consist of workstations. One is Cartesian robot with 3 axes from SMC. Fig. 2 this robot is portal construction with serial kinematics, which consists of 3 linear electrical drives. Frame is consisted of the extruded aluminium profiles. Repeatability of positioning is better than 0,025 mm and loading capacity is 100N. Workspace of this robot is cuboid with dimensions 1000x1000x350 mm. Envelope workplace is rectangular.

FIG. 2 MODEL OF CARTESIAN ROBOT AND FEEDING DEVICE

The control system of this robot is realized by PLC from Mitsubishi. In this time we can control 6 axes. Number of controlled axis is sufficient for industrial robot, but we want use this control system to control of all devices (shelf storage, storage manipulator, feeding device, fixture and etc.). That means we must extend this control system. Because the Mitsubishi PLCs can connect to cascade, expansion of this control system is no problem. Computers can realize programming of these PLCs. The program we can simulate on PC before we loading it to PLC. We are planning to use the workstations to educations and research in assembly process. In the concrete, we want built:

- Transporting devices
- Automated exchange effectors
- Feeding and orientation devices
- Inspections by sensors

Flexible manufacturing devices are in these days created mostly for piece production area or less series production area. The word “flexible” can be in automated productions interpreted as “simply” and “rapid” changeable. So this kind of systems is able to produce various kinds of objects without any time slip during the change of productions schedule.

Main mission of designed feeding device is manipulating with objects between flexible manufacturing cell and shelf storage system. This device is more teaching instrument, which aim is not reaching of maximal performances, but to show basic principles of objects manipulating operations. To these devices belong for example positioning platform, conveyors and accessories for manipulation. They are often used for intermediate operation transport and also as reservoirs.

Feeding device design

Designed feeding device will be located on the side frame of the robot construction. Workspace of the feeding device will reach in to the workspaces of shelf storage and multifunctional industrial robot. In this case it is important to crate another frame on which will be the feeding device located. Very important requirement to the feeding device design is, that fixation of feeding device will be located on the bottom part of flexible manufacturing cell frame. The design of the feeding device will be based on main requirements, which were given to the device:

- using of pneumatic actuator, which will influence to the whole design
- the material of the construction will be aluminium sheet, normalized by STN 424203
- feeding device body will be fixed on the bottom part of flexible cell frame
- individual designed parts must have the lowest possible weight
- rotary platform have to be tough enough and must be able to rotate in scale 180^0
- locking and clamping of the feeding device have to be tough enough.

Feeding device will have two working positions, on which will be located the pallets. The main task of the device is to manipulate with objects that are located on the pallets. Pallets will be transmitted between workspaces of the shelf storage and flexible manufacturing cell. One position will hit the workspace of the flexible manipulating cell and another one position will be accessible for shelf storage. Fig. 2

Feeding device has to be designed for maximal load of 10 kg. It is very important to regard whole load of designed feeding device construction, because big load can lead to the overcharge.

Shelf - storages manipulator

Shelf - storage manipulator has Cartesian workspace and tree DOF. The manipulated workpiece together with system palette will have less than 3 kg. The manipulator will take these pallets (together with workpiece) to rotational feeding device (interface device between assembly cell and shelf storage) and giving it is to shelf storage cells. Movement along X and Y-axis are realized by pneumatic cylinders. Movement along Z axis is realized by electrical stepper motor with possibility of usage reprogrammed positions addressed by 4 bits.

FIG. 3 ASSEMBLED SHELF - STORAGE WITH MANIPULATOR

In the shelf storage design time we must accept give conditions, which determine its structure. The shelf contain 3 rows and 4 columns, we have 12 cells.

4. CONCLUSION

Present development of automation leads to useful organisation of manufacturing machines with automated material flow and information when the controlling is realised by computer. To functionality of these systems, there is the necessity of material and information flow integrity; it means automation transport and automatic tool changing. For uniform assuring of transport, tool changing, of material manipulation was defined three areas positioned in the flexible manufacturing systems, concrete in flexible manufacturing - assembly cells. Three areas are storage, utility and operation area. According to described advantages and characteristics of areas is constructed and designed flexible – assembly cell in Institute of Manufacturing Systems and Applied Mechanics too. Her priority is continual connecting through the palette feeder next the shelf – storage and the end of the material manipulation is the shelf - storage, it means storage system. Although one of disadvantage is in flexibility of manufacturing – assembly cell. It means that flexibility of manufacturing – assembly cell is given only for particular facility ranges of workpieces but the suitable organisation design leads to full automation of manipulation and storage actions. By this

designing the manufacturing effectivity, turnover of storage system, safety of storage material and advantage is possibility of full time processing.

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