

PAPER • OPEN ACCESS

Improvement of productivity in low volume production industry layout by using witness simulation software

To cite this article: V Jaffrey *et al* 2017 *IOP Conf. Ser.: Mater. Sci. Eng.* **257** 012030

View the [article online](#) for updates and enhancements.

Related content

- [Assembly Line Efficiency Improvement by Using WITNESS Simulation Software](#)
A S H M Yasir and N M Z N Mohamed
- [Improvement of Productivity in TIG Welding Plant by Equipment Design in Orbit](#)
C Gnanavel, R Saravanan, M Chandrasekaran *et al.*
- [Healthcare system simulation using Witness](#)
Masoud Khakdaman, Milad Zeinavazi, Bahareh Zohoori *et al.*

Improvement of productivity in low volume production industry layout by using witness simulation software

V Jaffrey*, N M Z N Mohamed and A N M Rose

Faculty of Mechanical Engineering, Universiti Malaysia Pahang,
26600 Pekan, Pahang, Malaysia.

*Corresponding author: veyolla@gmail.com

Abstract. In almost all manufacturing industry, increased productivity and better efficiency of the production line are the most important goals. Most factories especially small scale factory has less awareness of manufacturing system optimization and lack of knowledge about it and uses the traditional way of management. Problems that are commonly identified in the factory are a high idle time of labour and also small production. This study is done in a Small and Medium Enterprises (SME) low volume production company. Data collection and problems affecting productivity and efficiency are identified. In this study, Witness simulation software is being used to simulate the layout and the output is focusing on the improvement of layout in terms of productivity and efficiency. In this study, the layout is rearranged by reducing the travel time from a workstation to another workstation. Then, the improved layout is modelled and the machine and labour statistic of both, original and improved layout is taken. Productivity and efficiency are calculated for both layout and then being compared.

1. Introduction

In a competitive market nowadays, the survival of any industry greatly depends on response time, production costs and flexibility in manufacturing. Food processing industry is a subset of manufacturing with unique challenges [1, 2]. A manufacturing company should have the efficient production system to accomplish the operation. The system should consist of people, equipment, and procedure designed for the combination of materials and processes that steer the company's operations [3]. The number of workstations makes the most of a strong impact on the performance of the manufacturing system in terms of production capacity, productivity, cost per unit, and maintainability. The amount of work that a system could accomplish will increase with the rise in the number of the workstation. It will cause the complexity of the system and thus cause the system hard to manage and sustain. The layout of the plants is an essential factor in determining the most appropriate material handling system. The layout is improved by minimizing the inventory of products and consequently enhances the total production [4]. The layout of a facility determines the structure and material flows of a production system, and thereby influences its operational performance over the long term [5].

Productivity is as the application of the numerous resources or inputs of an organization, industry or country, to achieve certain planned and desired results or outputs. In other words, productivity more broadly means production rate per unit of input, especially per unit of labour, for goods or services [6]. Productivity improvement as a process to achieves higher levels of output while consuming same or lesser amount of input resources, and can be defines as ratio of product being produced to what is required to produce it [7]. Well-designed facilities will give effect on material handling in term of efficiency and productivity, decreased production cycle time and resource transportation times [8, 9].



Witness simulation is an alternative to show how improvement will give advantages as it is made at the lowest cost and less disruption to the existing production operations [10, 11].

Witness simulation environment is the product of the British Lanner Group [12] and it is one of the most successful world-class environments in manufacturing simulation. Good plant layout will have less distance of material flow which will raise production [13] [14]. Through simulation, significant advantages over real life experimentation are provided in term of cost, time and repeatability when variability, disruption, and complexity exist. It is necessary to conduct facility and layout planning before any factory set up to ensure sustainable process and reduce losses [15-17].

2. Methodology

This study is conducted in a low volume industry in Malaysia, and for this research, data is collected by observing the layout, identify types and number of machines in the production line. The data collection also includes the number of employees, the layout of the production; the total time to produce the products. Time study is defined as a work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions, and for analysing the data so as to obtain the time necessary for carrying out the job at a defined level of performance [18].

Figure 1 shows the specific study area of the company to be studied and improved. The arrow represent on the process flow of the production line, as the focus of this study started from the filling and stamping line, and then the product is placed in an area labelled as buffer before sent to the expiry stamping line. The expiry date stamping line is the last workstation before it is placed in another buffer before packaging process.

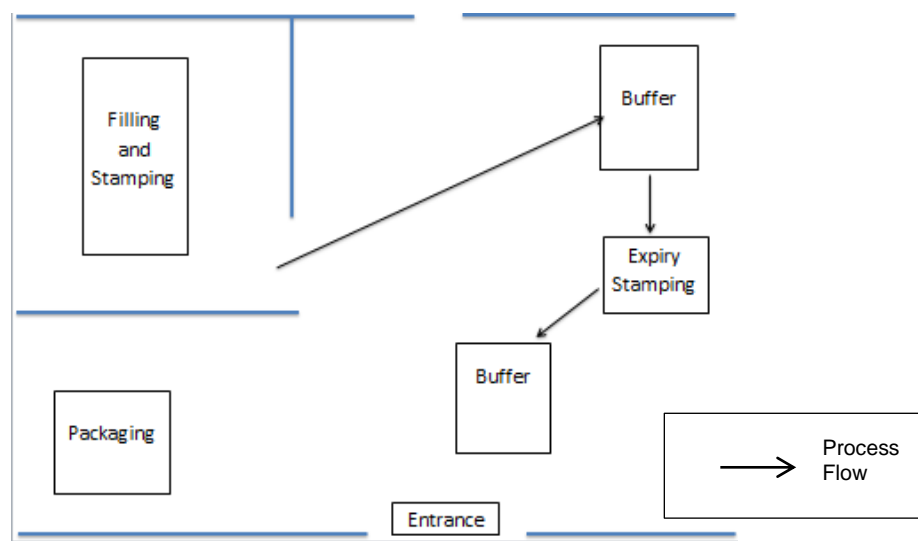


Figure 1. Study Area.

By using the data obtained from observation and through interview session with workers, the layout is designed by using Witness software and simulation is done to obtain the estimation of performance [19]. The efficiency and productivity are obtained by using the simulation result, which are from the machine statistic, labour statistic, and the output.

By using trial and error method, the efficiency and productivity of machine and labour of the existing layout are compared with the improved layout. The results are being analysed by referring to the previous study related to layout improvement. The new layout is being proposed when the result shows improvement in efficiency and productivity [17, 20]. The first step in building model is by observing the real layout, identifying how the real system works and the interaction among various components. It is critical to understand the manufacturing processes before attempting to mimic them by using simulation. The salient processes were studied separately in depth and understanding the

process operational characteristic, timings, and products flow before developing models. The crucial part is on the problems while building the model.

Figure 2 below shows the existing layout that been modelled by using the simulation software, Witness. The study area is modelled, which consist of filling and stamping machine, buffer, and expiry date printing machine. Workers are assigned to the workstation, where three labours are assigned on filling and stamping line, while, at the expiry date printing line, two labours are assigned.

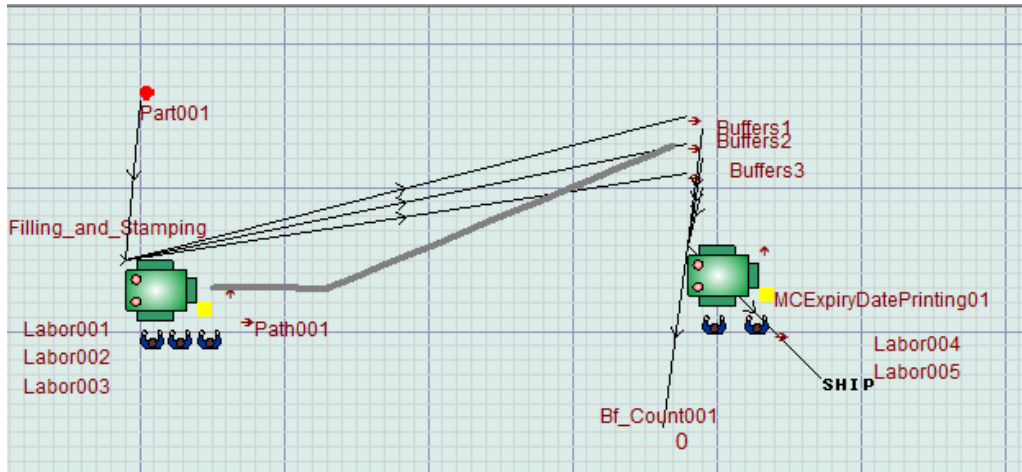


Figure 2. Layout modeled using Witness Software.

3. Results and Discussion

This study area selection is based on the problems identified through the observation. The person in charge and workers are also being interviewed to collect regarding the line to determine error. The problem detected in the layout is the high idle time of workers at the expiry date printing line, which causes the production to be lower than the target. Based on the simulation using Witness software, the idle and busy percentage of machine of the layout can be identified. To obtain an improved layout, try and error method had been applied. By reducing the distance, the time used to transfer the product can be reduced thus reducing the cycle time [21-23].

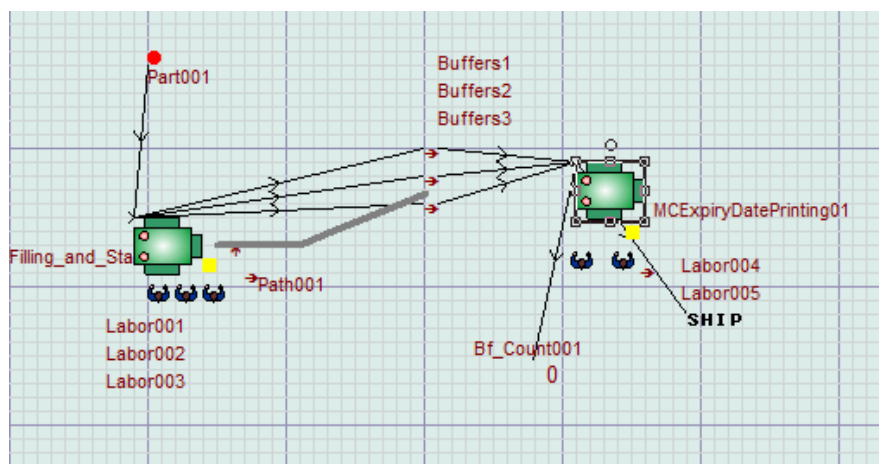


Figure 3. Improved layout modeled by using Witness Software.

Figure 3 shows the improved layout where the buffers are rearranged in order to decrease the distance from the filling and stamping workstation. Table 1 below shows the percentage of idle and busy of machines, filling and stamping machine and expiry date printing machine which are obtained from the original and improved layout. Based on the calculated percentage of improvement, it shows slight changes in the idle rate, as it reduced 2.84 on the filling and stamping machine that is from

14.4% to 12.00%. Meanwhile, for the idle percentage of the expiry date printing machine, the percentage of idle reduces from 47.61% to 46.53% which show a reduction of 1.08%. When the idle percentage decrease, busy time increase. For the filling and stamping machine, the busy percentage increases from 85.16% to 88.00%, while for expiry date printing machine, the busy percentage increases 1.98%, which is from 52.39% to 53.47%.

Table 1. Comparisons on machine utilization of original and improved layout.

Parameters		Original Layout		Improved Layout		Improvement	
		Filling & Stamping Machine	Expiry date printing machine	Filling & stamping machine	Expiry date printing machine	Filling & stamping machine	Expiry date printing machine
Machine utilization	Idle (%)	14.84	47.61	12.00	46.53	-2.84	-1.08
	Busy (%)	85.16	52.39	88.00	53.47	2.84	1.98

The busy percentage shows changes when the distance from the filling and stamping machine to the buffer are reduced. This will give effects on the transfer time and thus reducing cycle time. Since the scope of this study is limited to no cost addition, it still shows that the layout still have the chance to improve.

Table 2 below shows the improvement in labour efficiency and has been mentioned earlier, the efficiency of labour is calculated based on the busy time of labour. For labours that are assigned in the filling and stamping machine, the efficiency increases 2.80%, which is from 85.16% to 88.00%.

Table 2. Improvement of the labour efficiency.

	(Busy Time) Efficiency (%)		Percentage of Efficiency Change (%)
	Original Layout	Improved Layout	
Labour 1	85.16	88.00	2.84
Labour 2	85.16	88.00	2.84
Labour 3	85.16	88.00	2.84
Labour 4	52.39	53.47	1.08
Labour 5	52.39	53.47	1.08
Total Efficiency Change			1.07

For labour 4 and 5 who are placed in the expiry date printing line, their efficiency increases from 52.39% to 53.47%, which gives changes of 1.08% improvement. The overall change in the improved layout is 10.68% and the efficiency changes of the original and improved layout is presented in Figure 4 below. The increased in the percentage of efficiency affect the total production that lead to the increase in productivity. The increased efficiency is most probably caused by the reduced cycle time, which consequently reduced the idle percentage of labour.

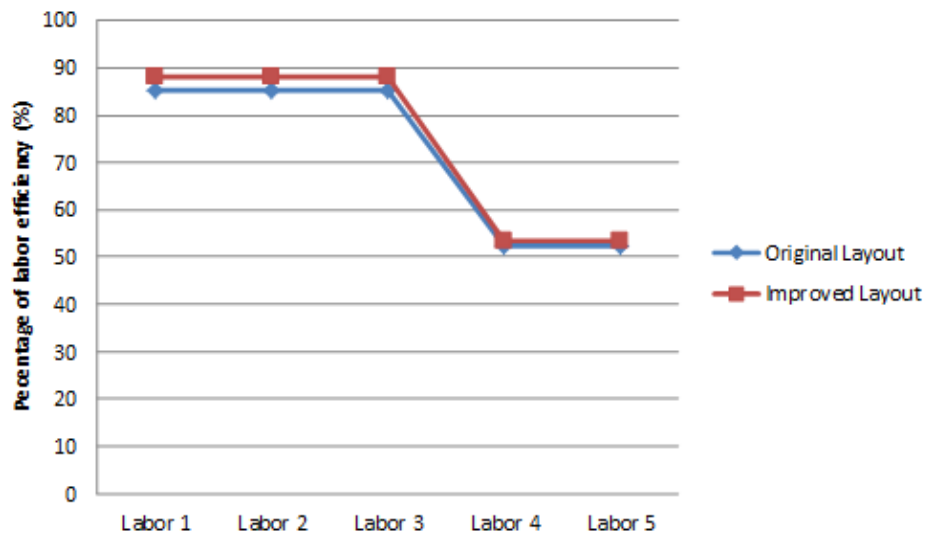


Figure 4. Efficiency changes of original and improved layout.

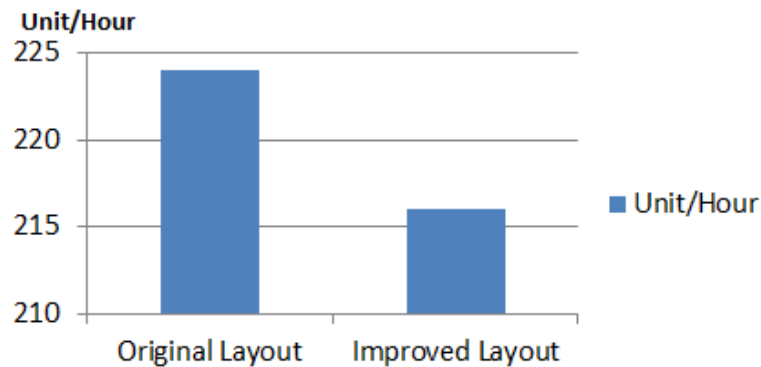


Figure 5. Productivity Comparisons of the Original Layout and the Improved Layout.

The original layout produces 216 units per hour, and after being improved, through simulation it can be seen that the productivity increases to 224 units per hour as shown in Figure 5. The study is limited to no cost addition, and it is recommended to the company to invest on addition of another expiry date printing machine so that efficiency and productivity can be increased. It is known that the printing machine will only able to print for one type of jelly drink flavour at one time as changing it frequently will take some times to change the code. Each box requires all flavour and thus, by having only one expiry date printing machine will cause the high idle time on the workstation. This will reduce the work in progress in the station. This recommendation is suggested for long-term consideration as adding machine requires a high cost.

Secondly, through evaluation using WITNESS software, there are high idle times in the expiry date printing machine, and it is recommended for the employees to be rotated to other stations to increase their efficiency [24, 25]. The company also should look into training their operators so they can perform work on other stations instead of hiring new labours.

4. Conclusions

A new layout has been designated by rearranging the layout, which is by moving the buffer closer to the filling and stamping machine. By simulating the layout by using the software, the efficiency of the machine is increased, productivity is also increased. The result obtained shows improvement, which is a reduction of 2.84% and 1.08% on idle time of the filling and stamping machine and expiry date printing machine respectively. Labour efficiency increase and this is done by reducing the distance between machines. Total of 10.68% changes in labour efficiency is calculated. Last but not least, in

term of productivity, the original layout produces 216 units per hour while the newly improved layout could produce 224 units per hour. The knowledge of manufacturing system can be used to improve the system of a factory to get a better performance and consequently increase productivity and reduces waste to get more profit.

References

- [1] Wanniarachchi, W.N.C., R.A.R.C. Gopura, and H.K.G. Punchihewa, Development of a Layout Model Suitable for the Food Processing Industry. *Journal of Industrial Engineering*, 2016: p. 8.
- [2] ElMaraghy, H., et al., A model for assessing the layout structural complexity of manufacturing systems. *Journal of Manufacturing Systems*, 2014. **33(1)**: p. 51-64.
- [3] K., N.M.Z.N.M.a.M., Decomposition Of Manufacturing Processes: A Review. *International Journal of Automotive and Mechanical Engineering (IJAME)*, 2012: p. 545-560.
- [4] Seyed Ali Mirzapourrezaei, K.Y.W., Ahmad Dargi, Morteza Lalmazloumian, Simulation of a Manufacturing Assembly Line Based on WITNESS, in *Computational Intelligence, Communication Systems and Networks, International Conference*. 2011. p. 132-137.
- [5] Bock, S. and K. Hoberg, Detailed layout planning for irregularly-shaped machines with transportation path design. *European Journal of Operational Research*, 2007. **177(2)**: p. 693-718.
- [6] Mitchell, P. Productivity in Mining. 2014; Available from: <http://www.ey.com>.
- [7] Helvoigt, T.L., An Analysis of Technical Efficiency and Productivity Growth in the Pacific Northwest Sawmill Industry. 2006, Oregon State University.
- [8] SUBY, R.J., Facility Layout and Location—An Analytical Approach. By R. L. Francis and J. A. White. . **Vol. 13**. 1975.
- [9] Gnanavel, S.S., V. Balasubramanian, and T.T. Narendran, Suzhal – An Alternative Layout to Improve Productivity and Worker Well-being in Labor Demanded Lean Environment. *Procedia Manufacturing*, 2015. **3**: p. 574-580.
- [10] O’Kane, J.F., J.R. Spenceley, and R. Taylor, Simulation as an essential tool for advanced manufacturing technology problems. *Journal of Materials Processing Technology*, 2000. **107(1–3)**: p. 412-424.
- [11] Pam Laney Markt, M.H.M. Witness Simulation Software A Flexible Suite Of Simulation Tools. in Proceedings of the 1997 Winter Simulation Conference. 1997.
- [12] Waller, A. WITNESS SIMULATION SOFTWARE in Proceedings of the 2012 *Winter Simulation Conference* 2012.
- [13] Azadivar, F. and J. Wang, Facility layout optimization using simulation and genetic algorithms. *International Journal of Production Research*, 2000. **38(17)**: p. 4369-4383.
- [14] Anucha Watanapa, P.K., Patcharee Duangpitakwong , and Wisitsree Wiyaratn Analysis Plant Layout Design for Effective Production in *Proceedings of the International MultiConference of Engineers and Computer Scientists*. 2011. Hong Kong: IMECS.
- [15] Ojaghi, Y., et al., Production Layout Optimization for Small and Medium Scale Food Industry. *Procedia CIRP*, 2015. **26**: p. 247-251.
- [16] BRONISLAV CHRAMCOV, P.V., Use of computer simulation with the aim of achieving more efficient production in manufacturing systems.
- [17] K.Hemanand, D.A., S.Chidambara Raja,G.Sundararaja, Improving Productivity Of Manufacturing Division Using Lean Concepts And Development Of Material Gravity Feeder –A Case Study. *International Journal of Lean Thinking*, 2012. **3(2)**.
- [18] Kanawaty, G., Introduction to Work Study. 1992.
- [19] Chramcov, B., The Optimization of Production System Using Simulation Optimization Tools in Witness. *International Journal Of Mathematics And Computers In Simulation*, 2013. **7(2)**.
- [20] Helber, S., et al., A hierarchical facility layout planning approach for large and complex hospitals. *Flexible Services and Manufacturing Journal*, 2016. **28(1)**: p. 5-29.
- [21] Amit, N., et al. Using simulation to solve facility layout for food industry at XYZ Company. in 2012 *IEEE Symposium on Humanities, Science and Engineering Research, SHUSER* 2012. 2012. Kuala Lumpur.

- [22] Hiten Patel, S.C.S., Review on Cycle Time Reduction in Manufacturing Industries. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 2014. **1(7)**: p. 955-956.
- [23] Ali Naqvi, S.A., et al., Productivity improvement of a manufacturing facility using systematic layout planning. *Cogent Engineering*, 2016. **3(1)**: p. 1207296.
- [24] Tidke, A.J., Designing Facilities Layout for Small and Medium Enterprises. *International Journal of Engineering Research and General Science.*, 2013.
- [25] F.G.Miller, T.S.D., and L.J. Mogas, Job Rotation Raises Productivity. *Industrial Engineering*, 1973. **5(6)**: p. 24-29