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EFFICIENCY OF TRANSPORT SYSTEMS INCLUDED IN FLEXIBLE MANUFACTURING SYSTEMS

BY

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Abstract. This paper highlights the manufacturing specifications of Flexible Manufacturing Systems (FMS) and that includes all the components and all the activities of a flexible production system. A special study is dedicated to modular transport systems and main parameters of these systems are calculated: volume of the transport task, the system efficiency and the number of carriers for required pallets.

Performance of production systems is dependent on the quality of the communication between all system components without considering the levels where the components are located. The information should be available, consistent, reliable and accessible in real time for each system module. This will avoid any blockage during overall manufacturing. In this sense, the possibilities offered by PLC’s are essential for data acquisition, circulation, storage and distribution.

The implementation of FMS achieves an important rise in performance by increasing productivity and reducing the necessary production space. This reduces scrap, stocks are removed, and it reduces the production staff. FMS require new skills to perform new tasks. The main advantages are the rapid adaptation of products to applications, increasing the degree of use of equipment, significant cost savings, the assurance of product quality and efficient use of labor.

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CIM System designed by FESTO Didactic (property of University Politehnica of Bucharest) is used for the case study and best practice to apply the calculus methodology to obtain the efficiency of the transport system

Key words: FMS, efficiency, transport system, modularity.

1. Introduction

Today, the design of industrial products uses methods and instruments for communications and decisions more effective. All activities planned for the realization of a product must be known and mastered by anyone involved in the design and manufacture of this product. For new products, good quality, when the market demand we must abandon the current ways of project management in design offices and also change the delivery methods in the production workshop in order to establish real communication. Computers must make the logical connection between design (CAD), preparation of manufacturing (CAM) and execution (CAP), including testing by simulation.

2. Structure of CIM Systems

CIM systems include all the components and all the activities of a flexible production system to understand the possible relationships between the different elements and different tasks. A CIM architecture can provide information on the progress of each activity, at any time, regardless of the state in which we find: design, operation or maintenance.

The administration of CIM systems is hierarchical. At the lowest level, is going to conduct real-time machines, robots, system transfer and storage of materials and finished parts. At the highest level, you realize the overall coordination of decision, forecasting, monitoring, simulation, diagnosis.

The performances in production mode are dependent on the quality of communication between all system components without the levels where the components has importance located. The information must be available, consistent, reliable and accessible in real time for each system module. This will avoid any blockage during the conduct of operations. In this sense the possibilities offered by technical calculators are essential for data acquisition, their circulation, storage and distribution. The CIM-FESTO system of the POLITEHNICA University of Bucharest (Figure 1) is a means of teaching the knowledge necessary for flexible production desktop. The CNC milling machine is the base element of the system that can be machined prismatic parts with maximum 100x140x30 mm dimensions. The transfer of the pallet in / or by the stock transfer system is controlled by a manipulator. The milling machine is controlled by the CNC equipment from Siemens (Sinumerik).

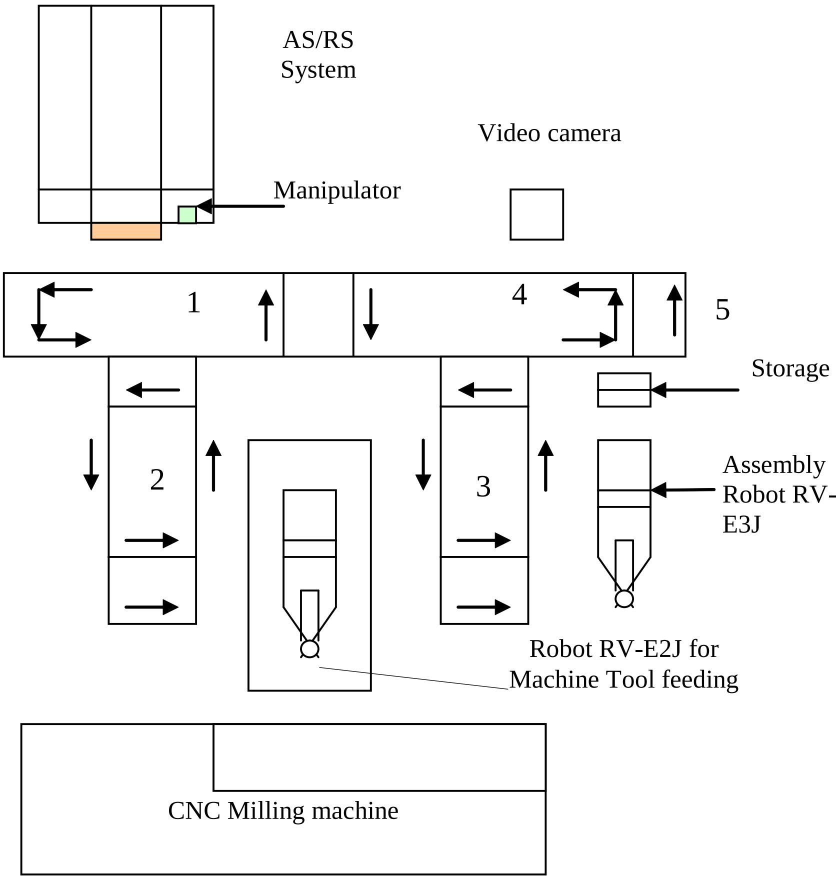

Fig.1 - The CIM – FESTO system structure

The pieces flow between workstations is provided by a conveyor-belt system (1-4), along which the sensors are placed, gaper's stops, diverters, code readers. Around this network, five workstations are located: 1 -the loading (and unloading) of the workpiece carrier on the conveyor belt; 2 -the supply station for milling; 3 –assembly system using a specialized robot arm; 4 -the infrared control machining and assembly; 5 -the manual correction of assembly errors; The power part of the machine tools is performed by a robot Mitsubishi RV-E2J model having 6 degrees of freedom. Control of the assembled product is realized in the detection field with an installation taking infrared radiation MSV-20 type.

The exchange of information between the flexible workshops system CIM FESTO are realized through the network reported in Figure 2. The exchange of information streaming involves the integration of communications, the use of computer networks and basic data specific to this production system.

The information includes the entire design of cycle and producing a workpiece and they refer in addition to the management of the system.
LUCAS (Layered Controller for Universal Automation Systems / controller with universal interface for automated systems) has been designed as universal programmable controller to each type of flexible system. It liaises between automated work units.

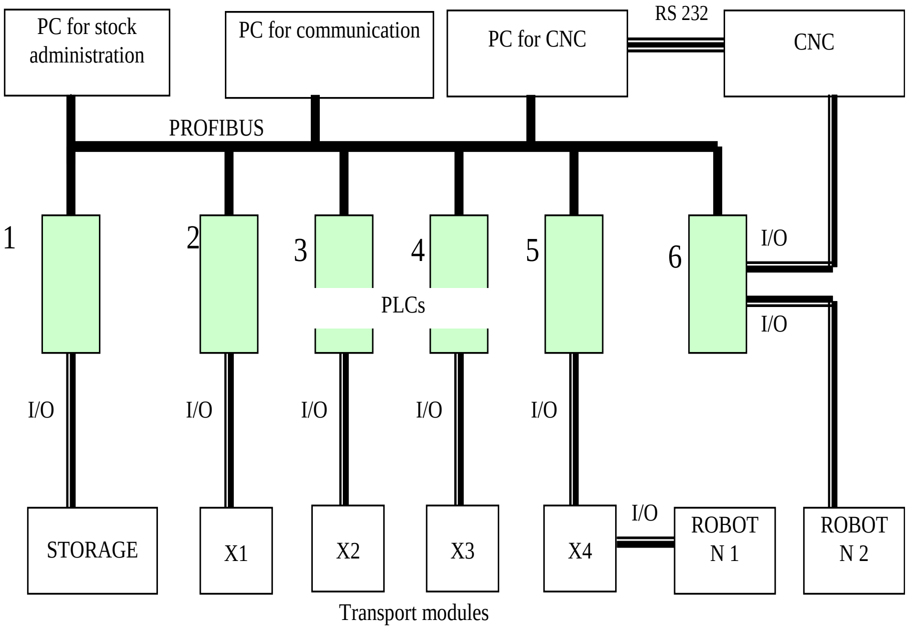

Fig. 2 - Communication into the system CIM FESTO

3. Calculation of the Efficiency of Transport System

The main parameters of a transport system are: the total work efficiency and the required number of conveying elements. Total Work Transport could be determined with the relationship:

$$T_{tw} = \sum_{i=1}^{n} \sum_{j=1}^{n} q_{ij}\, d_{ij} \qquad (1)$$

where is considered all trips between work cells. The efficiency of the transportation system is calculated using the relation:

$$E = \frac{d_m / v}{d_m / v + t_l + t_u + d_m^e / v} \cdot f \qquad (2)$$

where d_m is the average of the transport length, v –the linear conveyor speed, t_l – charging time for a work-piece, t_u –discharge time; d_m^e - general distance using empty transportation, q_{ij}^e -delivery flow in empty transportation, f –traffic factor.

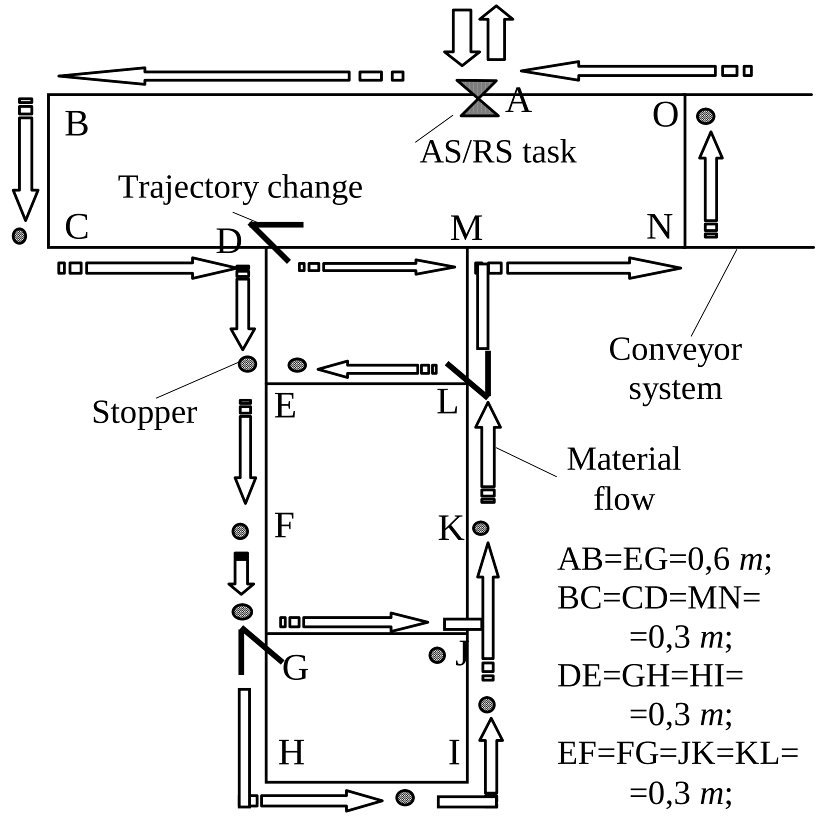

Fig.3 - Configuration of transport module

The total number of transport elements is calculated with the relation:

$$N = \frac{(d_m / v + t_l + t_u)\sum_{i=1}^{n}\sum_{j=1}^{n} q_{ij} + (d_m^e / v)\sum_{i=1}^{n}\sum_{j=1}^{n} q_{ij}^e}{60 \cdot f} \quad (3)$$

To use the conveyor system, the configuration of a module is shown in Figure 3. In Figure 4 we presented the four possibilities of roads for equipment.

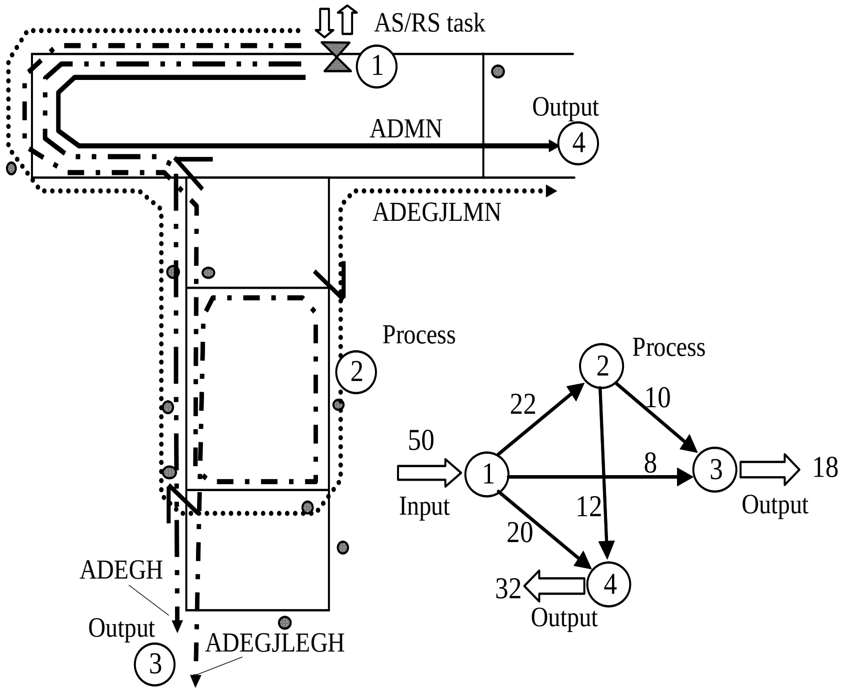

Fig. 4 - Road of material between different cells

Tableau no.1 Distances between work-stations, d_{ij} and the mouvements per hour, q_{ij}

d_i						q_{ij}				
From To	1	2	3	4		From To	1	2	3	4
1	0	2,7	2,4	1,8		1	0	22	8	20
2	-	0	1,5	1,2		2	0	0	10	12
3	-	-	0	-		3	0	0	0	0
4	-	-	-	0		4	0	0	0	0

It is considered v=5 *m/mn*, $t_l=t_u$=0,25 *min*, traffic factor f=0,85. Using the formula (1)...(3) we obtain the parameters E=0,37 et N=2.

4. Conclusions

The implementation of CIM systems achieves a higher gain in efficiency by increasing productivity and reducing the necessary production space. This reduces scrap, stocks are removed, it reduces the production staff. CIM systems require the formation of new skills to new tasks. The main advantages are the rapid adaptation of products to applications, increasing the degree of use of equipment, significantly reducing costs, the assurance of product quality and the efficient use of labor.

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EFICIENȚA SISTEMELOR DE TRANSPORT INSCRISE IN SISTEMELE FLEXIBILE DE FABRICAȚIE

(Rezumat)

Această lucrare evidențiază specificațiile Sistemelor Flexibile de Fabricatie, (SFF) şi care include toate componentele şi toate activitățile un sistem de producție flexibil. Un studiu special este dedicat sistemelor de transport modulare și parametri principali ai acestor sisteme astfel, se calculează: cantitate volumului de transport, eficiența sistemului și numărul necesar de paleti purtători .

Performanța sistemelor de producție depinde de calitatea comunicării între toate componentele sistemului fără a ține cont nivelurile la care sunt situate componentele. Informațiile trebuie să fie disponibile, consecvente, fiabile și accesibile în timp real pentru fiecare modul al sistemului. Acest lucru va evita orice blocaj în timpul fabricării de ansamblu. În acest sens, posibilitățile oferite de PLC sunt esențiale pentru achiziție de date, circulația, depozitarea și distribuția.

Punerea în aplicare a SFF realizează o performanța importantă prin creșterea productivității și reducerea spațiului de producție necesară. Acest lucru reduce resturi, stocurile sunt eliminate, și reduce personalul de producție. SFF-ul are nevoie de noi competențe pentru a efectua noi sarcini. Principalele avantaje sunt adaptarea rapidă a produselor la aplicații, creșterea gradului de utilizare a echipamentelor, reduceri semnificative ale costurilor, asigurarea calității produselor și utilizarea eficientă a forței de muncă.