Proceedings of the 2019 Winter Simulation Conference
N. Mustafee, K.-H.G. Bae, S. Lazarova-Molnar, M. Rabe, C. Szabo, P. Haas, and Y.-J. Son, eds

USING MODELING AND SIMULATION TO EVALUATE RECONFIGURABILITY OF AUTOMOTIVE ASSEMBLY LINES

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ABSTRACT

To address the issues of increasingly short life cycle of products, rapidly changing markets and customer needs, several manufacturing companies are attempting to develop and change their production lines. To this end, reconfigurable manufacturing systems (RMSs) have emerged as systems that can adjust to rapid changes in relevant hardware, software, and system structure with products' own productivity. Evaluation of reconfigurability is important to determine the optimal alternative in terms of productivity and flexibility prior to changes in production or assembly lines in RMS. This paper proposes a methodology to evaluate reconfigurability using modeling and simulation (M&S) for automotive assembly lines in South Korea.

1 INTRODUCTION

Nowadays, most manufacturing companies, especially automotive companies, are interested in the rapid reconfiguration of their production lines to stay ahead of the rapidly changing market as per the needs of various customers (Koren et al. 2018). This is because changing the composition of the production facilities and lines ensures a shorter life cycle of the product and can respond quickly to changing demand. As factory modification design requires considerable effort and capital, the evaluation of the reconfiguration of the production system becomes significant (Koren et al. 2018; Koren et al 1999). This study proposes a methodology to evaluate the reconfiguration of assembly lines through M&S in the design phase of the automotive assembly line.

2 RECONFIGURABLE MANUFACTURING AND ASSEMBLY SYSTEMS

The reconfigurable manufacturing system (RMS) is a new type of manufacturing system that has been designed to respond flexibly to changes in its hardware, software, and systems and to focus on enabling rapid and cost-effective adjustment in fluctuating markets. This system also allows the upgradable production capacity or functionality as compared with other manufacturing systems (Koren et al 1999; Marco et al. 2018). The primary purposes of this system are adjusting production system flexibly, keeping high productivity, and reducing the cost of a product's life cycle (Koren 2006). RMS aims at gathering the chief advantages of traditional manufacturing systems combining flexibility with high throughput.

The reconfigurable manufacturing line (RML) is one of the manufacturing lines applied with an RMS. This kind of production line contains reconfigurable machines, facilities and equipment. It allows changing the configuration of production lines in response to product and model change. As a method of evaluating the reconfigurability of automotive assembly lines, a system framework using an RMS and RML is suggested in this paper.

3 RECONFIGURABILITY EVALUATION USING MODELING AND SIMULATION

The key factors of evaluation of RML are smoothness in reconfiguration, the responsiveness of the assembly line, production capacity, demand satisfaction and lifecycle cost of the product (Youssef et al. 2006). Space utilization was also defined as another key factor in this case.

Figure 1 shows the proposed framework for reconfigurability evaluation using M&S based on the above defined key factors. With this framework, reconfigurability factors of the reconfigurable line can be evaluated before the line configuration or modification, and decision-makers can make decisions with less uncertainty.

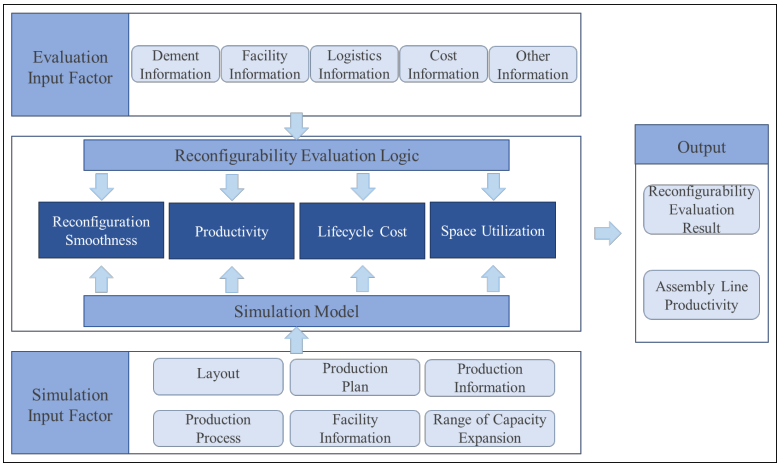

Figure 1: Reconfigurability evaluation framework

4 CASE STUDY

For implementation, a reconfigurable door-trim assembly line as an RM, which was a testbed developed by an automotive module manufacturer in Iksan, South Korea was compared with existing dedicated manufacturing line (DML). Both DML and RML can produce four products each. Comparing simulation and evaluation results of DML and RML, the throughput of DML was 11% higher than RML. However, the operation rate and space utilization of RML were 20% and 40% higher than DML. To sum up, the comprehensive evaluation factor of RML was 40% better than DML. These results explain that RML has better responsiveness, productivity and lower lifecycle costs.

ACKNOWLEDGEMENT

This work was supported by the IT R&D Program of MOTIE/KEIT (10052972), and the Virtual Engineering Platform Construction grant of the Korea Evaluation Institute of Industrial Technology (KEIT) funded by the Ministry of Trade, Industry and Energy (N0002601).

REFERENCES

Koren, Yoram, Xi Gu, and Weihong Guo. 2018. “Reconfigurable manufacturing systems: Principles, design, and future trends”. *Frontiers of Mechanical Engineering* 13.2: 121-136.

Koren, Y., Heisel, U., Jovane, F., Moriwaki, T., Pritschow, G., Ulsoy, G. and Van Brussel, H. 1999. “Reconfigurable manufacturing systems”. *CIRP annals*, 48(2): 527-540.

Youssef, Ayman MA, and Hoda A. ElMaraghy. 2006. “Assessment of manufacturing systems reconfiguration smoothness”. *The International Journal of Advanced Manufacturing Technology*, 30.1-2: 174-193.

Marco Bortolini, Francesco Gabriele Galiza and Cristina Mora. 2018. “*Reconfigurable manufacturing systems: Literature review and research trend. Journal of Manufacturing Systems* 49: 93-106.

Koren, Yoram. 2006. “General RMS characteristics. Comparison with dedicated and flexible systems”. In *Reconfigurable manufacturing systems and transformable factories,* 27-45. Berlin, Heidelberg: Springer.