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LOGISTIC PROCESSES IN ENTERPRISES USING FLEXIBLE MACHINING SYSTEMS (FMS)

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Abstract: *In the article, the logistic processes of deliverance, production, distribution and utilization have been presented. The factory under analysis is of the machine building branch. In particular, the production processes have been discussed, considering storage organization, transport units and work places.*

1. INTRODUCTION

It is not easy to define main purposes of logistic strategy in the factory, because any factory has its own requirements due to logistics. Many input flows, inner dislocations, resources and outflows are created after the proper decision in the informative process is made. Effectiveness of all those processes depend on technical infrastructure which includes the transport vehicles, buildings, storages, machines operating the storage, transport packages etc. Logistic processes may cover many activities where typical flows, resources, and infrastructure take place in the production factory. In the production processes included into Flexible Machining Systems (FMS) logistics means mainly effective and fully automatized inner transportation, properly projected flow channels in the production processes, and the storage of the products under operation. In the FMS, all the stages of production must be automatized, from the first loading position, through all machine tools and additional stages, to the unloading position.

2. LOGISTIC STRATEGY AND SYSTEMS IN THE FACTORY

Logistics in the factory includes many stages. First of all it is resources management concept which deals with effective materials' flow during the production. The last stage, often applied nowadays, is the channel management which covers all the materials' flow in the factory, from the deliverance of rough material or initially formed products to the end of the process, i.e. the final product ready for customer. Materials' flow covers deliverance area, production and distribution. Flow chart of logistic systems in the factory is shown in the fig. 1.

Input logistics means the area of deliverance and production, and output logistics means production and customer service. There is one more area between them, which is the inner logistics of factory.

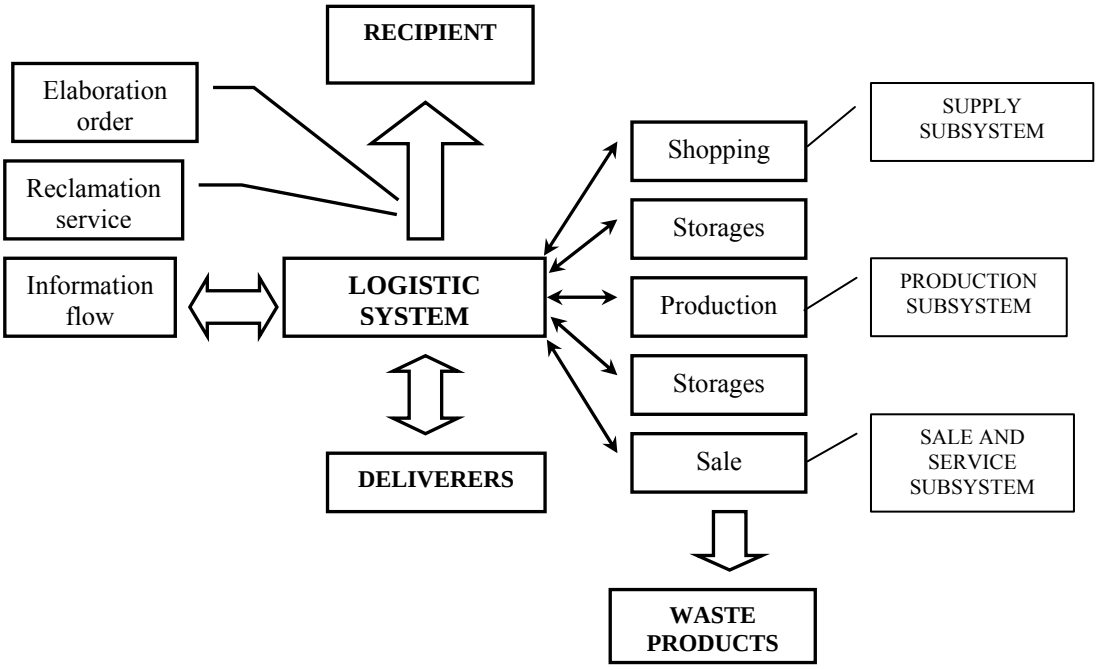

Fig. 1. Example of the logistic system in factory

Logistic strategy in most factories deals with decision areas. Those are order handling (the level and standards of service), localization of production and storages, resources, warehousing, transportation. Particular attention must be paid to marketing, financial issues and informatization of the whole enterprise. In the particular factory's activity areas may b pointed out following:

- deliverance processes,
- production processes,
- distribution and dealing with the turned back products,
- utilization processes.

When planning the logistic strategy, the demand on the products must be taken into consideration, i.e. the ordered amounts and predictions on selling.

2.1. PROCESSES IN THE LOGISTICAL DELIVERANCE CHAIN

„Deliverance chain" means the flow of the materials from the original source through all the in-between stages unto final form, e.g. the deliverance to the customer. To create such a chain of deliverance, one must create logistic chain, known also as the storage-carriage chain. Logistic chain is the technological connection of the storage and re-loading points through the transportation of the workpieces and organizational coordination of the operations and processes in the factory [8]. The parts of the logistic chain are timetables of the flow on the strategic and operational levels, participation in the supply and demand planning, control over the resources and deliverance levels, and the organizing of the product sending, service deliverance and the information exchange.

2.2. SUPPLY PROCESSES

Pfohl [9] defines supply logistics as a connection of the distribution and production logistics. Also the accessory processes are mentioned, namely re-loading, packing and

marking. Those processes are aided with information flow. Transformation of the materials in the logistic process of factory means the changes of time, space, amount, kind, and properties concerning with carriage, re-loading and storage.

The supply processes cover the deliverance of the materials needed for production. Those are rough materials, initially formed workpieces, details and units needed to manufacture a new product. The factory must define appropriate supply sources, amount of delivered materials, quality and terms of delivery. The costs should be held possibly low, however not to affect the quality.

In the supply logistics, three main principles bound:

- Individual supply when needed – this kind takes place when the unitary product is manufactured, and it is impossible to predict further demand. The needed material is delivered only when the demand takes place.
- Supply and resources level holding – in that case, the optimal order amount is needed. Materials are stored in factory in order to meet inner demands.
- Deliverance synchronized with the production or wear – here the deliverance on call respectively deliverance planning and control is applied. Current day-supply is carried directly from the vehicles to the production places. The storage is used only as the safety reserve.

The choice of the supplier is very important to ensure needed materials supply. There are criterion of the ideal supplier choose: price of deliverance, quality of materials, delivery terms, warranty and dealing with complaint, financial condition of the supplier, his flexibility and opinion of his customers. Moreover, the additional criterion may be applied, e.g. one may prepare the list of possible suppliers and to verify systematically its contain. The list may show the valuation of the logistic processes, time of delivery, quality of delivered goods, terms of payment etc. One of the best ways is the supply system called Just-in-Time (JIT). To enable this, the factory must have an integrated system of production and service management.

2.3. PRODUCTION PROCESSES

Every flexible system apart of NC and CNC machine tools, machining centers and accessory positions, must have central production storage, local storages alongside the positions and automatic transport and manipulating units. What kind of devices would be applied, it depends on the branch and size of factory. FMS contains also of information flow system using computers for management with programs for control of the work process and information flow in the whole production system. The basic system of FMS is machine system and tool subsystem that contains tool kits with holders, and technical means for their storage, carriage and manipulation [3]. FMS is able to machining several details of different kinds at once, because of interchangeability and complementability of the machines.

Logistics of the production processes consists of projecting of the production flow channels, inner carriage and resources of work-in-progress. In large extend production process depends on the complicity of the product. If it is complicated, it must undergo many operations and technological procedures.

When projecting certain technological process, one must take into consideration amount of final products, applied technology and organization. Must be done following:

1. To plane properly machines and to choose their kind.
2. To define number and dimensions of the pallets.
3. To place properly work positions according to appropriate organizational structure.
4. To establish the number and type of the transporting devices.

2.3.1. Storage

Central storage of production performs many tasks, such as:

- Equalization of the effectiveness and work-time on the cooperating machines,
- Compensation – reserves which may compensate the disruption, e.g. malfunction of the machine,
- Reserve storage – storage of the workpieces waiting for machining, and those waiting for being moved out of system after machining [2].

Central storage may perform many different tasks, e.g. it may serve as a storage aside machining position, as storage for workpieces after initial machining, Or as storage of empty pallets and containers. In every factory the storage must be on the possibly high technical level, i.e. on the level enabling quick change of the pallet seat height, building of the additional storage levels and keeping of the stored pieces clean.

2.3.2. Pallets

Pallets used in the production and in flexible systems, may be divided into two groups: for objects and for transportation. To choose appropriate pallets, first must be chosen ones for income or outcome of the production process. Usually those are the pallets for transportation of workpieces after initial machining, or completed. The other kinds of pallets are ones used inside the flexible system which may be standardized dimensionally or made especially for certain workpiece. In that case the dimensions and shape of the workpiece is important, and how many details would be placed in a pallet. It is also important, if the pallet may be put directly on the table of machine tool. Pallets usually are stored in special areas not far from working positions, in order to keep process continual in case of malfunction of when the production overrun the outgo of workpieces.

2.3.3. Work positions

Decision where the machining centers in the system should be placed; one must consider flexibility of the route in order to enable continuation of the production of this kind of workpiece despite the local malfunction. The production and accessory workplaces should be placed avoiding so called bottlenecks limiting flexibility of system. If the system is out of work even for a short time, this would lead to expenses. The most useful location of the machines in FMS is the parallel location shown in the fig. 2. Buffer alongside the workplaces may serve as manipulators of buffer stocks for pallets and containers. Transportation path has circulating structure, which advance is that the workpieces come to the machining centers in the same position. In such a structure take place casual choose of the tools, and the multi-processed machining may be performed in any sequence.

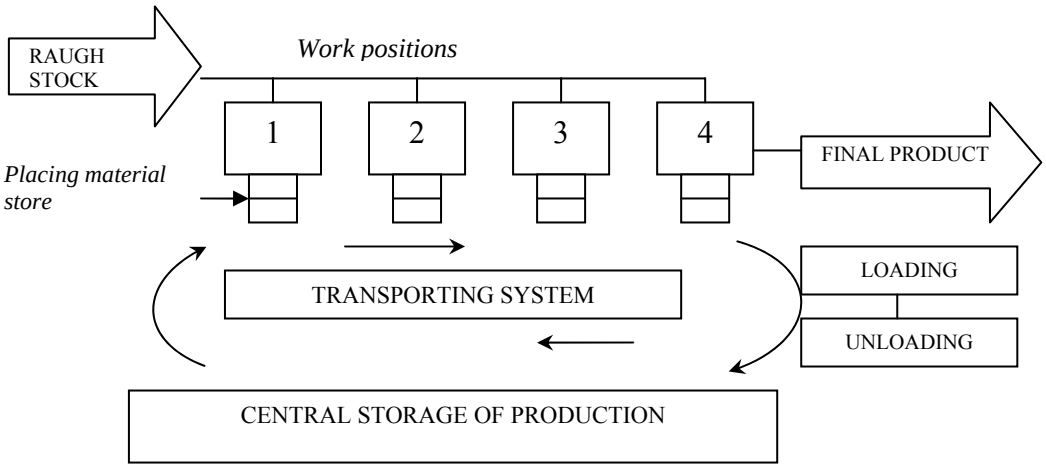

Fig. 2. The parallel structure of the Flexible Machining System

2.3.4. Transporting devices

Transporting system is one of the subsystems of FMS and is used for carriage of the objects and tools between the central storage and particular machining positions. The important task is the choice of the transporting devices which depends on the size of the factory, loadability of the beam and the floor, crossings of the transport routes, and their usefulness in the flexible system. The initial parameters for devices choose are following:

- mass of the workpieces to be transported,
- degree of the workpiece sensitivity,
- control of the pallets on the workplace,
- distance between the workplaces.

There is a wide range of transportation devices applied in the FSM. They are among others robots and manipulators, load carrying devices as conveyors (with or without strands, cargo chutes, hybrid transporters), strand transporters with barrows, transfer transporters with pallets, short distance material handling devices – load carriers (fork-lift trucks, fork-accumulator trucks, combustion on electric engine lift trucks, special trucks). There are also most developed technologically robotized carriage for short distance handling (mobile robots of 1^{st}, 2^{nd} and 3^{rd} generation), as well as rail less AGV (Automated Guided Vehicles). AGV are called also autonomic mobile robots and they play the role of the flexible transport device in factory. Inner transportation influences the effectiveness of the factory, and depends on the level of the transportation devices development.

2.4. DISTRIBUTING PROCESSES

It is clear that the distribution logistics deals with the transportation of the workpieces and materials produced by the factory to the customer or consumer. Distribution is closely connected with customer service and the time of deliverance. The goods and services must be supplied to customer in proper time. It is also important to ensure storage near the production place as a part of the integrated logistic chains, and to ensure the available in time resources. The flow analysis must be performed with professional consulting, as well as the analysis of the interaction of supplier and receiver. There are two methods of deliverance to customer:

- deliverer delivers goods to customer (deliverer uses his own deliverance logistic system),
- customer gets goods himself (using his own supply logistic system).

In modern factories, there are many ways of goods flow from the manufacturer to the final customer. The three ways are most common:

1) directly from the manufacturing process,
2) from the storage of factory,
3) from the other storage, e.g. regional storages.

Shipment of the rough materials and final products is the basic part of the logistic system in factory. Particular attention must be paid to the complaints and turned back products, and the spare parts flow which are closely connected with service. The dealing with the returned products is called *reverse distribution*. Most factories have a problem with it, because they are not ready to operate the reversed flow of goods. This kind of operation creates much higher expenses than a normal one.

2.5. LOGISTICS OF THE WASTES (RECYCLING)

Every factory emits various kinds of wastes. This led to the development of the logistic branch dealing with wastes enabling to recover some costs and to increase environmental effectiveness of the production. Utilization logistics is to store and to transport

safely the waste materials. The question, if particular factory should apply utilization process, depends on the branch and the manufacturing technologies. Nowadays the factory must solve two main problems:

1) reasonable waste management on the current production,
2) management of wastes deposited in dumps for many years.

Those problems lead to the various intensive actions in the area of waste logistics. Its important aspect is the simulation of the factory's work in order to find and to introduce new technologies and materials, which cause less damages of the environment, both in toxic and quantitative degrees.

3. CONCLUSIONS

Logistics became the essential part of many newly defined processes. Good example is the JIT concept. To apply it one must introduce properly integrated management system. However, this concept will not work without reliable logistics providing appropriate deliverance, and production logistics enabling the effective usage of resources.

Each of discussed logistical processes influences the quality of final product and the customer's satisfaction. It is important also in the analysis of the value added chain, e.g. the group of processes which decide how effective and competitive the company is. Logistic process in company runs horizontally and integrates vertical functions like supplies and production. It influences dimensions of space and time in the implementation of orders and the flow of materials. Most appropriate strategies in the factory are the new methods of implementation of logistic processes using modern digital technologies necessary in the conditions of competition. The main criterion of the competitive predominance is the high quality of products, time and flexible reaction to the customers' expectations. Access to the new technologies should become priority, because it would enable to ensure the development of the logistics in its every level. This requires the appropriate attitude, time, money, and above all the experience.

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