Proceedings of the 2009 Winter Simulation Conference
M. D. Rossetti, R. R. Hill, B. Johansson, A. Dunkin and R. G. Ingalls, eds.

CHANGES SIMULATION IN THE ORGANIZATION OF PRODUCTION – CASE STUDY

Marek Fertsch
Pawel Pawlewski

11 Strzelecka Str.
Institute of Management Technology
Poznan University of technology
Poznan,60-965, POLAND

ABSTRACT

The authors of the present paper investigate the case of using simulation in order to analyze the efficiency of changes in the organization before their implementation. The research considers changes in the organization of a selected company. The article discusses the method of assessing the efficiency with use of simulation before the actual changes are implemented. Finally, conclusions on the general characteristics of the analyzed method are provided.

1 INTRODUCTION

According to the typical classification, three simulation types are distinguished:

- Discrete processes simulation – the most widely used and providing the most fully described methodology. It offers a highly developed IT assistance, based on a number of systems available in the market.
- Continuous processes simulation – also offers a well developed methodology. In practice it is not as commonly used as discrete processes simulation. The number of continuous processes simulation systems which are available in the market is also smaller than in case of discrete processes.
- MRP simulation, also known as 'what-if' simulation – can be implemented with actually every ERP system. The idea of the simulation is to analyze various possible scenarios with use of procedures implemented in the system and manipulating data introduced into the system (mainly by the master schedule) (Wight 1984).

Full overview of features of all types simulation contains paper of Ricky G. Ingalls (Ingalls 2008). Apart from the above-mentioned areas, the use of simulation in other cases is rather uncommon. However, researchers work on expanding the use of simulation upon new problem categories (Farr, Tannock and Holm 2007). The question is why it is so. As a matter of fact, simulation is based on modelling the reality. In his classic work, J. Forester (Forester 1965) presented the classification of models used in the management and economical sciences. Forester noticed that most of the models used in the discussed area, were stable-steady state models. Since that time, the situation has probably changed a little. However, it should be noted that the models of stable-steady state category can be successfully used for describing certain management problems, i.e. mainly layout planning and modelling problems and, to a wider extent, problems of changes in an organization. While changes are being implemented, the organization system rapidly transforms from one state to another. This change does not result from a random schedule of events, but from a deliberate decision of a manager.

Such a decision is made based on evaluating the efficiency of implementing a change. A change is considered to be an investment, and it is usually connected with capital expenditure. In order to asses the effects of the implemented change the methods of assessing the investment efficiency are used. A exhaustive review of available methods is provided in the work (Bernstein 1995). However, in case of investing in fixed assets, the methods are based on certain assumptions, substantial effects predictions, which are later converted into financial measures. Nonetheless, in the methods of assessing the investment efficiency the way of determining substantial effects is not usually determined.

Simulation is one of the tools which may be considered for use in order to determine substantial effects while implementing changes in a organization. The present work discusses the possible uses of simulation based on a specific example. This paper is organized as follow: in section 2 the problem of formulating, the assumptions and course of the simulation experiment are described in section 3, section 4 contains results of simulation experiment, final conclusions are stated in section 5

2 FORMULATING THE PROBLEM

The company delivers components of telecommunication systems to other companies operating within an international corporation. Periodically, the demand exceeds the potential of the company. The products are made to individual orders of customers. The customer provides documentation and the product is equipped according to data included in the documentation. Delays in providing the documentation result in stoppages in the course of assembly. A hypothesis was formulated that shortening the production process will provide a solution to the company problems. The hypothesis was to be verified by means of simulation experiment. The experiment was also supposed to verify the assumed method of shortening the cycle.

3 THE ASSUMPTIONS AND COURSE OF THE SIMULATION EXPERIMENT

A model of the production process in the investigated company was built as shown in Figure 1.

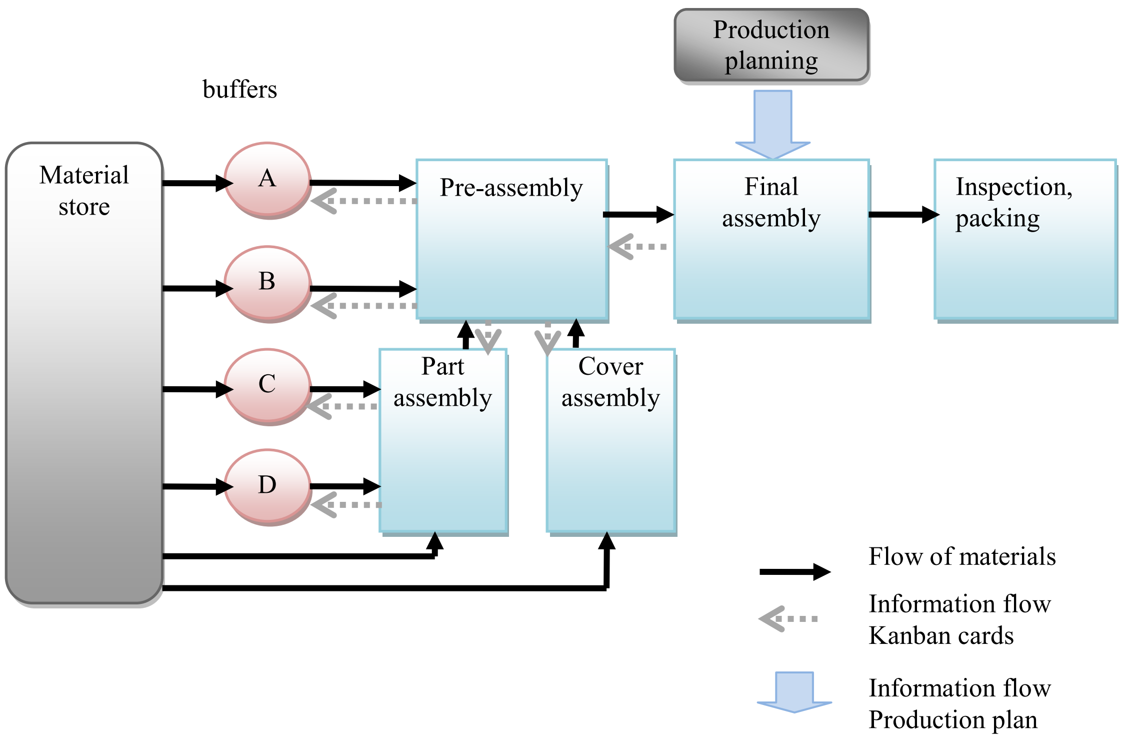


Figure 1: Production system of the investigated company – the initial state

The organizational changes tested in the investigated conditions were as follows:

- Changes in planning - a monthly production plan, which previously was delivered to the final assembly stand, in the changed conditions was to be passed over to the inspection and packing stand.
- Creating a new buffer E between the inspection and packing stand and final assembly stand; fully-assembled products were directed to this buffer. In case the customer did not provide precise product specification, one of three typical products selected by means of an analysis was put in the production plan. The product was then adjusted to the customer's specification at the inspection and packing stand; the redundant components were removed and returned to buffer A.

The model of the tested system in the company is shown in Figure 2.

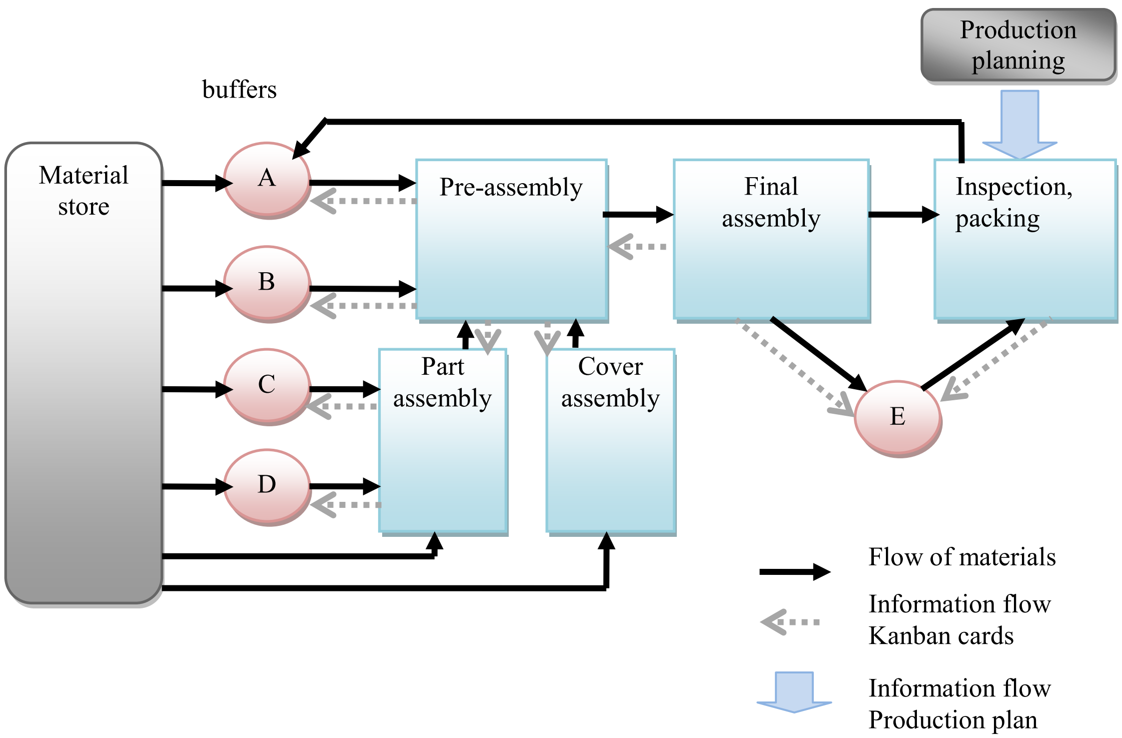


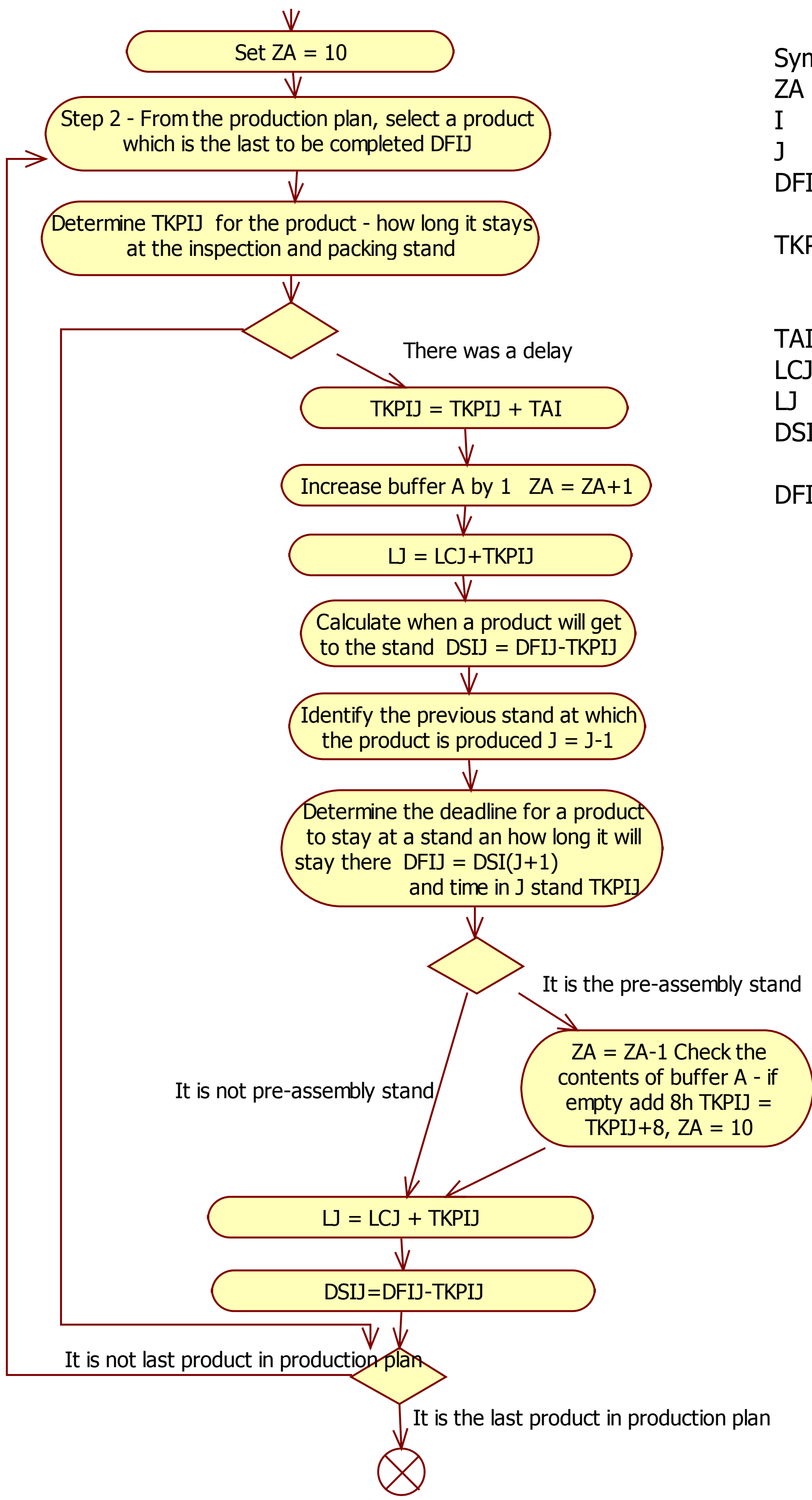
Figure 2: The simulated organizational changes in the production process of the investigated company

In order to conduct the experiment:

- according to the operating technology, it was determined how long it takes for each product to stay at each stand
- additionally, the technology of adjusting a product to the customer's needs was developed for the inspection and packing stand; based on this technology, it was determined how much extra time a product needs at this stand.
- the production data from the previous year was assumed to be the input data for the experiment; in case of products whose delivery was postponed due to a delay in providing the product specification by the customer, some extra time was presumed to adjust a product to the customer's needs at the inspection and packing stand.
- products delayed due to the lack of material in buffer A were also analyzed; the method of supplying buffer A was maintained: once per a working shift the stock was restored, the stock level was accurately observed.

In order to carry out the simulation, the modified algorithm of capacity requirement planning was selected in the version of planning back with limited capacity. The idea of modifying the algorithm was to control the stock in buffer A. The very moment the stock decreased down to zero, the time necessary to complete the pre-assembly was lengthened by eight hours, i.e. one working shift.

Figure 3 shows the modified algorithm of capacity requirement planning. The calculations were made with use of a software application created especially for the purposes of this research in Microsoft Office Excel 2003.



Symbols:
ZA - inventory in buffer A
I - product number
J - stand number
DFIJ - the latest production dead-line
TKPIJ - time how long it stays at the inspection and packing stand
TAI - customization time
LCJ - currentl stand J load
LJ - stand J load
DSIJ - time when a product will get to the stand
DFIJ - the deadline for a product

Figure 3: The algorithm of modifications in capacity requirement planning

4 NUMERICAL SIMULATION EXPERIMENT

The calculations were made for twelve month-long cycles on the basis of last year's data concerning the course of production. The obtained results are shown in Table1.

Table 1: Results of preformed simulation experiment

Month	1	2	3	4	5	6	7	8	9	10	11	12
Number of products	174	182	195	195	175	184	170	170	175	180	180	173
Number of products with Incomplete documentation	15	10	20	12	17	14	12	14	10	16	14	13
Length of delays - historic data (days)	42	30	52	30	21	28	26	26	22	30	25	26
Total time the products spent in the production system-historic data (hours)	753.4	676.8	884.0	708.0	588.0	656.0	616.0	616.0	596.0	672.0	632.0	616.0
Total time the products spent in the production system data from the simulation (hours)	441.4	460.8	492.0	500.0	500.0	480.0	432.0	448.0	452.0	464.0	456.0	440.0
Total number of delays in buffer A – historic data	7	11	14	12	13	10	6	7	12	10	12	9
Total number of delays in buffer A – data from the simulation	3	3	3	4	5	6	3	5	4	4	3	4

The average shortening of the production cycle in a year-long period was calculated by subtracting the total time the products spent in the production system in the course of the simulation from the total time the products spent in the production system according to the historic data, and then dividing this difference by the number of manufactured products. The results of the calculations show that the production cycle was shortened by 1.13 hours on average and, therefore, the proposed hypothesis is confirmed. Moreover, the decrease in the number of delays in buffer A, observed in the course of the simulation, proves that the investigated solution can reduce the number of stoppages that happen in buffer A due to the lack of components.

5 CONCLUSIONS

The discussed use of simulation in order to asses the efficiency of changes in the organization of the production process proved to be successful, since it convinced the management of the company of implementing the suggested changes. From the methodical perspective, the authors wish to emphasize the following issues:

- The use of simulation in the analysis of organizational changes, as opposed to most cases of the discrete and continuous processes simulation, does not have the standard methodology of the model structure. Each time, the model must be created from the very beginning, just for the sake of a specific problem to be solved.
- Data availability is very important for solving the problem. The authors of this work used historic data. In case such data are not available the use of simulation may be difficult or even impossible.
- The simulation of changes in an organization, as opposed to other simulation uses, is not supported by a standard IT assistance wide described in (Klingstam and Gullander 1999). The software must be designed to serve the needs of a specific experiment.

The problem of model validation and the obtained results is a significant, yet still open case. The classic methods, applied to other uses of simulation, are rather difficult to apply to the investigated area.

REFERENCES

Bernstein P.L.1995. *The Portale MBA in Investment*, J. Wiley & Sons, Inc., New York

Farr, R. Tannock, J. Holm, S. 2007. Parametric Factory Simulation for the Responsive Enterprise. *In Proceedings of International Conference On Responsive Manufacturing ICRM*

Forrester J.W. 1965. *Industrial Dynamics*, The MIT Press, Cambridge, Massahuttes

Ingalls, R.G. 2008. Introduction to simulation. *In Proceedings of the 2008 Winter Simulation Conference*, ed. S. J. Mason, R. R. Hill, L. Monch, O. Rose, T. Jefferson and J. W. Fowler, Institute of Electrical and Electronics Engineers, Inc.

Klingstam, P. Gullander, P, Overwied of Simulation Tools for Computer – aided Production Engineering, *Computer in Industry*, 38 (1999) pp. 173 – 189.

Wight O. W. 1984. *Manufacturing Resource Planning: MRP II,* revised edition, Oliver Wight Limited Publications, Inc., Essex, Junktion, VT

AUTHOR BIOGRAPHIES

MAREK FERTSCH is a Professor at the Department of Computer Science and Management at the Poznan University of Technology. He holds a PhD and DSc in Mechanical Engineering from the Poznan University of Technology. His research interests include manufacturing systems, production planning and logistics. He is a member of ISIR. His e-mail address is <marek.fertsch@put.poznan.pl>.

PAWEL PAWLEWSKI works as an Assistant Professor at the Department of Computing and Management, Poznan University of Technology. He holds a PhD in Mechanical Engineering, specialization “organization of production systems” from the Poznan University of Technology. His research interests include organization of manufacturing systems, monitoring of operations management, reengineering and IT application for logistics His e-mail address is <pawel.pawlewski@put.poznan.pl>.