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OPTIMAL SOLUTION FOR ORGANIZING THE LOGISTIC PROCESS OF JUST-IN-TIME CONCEPTION

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Slavica Cvetković[1], Nada Barac[2]

[1]Engineering Faculty, Kosovska Mitrovica, Serbia, smijoc@eunet.yu
[2]Faculty of Economics, Niš, Serbia, barac@bankerinter.net

Abstract. *This paper focuses upon the synchronization of all activities within the manufacturing system, which is a permanent challenge for both successful manufacturing and business in general. For the realization of this research task it is necessary to start with the structure of the manufacturing system and to set up a hierarchy of objectives as well as strategies to be employed in their realization. The validity of the proposed concept is assessed by means of computer simulation, using the initial data from the industry.*

Key words: *Just-in-time, Segmented Manufacturing, Customer, Stocks.*

1.INTRODUCTION

The aim of this paper is to create the conditions for efficient application of the flexible manufacturing based on the Just In Time concept and to enable the following:

- Higher quality of products, i.e. manufacture without failures,
- Manufacture in accordance with market requirements,
- Increased flexibility of manufacturing capacities,
- Shortening of manufacturing cycle,
- Essential reduction of time periods required for preparing and final activities,
- Clearly defined methodology of planning,
- Co-operation and reliability between the customers and suppliers,
- Active engagement of all participants in reference to realization of the objectives established,
- Effective control (handling) of the material,
- Reduction of goods stocks, and,
- Increased reliability of delivery, etc.

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2. STRATEGIC J I T PRODUCTION

There is quite a spacious field for management affirmation within the domestic metal processing industry. In order to integrate the interests of various subjects and to implement their integration in our conditions, it is necessary not only to solve the remaining ideological problems, but also to establish the economic subjects on the principles governing the enterprise concept. It is also necessary to build the infrastructure (stock exchange, banks, etc.) through which market economy among enterprises, as units of market competition, could function. Besides, it is necessary to have additional knowledge in the following fields: marketing, finances, information systems, project management, and the like. In order to apply the JIT concept within the business system it is necessary to provide adequate adjusting of the associate companies such as: suppliers of raw material, tools, energy. Their importance is not sufficiently emphasized when considering the implementation of JIT in an enterprise.

Central elements in Just In Time manufacture are:

- no stocks of any kind,
- flexibility present in each situation, especially in relation to customers,
- reduced time of delivery,
- total quality control, and,
- complete prevention maintenance.

One definition of JIT manufacture claims that the manufactured quantity should be as low as possible at the latest possible moment, showing a tendency of unit series production. It is realized in the manufacture governed by flow principle (synchronization of capacities and mechanical engagement). This type of manufacture should eliminate reserves because they make difficulties for the flow of material. The principle of flow can be realized in practice only step by step, by synchronizing the capacities, reducing the stocks, shortening the time of preparation, and minimizing the time of both transport and stoppage. Minimum engagement of resources is achieved in this way. Structural changes in the logistic chain are required to carry out the JIT concept. Internally, it is necessary to make segments of manufacture within the enterprise in order to free the capacities. Externally, the number of suppliers is to be reduced and directly connected with manufacturing program of the customer; therefore the logistic functions are transferred to the enterprises providing freight and services. The formation of small organizational units and their direct orientation towards market requirements should be anticipated when the complete logistic chain is considered. The program of strategic manufacture planning and organizational concepts of manufacture should also be taken into account.

This results in a new organization of manufacturing within the factory in reference to the flow of both the material and information in order to direct all activities to meet market requirements. The JIT concept consists of several elements:

1. Integral data processing,
2. Segmented manufacture, and,
3. Co-ordinated purchase with manufacture.

Successful implementation of this concept when carrying out all the activities result in an increased productivity, a higher quality of products and better system performance together with significant reduction of expenses.

It is not possible to design one universal systematic approach that would embrace an effective implementation of the JIT concept without its modification because each manufacturing process has its own objectives and characteristics. Therefore, before any JIT manufacturing concept is implemented, it is necessary to determine its objectives and the strategy of its realization. The main objective of the JIT concept is to design such a system which would enable business activities to be performed within the manufacturing system with the material, equipment and work force available in the amount required, at the proper time, and also on the site where a certain activity should be performed. This objective can be achieved by carrying out six basic sub-objectives:

1. Integration and optimization of each phase of manufacturing process,
2. Constant revision and improvement of quality control system,
3. Manufacturing costs reduction,
4. Manufacturing designed for a known customer,
5. Permanent development of manufacturing flexibility, and,
6. Provision of reliable suppliers and keeping permanent contacts with both the customers and suppliers.

It should be mentioned here that realization of the six above-mentioned objectives does not automatically guarantee a successful implementation of the JIT concept. On the other hand, the realization of only one of these objectives automatically leads to unsuccessful application of the JIT concept. The concept of objectively-directed analyses, designing and programming as suggested by this work is unavoidable whereas the expended Petry's networks should be used to provide help in creating the model behavior. The suggested approach to work out the simulation model is the most up-to-date reply to outstanding problems occurring in this field. In addition to the above-mentioned difficulties occurring in the model work-out, i.e. (system behavior and its control) perception, it should be emphasized that in order to obtain a functional and useful model the following is required:

– to implement the chosen management strategy into the simulation model which, in the widest sense, implies the setting-up of the basic JIT criteria and a set of objectives for its realization, and,

– to provide such output results of the simulation model which would influence the selection of management activity.

The suggested procedure is used for working out the simulation program, which describes the behavior of the actual system of technology. This is an original concept, which integrates both the hierarchical and the object-oriented approaches to the system analysis and synthesis. These approaches enable the design of classes which comprehensively describe possible states of the system entities significant from the aspect of modeling, as well as all the activities in which these entities take part during the functioning of the system. The application of the extended Petry's network to model designing enables its irreproachable execution by means of a simulated program coded within the objectively directed language C++. This methodology represents a modern answer to the complex question of creating technological system models. The transient entities of the system can be observed by analyzing the system structure. It is noticed that the basic entity of the system is the subject of work. The following are permanent entities of the system model: crane, (radiator) heating plate line, plate welding machine, connection welding machine, heating plate inspection bath, radiator inspection bath, conveyer belt, semi-final products storehouse, finished products storehouse, areas for intermediate parts storing, palettes,

and a worker. Having noticed the entities, it is now possible to perform the analyses. The basic task in determining the time periods needed for various operations is to take care of an optimal term plan, which requires the existence of certain criteria, i.e. indicators of the system performance. The criteria most generally used are the length of manufacturing cycle periods, the quantity of stocks throughout manufacture, usability of system resources, delivery terms of finished products, or the criteria based on costs. Without clearly defined optimization criteria, which would provide for the elements needed for term plan quality, there is no sense in carrying out the simulation experiment. The basic criterion governing the execution of simulation program in this case is a prompt delivery of the product to the customer. If there is a complex situation when several RN are waiting for the same machine, the simulation program chooses the work order with the highest degree of priority. It is important to emphasize that there is no unique solution to terminate operations. Which technique should be applied in the actual domain depends on its complexity, structure and levels of decision making, the nature of limitations, optimization measures and other numerous factors. Therefore, it is neither recommendable nor worthwhile to try designing a universal simulation tool that can be applied to all possible cases in practice. Numerous characteristics of technology system flexibility, which have crucial influence on its performance, can probably be included in one software package. However, its coefficient of efficiency in the case of individual users would be minimal due to several reasons. By increasing the universality of the simulation package regarding the termination issue, its flexibility is reduced if applied to individual cases. This paper suggests original simulation model work-out for each case individually because all specific elements of the system modeled will be included in the program. The users have access to a program, all users' requirements are embedded into it, and finally, as the program is written in objectively directed language C++, it is possible to rewrite it without difficulty in the case of additional requirements.

The specific characteristics of this simulation program imply that the objectively directed and the hierarchical approaches are integrated in analyses and synthesis of the system, and that the Petry's network is used for describing processes within the system. The result of such an approach is a model, which completely transfers the attributes of the system and possible activities of its elements and the processes within it. The process of model execution follows the line of certain subjects' activity identical to the realization of competitive processes, which take place in the real system. (PC) Computer simulation enabled by the application of the extended Petry's network is used in the model work-out as well as in the simulation program routine designing.

The performance of this program primarily shows the fact that the complete situation present in the real world (workshop and its environment) is relocated in the computer. Therefore, the possibilities of modern information technologies are applied to the problem to be.

The simulation program begins execution with one transient assumption that the materials required for reproduction are available in the input storehouse. Then it follows the situation in real system and determines the time necessary to carry out certain operations. All the work orders are then processed and sent to the input storehouse. The work orders with priority governs the execution and they are defined as the time of their occurrence in the output storehouse, the time required to be transported to the customer and the given delivery term. The program generates data at the moment of each work order occurrence

within the system, at the time required for its realization, and automatically takes into account the priority of each work order. Having done the simulation experiment, the program automatically counts the latest moment of the reproduction material ordering for each work order on the grounds of its occurrence within the system. The logistic chain supporting the main principles of the JIT concept is in this way closed, connecting the supplier with the customer, simultaneously using the performances of the obtained software. The user has the situation in the semi-final product storehouse, which enables normal functioning of the manufacturing process and an optimal level of supplies. Besides, the program finds the optimal manufacturing term plan which depends on the priority of certain type of radiators. Figures 1 and 2 show the two basic menus enabling the perception of some of the operations offered to the users.

It is not possible to fulfill all these factors quite satisfactorily when designing the general purpose application in a classical way. The reason for this lies in the fact that it is not possible to model a certain group of real systems applying enough abstraction to enable optimal control decision-making both at the level of tactics and of operative realization. The general purpose software can not model the identity of each individual system, that is, it can not model all specific requirements appertaining to the structure and behavior which are at the lower level of abstraction. Therefore, expert knowledge in this application designing (objectively directed methodology and Petri's networks) together with both the specific knowledge of industrial engineering and specific knowledge and requirements of the user can produce satisfactory software or that with high performance. Another very important characteristic which singles out this approach of software designing is found in the fact that its execution requires the data about the initial space of system state (usually available from the manufacturing and technological documentation).

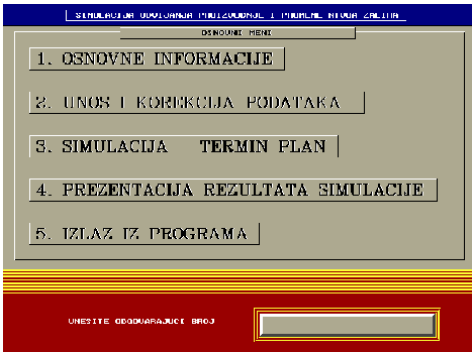

Fig. 1.

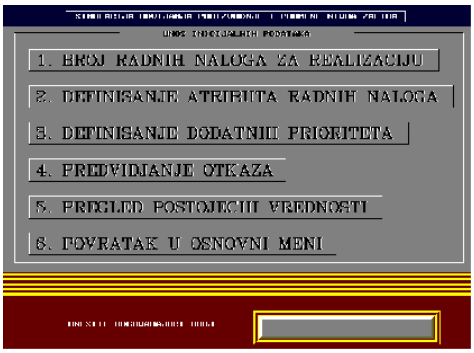

Fig. 2.

Other data describing the dynamic of change of the space of system state are realized automatically by the software. It is not the case with the general purpose software, apart from trivial problems. Therefore, it is necessary to define a whole set of additional data (usually by means of suitable models) for the beginning of the simulation experiment. Here we are faced again with the complexity issue. Therefore, the quality of the model is reduced also bringing about negative consequences: the decision-making control is far from being optimal, the coefficient of efficiency of the system performances is low and the losses can not be avoided. Software performances are related to its ability to support

the main postulates of the JIT manufacturing concept. Figure 3 shows the average change of system work orders depending on the change of finished products delivery terms.

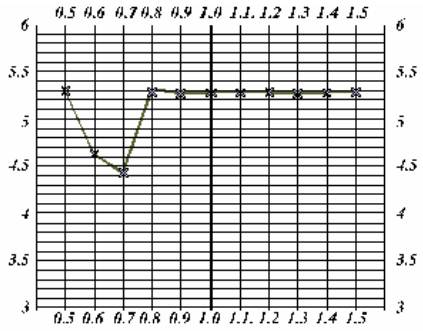

Fig. 3.

It could be seen from the diagram that the number of work orders within the system is reduced with the reduced terms of delivery.

3. CONCLUSION

The emphasis of this work is on the synchronization of all activities within the manufacturing system, which is a permanent challenge for both a successful manufacture and business in general. For the realization of this research task it is necessary to start with the structure of the manufacturing system and to emphasize the hierarchy of objectives as well as also the strategies which should be employed for their realization. The validity of the proposed concept is estimated by computer simulation, using the initial data from the domestic industry.

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OPTIMALNO REŠENJE ZA ORGANIZACIJU LOGISTIČKIH PROCEA JUST-IN-TIME PROIZVODNJE

Slavica Cvetković, Nada Barac

Ovaj rad se bavi sinhronizacijom svih aktivnosti u okviru proizvodnih sistema što predstavlja stalan izazov kako za uspešnu proizvodnju tako i za poslovanje. Da bi se ostvario ovaj istraživački zadatak neophodno je početi od structure proizvodnog sistema i da se naročita pažnja posveti hierarhiji ciljeva, a takođe i strategijama da bi se one realizovale. Procenu validnosti predloženog koncepta procenjuje kompjuterska simulacija koristeći početne podatke iz industrije.

Ključne reči: *Just-in-time, segmentna proizvodnja, potrošač, zalihe*