The assembly line feeding problem: classification and literature review

Nico André Schmid
Ghent University, Department Business Informatics and Operations Management
e-mail: nico.schmid@ugent.be

Veronique Limère
Ghent University, Department Business Informatics and Operations Management
e-mail: veronique.limere@ugent.be

In recent years some trends in several product assembly systems emerged, namely mass-customization [Boysen et al., 2007], integration of new product functionalities [Göpfert et al., 2016] and increase in the number of models (e.g. BMW, a German car manufacturer, increased the average number of models offered per year to 37.85 in the period between 2010 and 2016, compared to only 22.3 in the period between 2000 and 2010). These trends have a significant impact on assembly systems since all of them lead to an increasing number of parts required for the final assembly, either by increasing the number of parts required at the border of line (BOL) in general (for new functionalities or new models) or by increasing the number of part variants (mass-customization).

Within the assembly line feeding problem (ALFP), the optimal way of supplying assembly stations with parts is examined by assigning different feeding policies to parts. This is mostly based on cost minimizing considerations. The most prevalent line feeding policies are *line stocking*, *kanban*, *sequencing* and *kitting* [Limere et al., 2015, Sali and Sahin, 2016]. Line stocking and kanban both provide parts in homogeneous filled load carriers. Applying line stocking, a full load carrier (as supplied by the supplier) is provided to the BOL, whereas applying kanban means providing smaller quantities by splitting load carriers into bins. In sequencing and kitting, parts are prepared in the order of demand. In case of sequencing, a container holds variants of one particular component, whereas in case of kitting, different components are grouped and load carriers are filled heterogeneously.

The focus of this research is on reviewing literature about the actual ALFP, namely on the assignment of line feeding policies to parts, as well as about related subproblems like e.g. the optimization of milkrun transports within assembly systems. This problem is highly complex due to different decision levels, processes, variable parameters and constraints. In order to help structuring previous and future work, we provide a classification with a three tuple notation as firstly introduced by Graham et al. for machine scheduling [Graham et al., 1979]. Significant decisions and subproblems, occuring in different processes within the ALFP, are classified. This problem includes only in-house logistics and can hence be delimited from external logistics or SCM. Research in this field is becoming more and more attractive to researchers, which can be seen by the rising number of publications. Research is mainly initiated in 1992 [Bozer and McGinnis, 1992] and round about 100 papers are analyzed in this review.

The main contribution of this work is twofold. First, we do not only summarize previous research topics but also indicate open research fields, which hopefully motivates researchers to fill the research gaps. Secondly, this work provides, through the classification, a comprehensive framework for researchers to easily identify decisions and subproblems of the ALFP, which can be included in future work.

References

[Boysen et al., 2007] Boysen, N., Fliedner, M., and Scholl, A. (2007). A classification of assembly line balancing problems. *European Journal of Operational Research*, 183(2):674–693.

[Bozer and McGinnis, 1992] Bozer, Y. A. and McGinnis L. F. (1992). Kitting versus line stocking: A conceptual framework and a descriptive model. *International Journal of Production Economics*, 28(1):1–19.

[Göpfert et al., 2016] Göpfert, I., Grünert, M. and Schmid N. A. (2016). Logistiknetze der Zunkunft - Das neue Hersteller-Zulieferer-Verhältnis in der Automobilindustrie, in: Logistik der Zukunft - Logistics of the future. 7. Auflage:175–217.

[Graham et al., 1979] Graham, R. L., Lawler, E. L., Lenstra, J. K. and Rinnoy Kan A. H. G. (1979). Optimization and approximation in deterministic sequencing and scheduling: a survey. *Annals of Discrete Mathematics*, 5:287–326.

[Limere et al., 2015] Limere, V., van Landeghem, H., and Goetschalckx, M. and McGinnis L. F. (2015). A decision model for kitting and line stocking with variable operator walking distances. *Assembly Automation*, 35(1):47–56.

[Sali and Sahin, 2016] Sali, M. and Sahin E. (2016). Line feeding optimization for just in time assembly lines: An application to the automotive industry. *International Journal of Production Economics*, 174:54–67.