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LAYOUT DESIGN OF FLEXIBLE MANUFACTURING SYSTEM

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ABSTRACT: *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 the 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. 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. The design of manufacturing system is a part of production 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.*
KEYWORDS: *Paperless manufacturing, flexible manufacturing, robotized manufacturing, material flow*

INTRODUCTION

At the end of 2008 our workplace - Department 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. [2]

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 connection between these two laboratories enables 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. [1]

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.

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

MANUFACTURING SYSTEM DESIGN

The design of manufacturing system is a part of production 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 manufacturing systems design is a fine prepared project which include the several kinds of calculations (capacity, space, manpower,…), material and information flow and others.

In manufacturing system design time are very important the realization of following tasks:

- *data collection and analyze methods for manufacturing system analyze,*
- *methods for measuring and analyzing of tasks,*
- *manufacturing systems design methodology,*
- *methodology of manufacturing system controlling,*
- *computer simulation of designed manufacturing system,*
- *methodology for a continuously improving of a design team work.*

In base of manufacturing systems organization we can design these systems by following profiles:

- *technological – machines are fully interchangeable,*
- *subjective – its characteristic is sequence of the material flow,*
- *combined – enables variability of material flow,*
- *virtual – the same machine is associated into several cells on base of actual needs. [3]*

The control system of manufacturing system is connected at input side to manufacturing management system of company. This system provides the planning and managing of manufacturing requests and in the connection to control systems of a several manufacturing processes provides the information and material flow integration in the higher level. This means that this management system provide the managing the whole material and information flow on all manufacturing phase.

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. [4]

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 material 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 …). [4]

The general sequence of material flow planning is a following:

- *material flow analyze, volume of transport operations determination,*
- *layout*
- *analyze of existing devices,*
- *design of transport systems variants,*
- *computer simulations and dynamical dimensioning of material transport and handling devices.*

In this time we solve the equations of material flow (Figure 1)

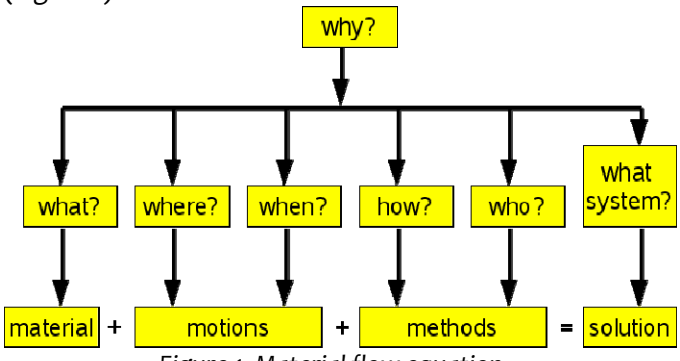

Figure 1. Material flow equation

One of most usual method to material flow representation is a triangle net method. The triangle net of relations (Figure 2) described the factors and relations between workplaces which acting to material flow.

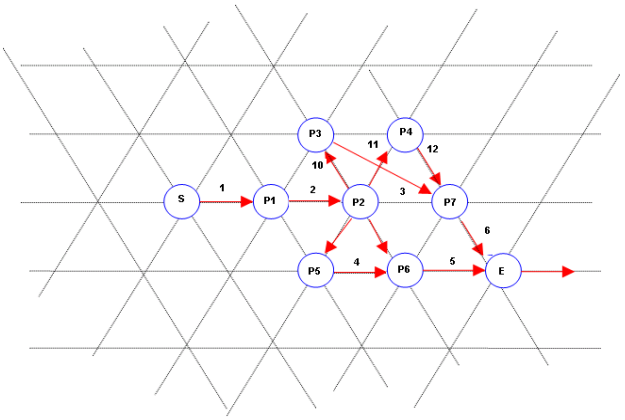

Figure 2: The triangle method

This triangle graph shows all the relationships, the most important factors which are affecting on the material flow. Relations between the deployment or permanent place of work and factors affecting them, as well as between sites and the actors themselves are classified in some way.

The classification of relationship is analytical work requiring detailed knowledge of the situation and many technical aspects.

Assign a classification code corresponds to a specific rule addressing the project deployment. For greater clearness it is recommended to identify the individual classification colors.

This procedure assumes the practical application of this method:

1) *First, we develop checkerboard table transport relations between objects whose spatial situation we want to address,*
2) *Then we determine the order of magnitude of the volume of transported material and the serial number inscribed in the upper right corner of each box in the occupied checkerboard table*
3) *We have to construct a table of transport relations between objects. It consists of a number of columns, there are transshipments, and has 4 lines. In the first is order. In the second row are written symbols selected suppliers, to the third row are written customers. In the last line is given the volume of traffic,*
4) *It is necessary to draw in the triangular network module. With it will solve the entire network.*
5) *We are solved spatial situation so that we in look up the auxiliary table supplier and customer, who are assigned to the first order number. We draw the symbols in any two adjacent vertices in an arbitrary triangle network. To the fourth row we can bring mutual traffic volume above oriented*

segment. By this segment are two points connected. It is necessary to state only serial number. In the next step, we are searching for that point, fourth and further points to the most intense flow into one of those pairs. We proceed to the deployment of all or at least the main objects in the examined area. [2]

THE POSSIBLE VARIANTS OF FLEXIBLE PRODUCTION SYSTEM LAYOUT AT OUR LABORATORY

In Figure 3 are showed the simplest variant of flexible manufacturing system layout. This system contains two machining centers (milling and turning), assembly station, shelf storage with manipulator and industrial robot on rail.

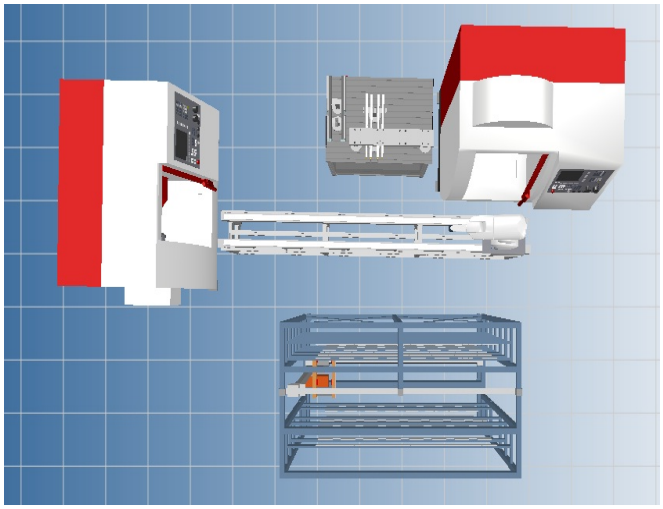

Figure 3: The first variant of production system layout

The other variant of layout is shoved at Figure 4. This variant is a more complex. This flexible manufacturing system contains devices from a previous variant and it is extended by a transport system in a closed loop, quality control station and by a robotized assembly station.

At our institute we would be like realize the second variant of a flexible manufacturing system.

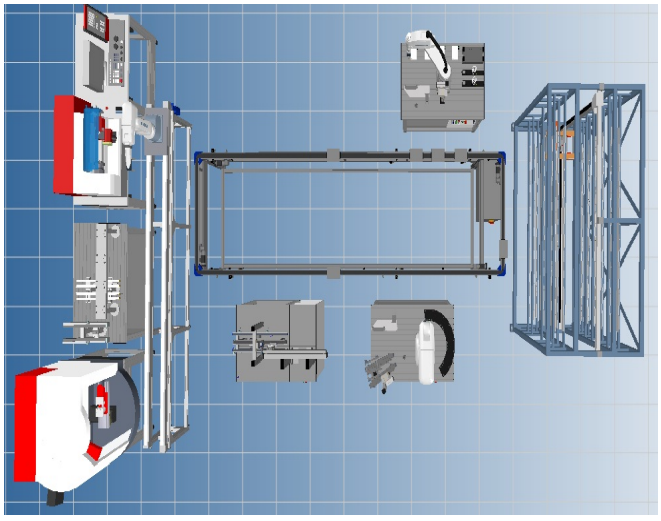

Figure 4: The second variant of production system layout

CONCLUSIONS

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.

In the final phase of this project in year 2012, the flexible production system will be linked with the CAD laboratory of our institute and it will arise as "laboratory flexible manufacturing systems with robotic handling for environment of without drawing production.

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. [2]

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