# SIMULATION OF PRODUCT LOGISTIC, INVESTIGATION OF FACILITY LAYOUT CAPABILITIES

M. Kršulja, G. Cukor and Z. Car

Faculty of Engineering, Vukovarska 58, 51000 Rijeka, Croatia

**Keywords: S**imulation, Optimization, Machining, Production planning, Production line design, Job shop

**Abstract.** In this study an investigation of material flow through a specific manufacturing environment will be conducted. Production logistic for selected material depends on the layout of processing machines in the job shop and the product path. Sophisticated control of productivity, costs, equipment utilization, product path, production times, production capacity etc. is achievable with adequate data monitoring and understanding of all relevant data. Simulation will enable detection of the most influential parameters and obtained results will be used as a guide for production scheduling and a more scientific decision making. Method strategy specific for given production will be created and an improvement of overall performance is expected in current plant production. Comparisons of several layouts and their performance will be analyzed in order to satisfy management demands and validate investments. A model of optimum resource load in order to achieve desired output will be monitored and further improved. The simulations will be conducted with software Tecnomatix Plant Simulation 9. The experiment data was conducted in middle sized plant that produces chairs, tables and other furniture.

### Introduction

In order to lead a successful production enterprise complex technical systems have to be planed and their efficiency monitored. One of methods for control of production planning is factory simulation. Simulations are executed in order to control and monitor several trends of process optimization such as product life cycle, maintaining demands for quality and lot sizes, increase of flexibility in order to increase product complexity and variety [1, 2]. Such trends can help in increasing the competitive pressure and can offer different solutions when considering new products or lowering production costs.

Methods for the planning of manufacturing systems are regularly conducted in order to test different industrial scenarios by implementing innovative procedures when planning the layout of manual and automated work cells. Virtual simulations are characterized by the dynamic positioning of not only work cells but also of product path and thus shortening of product life cycle, with focus on sophisticated control that provides high accuracies in final product dimension and processing times.

Sophisticated control is possible to be achieved with understanding of all relevant data. The magnitude of data requires knowledge of all processes and adequate tool for data monitoring. Quality management of material flow and work cell organization can be achieved with software Tecnomatix Plant Simulation [3-8].

The plant produces different products some of them geometrically similar. Different technologies are strategically positioned in order to achieve maximum production flexibility and cycle times for variety of products. In order to keep quality management of production changes in product paths or incorporation of new work cells layout remodeling is necessary [7-9]. In this paper such a remodeling is presented and alternative solutions with different optimization advantages given. Based on management policy several parameters are given as the final goal such as shortening of production times, greater product quality, safety requirements, financial budget, new work cells etc.

In this study a model of actual factory layout and production process will be presented and a new robust model will be designed on its basis. The new model will incorporate several improvements that will be expected to offer better results, and therefore several models will be tested the aim is to reach transferable findings for the real production process. The best results will be analyzed and based on their result implemented in the final model. In Table 1 production parts needed for single chair (Fig. 1) construction, necessary operations are Op.10 cutting, Op. 20 Polishing, Op. 30 Bending, Op. 40 Punching, Op. 50 bending, Op. 60 injection moulding, Op. 70 welding per 8 hours. Final operations include painting, assembly, control and packaging.

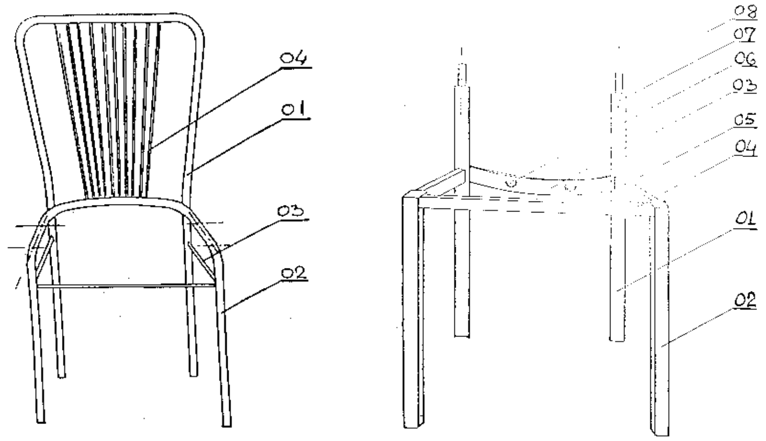


Fig. 1 chair 1 and chair 2

Table 1. Production parts for chair 1, 100 pieces in 8 hours

| Nr. Piec. | Name | Material | Kg | Pos. |
|---|---|---|---|---|
| 10 | Back of chair | Ø5x490 | 0.076 | 04 |
| 1 | Leg holder | Ø6x1062 | 0.236 | 03 |
| 1 | Front legs | Ø20x1.2 x 1948 | 1.112 | 02 |
| 1 | Back legs | Ø20x1.2 x 2250 | 1.380 | 01 |
| 4 | Chair taps | Polyethylene | 0.006 | / |
| 1 | Chair cushion | Wood | / | / |

Table 2. Production parts of chair 2, 250 pieces in 8 hours

| Nr. Piec. | Name | Material | Kg | Pos. |
|---|---|---|---|---|
| 2 | M8 screw | | | 07/08 |
| 4 | Ear seat carrier | Steel strip 20x25 | 0.014 | 06 |
| 2 | Side seat carrier | Ø 25x10x1.4x360 | 0.281 | 05 |
| 1 | Front seat carrier | Ø 25x10x1.4x380 | 0.299 | 04 |
| 1 | Back seat carrier | Ø 25x10x1.4x334 | 0.257 | 03 |
| 2 | Front leg | Ø 25x25x1.4x435 | 0.508 | 02 |
| 2 | Back leg | Ø 25x25x1.4x610 | 0.712 | 01 |
| 1 | Chair taps | Polyethylene | 0.006 | / |
| 1 | Chair cushion | Wood | / | / |

Final assembly for metal construction is done with $CO_2$ welding, total 100 pieces are produced in 8 hours, after operation of painting procedure, 100 chair cushions and 400 chair taps are assembled to make the final product of chair 1 and packed for shipment. For chair 2 (Table 2) 250 pieces are produced in 8 hours, after operation of painting 250 chair cushions and 1000 chair taps are assembled to make the final product.

**Simulation approach**

Factor layout (Fig. 2 and 3) has been integrated into Em-plant software and divided into manufacturing and assembly cells. Factory consists of 18 main cells: 1. Warehouse of incoming material, 2. Warehouse of finished products, 3. Assembly line 1, 4. A line for electrostatic painting, 5. Additional warehouse for raw materials, 6. Warehouse of tubes, 7. Cell with cutting machines, 8. Assembly line 2, 9. Warehouse for tooling, 10. Cell with bending machines, 11. Cell with welding machines, 12. Cell with milling and lathe machines, 13. Warehouse for plastic parts 1, 14. Cell with machines for plastic blowing, 15 Cell with machines for inject moulding, 16. Warehouse for plastic parts 2, 17. Warehouse for plastic material, 18. Cell for tool maintenance.

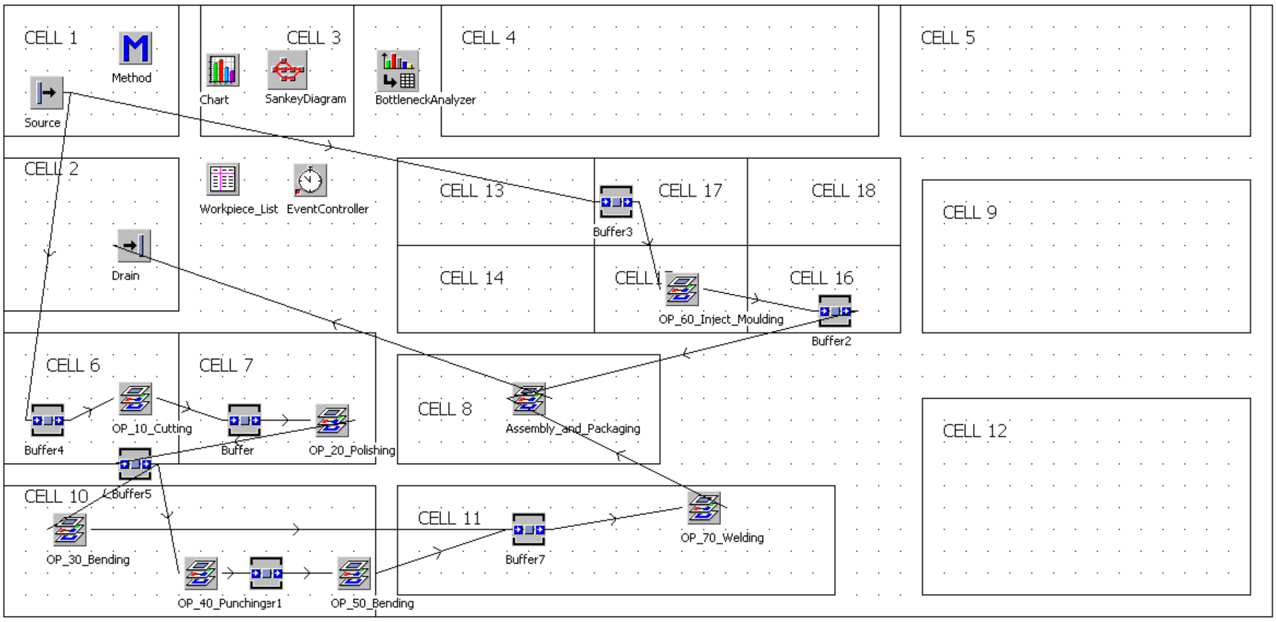


Fig. 2 Layout of factory job shop

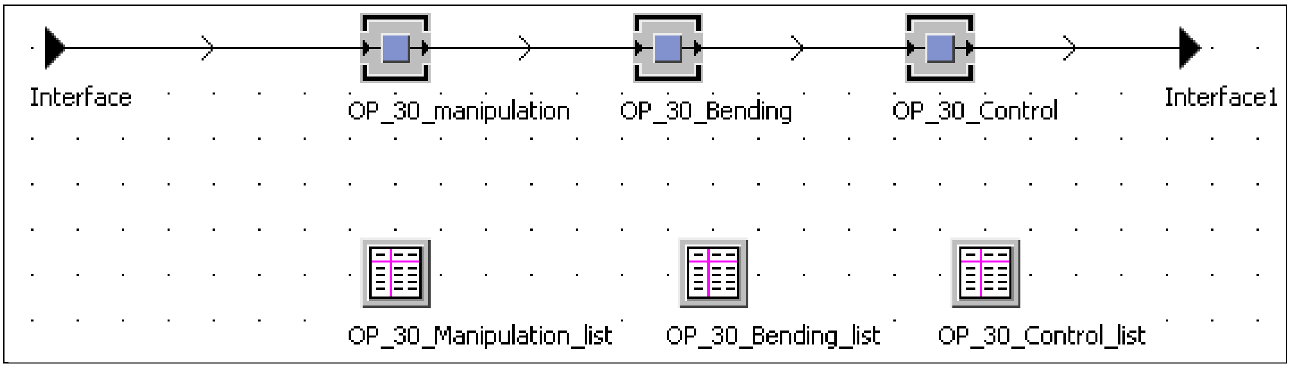


Fig. 3 Input into processing

Input into processing was done on the account of operation times for workpiece manipulation times, bending times and control time for specific workpiece as shown in Fig. 3. Times can be inserted by table data but for our simulation times received from factory were used. The plant simulation was done for two products chair 1 and 2 and for 8 hours of production. The bottlenecks were detected and with buffers and activation of additional free machines the optimal product flow was determined. Control times were inserted and quality management was implemented. Buffers were inserted mostly between cells and their optimal workpiece holders and quantity sizes were determined.

**Conclusion**

In this paper a model of factory layout has been modeled. A simulation of chair production has been shown. Critical parts necessary for product flow addressed. The capabilities and weakness of factory layout were analyzed. The resulting model can be used for various purposes such as production planning with varying amounts of material, production planning with different order of operations, changes in operations time, adding and moving machinery used in production, changes in distribution of machinery, manpower needed for control, calculation of production costs with various parameters, etc. The layout is now prepared for bigger production loads and simulations of all factory production for quarter and yearly basis but also for insertion of small production runs. Several new machines will be inserted into specific cells and tested in order to improve and widen the production process. In future research more complicated product flow will be addressed and for possibilities of new technological cells insertion or modification of existing ones will be analyzed. The output capabilities of used machines will also be integrated in simulation in order to predict error possibilities, breakage and maintenance stops.

**Acknowledgements**

The authors would like to acknowledge the support provided by the Fundation of University of Rijeka, National CEEPUS Office of Croatia and National CEEPUS Office Czech Republic, which helped the research through mobility in the frame of the CEEPUS II HR 0108 project.

**References**

[1] Car, Zlatan; Barišić, Branimir; Kršulja, Marko: Simulation and Modelling of Paths Processing Time in a Flexible Manufacturing System. *Výrobné inžinierstvo*. VIII (2009), 3; 40-45.
[2] Maričić, Sven; Car, Zlatan; Ueda, Kanji: New Trends in Intelligent Manufacturing. *Engineering review*, 28 (2008), 2; 91-100.
[3] Car, Zlatan; Hatono, Itsuo; Ueda, Kanji: Reconfiguration of Manufacturing Systems Based on Virtual BMS. *CIRP Journal of Manufacturing Systems*. 33 (2004), 1; 15-24.
[4] Adar A. Kalir, Subhash C. Sarin: A Method For Reducing Inter-Departure Time Variability in Serial Production Lines, *Int. J. Production Economics*, 120 (2009) 340–347.
[5] Ari-Pekka Hameri: Production Flow analysis Cases From Manufacturing and Service Industry, *Int. J. Production Economics,* 129 (2011) 233 - 241.
[6] Nima Safaei, Reza Tavakkoli-Moghaddam: Integrated Multi-Period Cell Formation and Subcontracting Production Planning in Dynamic Cellular Manufacturing Systems, *Int. J. Production Economics,* 120 (2009) 301- 314.
[7] Stankovic, I.; Car, Z; Barišić, B.: Comparative Simulation of Heavy Machinning Production System, Engineering Review, 31-1 (2011), 1-11.
[8] R. Lenort et al.: Analysis and Identification of Floating Capacity Bottlenecks in Metallurgical Production, ISSN 0543-5846 METABK 46 (1) 61-66 (2007).
[9] Sladić, Saša; Car, Zlatan; Barišić, Branimir.: Evolutionary Based Production Planning, Proceedings of 9th International Scientific Conference "Automation in Production Planning and Manufacturing", Zilina, 2008. 252-258