A decision model for kitting

Veronique Limère

Supervisor: Prof. Dr. Ir. H. Van Landeghem

***Abstract* _ This article gives an overview of the future research directions that will be explored during my PhD. The subject of this research will be parts kitting, or the practice of putting together a collection of components and/or subassemblies that support a certain assembly operation before delivery to the shop floor.**

***Keywords* _ production and assembly operations, design of parts kitting systems, performance measurement**

I. Introduction

Nowadays, customers put a lot of pressure on the market to get timely delivery and low prices. In addition, more and more variation in the assortment is demanded and custom-made products are often requested. This trend leads to an increased amount of parts moving around on the shop floor.

To cope well with these tendencies in the market, manufacturers need to have good control over their operations and look for improvements where possible. In this viewpoint, kitting was introduced as a counterpart of line stocking. Whereas in line stocking parts are supplied to the line in bulk by means of individual component containers, in kitting components are grouped together by assembly and supplied to the line in kit containers.

II. Definitions

Kitting is the practice of putting together a kit of components and/or subassemblies before delivery to the shop floor.

A *kit* is then a specific collection of components and/or subassemblies that together support one or more assembly operations for a given product or shop order (Bozer and McGinnis, 1992). The content of the kit is given by the *kit structure*.

Kit assembly is the process of putting all the contents of a kit in the right *kit container*.

There exist two types of kits that support assembly operations in a different way, namely stationary kits and traveling kits. *Stationary kits* are delivered to a workstation and stay there until they are emptied. *Traveling kits* on the other hand travel along with the product and are gradually depleted when supporting different workstations along the line.

These definitions already give a good view on how kitting works in a manufacturing environment. Besides, some of the advantages and limitations of kitting can be summed up.

V. Limère is a Ph.D. Student at the Department of Industrial Management, Ghent University (Ugent), Belgium. E-mail: Veronique.Limere@ugent.be .

III. Advantages and Limitations of Kitting

Kitting can be seen as an application of lean manufacturing in that it strives to eliminate waste. Some of the advantages are summed up below:

- A wide array of individual component containers is replaced by a limited amount of kit containers. This leads to:
  - Improved control over and better visibility of the flow of components on the shop floor. As a consequence part availability will also better.
  - Less work-in-process at the work stations, and consequently shorter lead times.
  - Savings in manufacturing space and a better organized shop floor.
  - Increased flexibility; product changeover can be easily accomplished.
- Parts are readily available at the workstation, sometimes pre-positioned or coming out of the kit in the correct order. This leads to:
  - Increased operator productivity because no time is lost looking for the right components.
  - Potential increase in product quality because errors are avoided or are caught in an early stage.
    This benefit of kitting can be fully exploited by simultaneously applying the concept of Poka Yoke. If in a kit container a fixed spot is reserved for each part, a kit will never be supplied to the line before every spot is filled up. This serves as an extra built-in check. On the other hand, the operator will also notice that something went wrong if he did not use all parts available in the kit.
- Increased standardization and a well-organized shop floor.
  - When kits are standardized, this offers an opportunity to implement robotic handling.
  - There will be less damage in the transportation process.
  - Learning curves for new personnel will be lower.
- Increased operator satisfaction thanks to all above-mentioned benefits, basically an improved organization and increased productivity.

To give an unbiased representation of the concept of kitting we are obliged to also treat some limitations.

- Some time and effort is needed for kit preparation. This is a non value adding activity.
- There will most probably be an increase in storage space requirements.
- When different kits contain common parts, an assignment of available parts to kits needs to be done.

- Temporary shortage of parts will decrease the overall efficiency of kitting.
- Defective parts in the supplied kits will lead to shortages at the workstations.

IV. Implementing Kitting

More than one practical issue comes to mind when deciding on how to implement kitting. Literature on kitting is until today rather limited, but in this section we will give a short overview of issues that have already been scrutinized.

A. Assignment

Chen and Wilhelm (1993, 1994, and 1997) and Chen (2003) already extensively studied the problem of allocating a limited amount of available components to different kits that are in demand of these components. They developed an optimal algorithm for the basic problem and compared two heuristics commonly used in the industry with a newly developed heuristic. In addition they added the assumptions of parts being substitutable and linked substitution to the problem. All of their models were developed to minimize total costs – including job earliness, job tardiness, and in-process holding costs.

B. Design of kitting systems and performance measurement

Bozer and McGinnis (1992) propose an evaluation model to compare kitting with line stocking and to compare different options of kitting with each other. The performance measures used are the following: the necessary storage and retrieval of component containers, the flow of component and kit containers, the shop floor space requirements, and the average work-in-process.

Brynzer and Johansson (1995) also discussed a number of case studies in order to get more insight in the design of kitting systems and the influence on its performance. Some issues discussed were the location of the kitting system, the work organization behind the kitting operation, the relevance of a batching policy for picking the kits, the need for zone picking and the type of picking information used.

C. Packaging

De Souza et al. (2008) propose a model for the assembly line feed problem. This model decides how to pack the necessary items in the available containers. The model strives to minimize holding costs and handling costs while considering among other things the availability of containers and the demand that must be met. The authors propose an integer programming model as well as an heuristic to solve the problem.

D. The influence of uncertainty on kitting

Choobineh and Mohebbi (2004) look at the positive effect of component sharing on kit availability, given that there is considerable uncertainty in the environment. The uncertainty can deal with variability in the procurement lead times of the components, or with the varying demand.

Som et al. (1994) and Ramachandran and Delen (2005) show some more theoretical derivations about the work-in-process and the output of kitting operations that are afflicted with uncertain inputs.

E. Routing

A lot of information about routing of containers can be found in the general literature on order picking.

V. Research Proposal

In practice, kitting is already found in a lot of production organizations. Nevertheless, considerable uncertainty still exists in the industry concerning costs and revenues of this supply method.

The purpose of this PhD research therefore will be to contain the advantages and disadvantages of kitting in some quantitative performance measures. Based on these performance measures we will strive to construct an optimization model that can serve as a basis for the industry for making decisions when thinking over several options to supply an assembly line.

The possibility to integrate kitting with other relevant production issues is also under consideration. Ideas that come to mind are the integration of kitting with line balancing or kitting with production scheduling. When we consider the whole in-plant logistic system, kitting also influences (or is influenced by) the storage system, the transportation system and the operator workload. There exist today no research papers that cover this holistically.

VI. Conclusion

This research still is in its infancy. The following steps will have to be taken to proceed. First of all we need to look at the current practices in the industry and get a clear feeling of the needs that exist. Another important step will be the determination of relevant performance measures. Finally industry data will be used to support the study. Some of the companies that are prepared to cooperate are Volvo Trucks and Ford Genk.

References

[1] Bozer Y.A., McGinnis L.F., 1992. *Kitting versus line stocking.* International Journal of Production Economics, 28, 1-19.

[2] Brynzer H., Johansson M.I., 1995. *Design and performance of kitting and order picking systems.* International Journal of Production Economics, 41, 115-125.

[3] Chen J.F. and Wilhelm W.E., 1993. *An evaluation of heuristics for allocating components to kits in small-lot, multi-echelon assembly systems.* . International Journal of Production Research, Vol. 31, No. 12, 2835-2856.

[4] Chen J.F. and Wilhelm W.E., 1994. *Optimizing the allocation of components to kits in small-lot, multi-echelon assembly systems.* Naval Research Logistics, 41, 229-256.

[5] Chen J.F. and Wilhelm W.E., 1997. *Kitting in multi-echelon, multi-product assembly systems with parts substitutable.* International Journal of Production Research, Vol. 35, No. 10, 2871-2897.

[6] Chen J.F., 2003. *Component allocation in multi-echelon assembly systems with linked substitutes.* Computers and Industrial Engineering, 45, 43-60.

[7] Choobineh F. and Mohebbi E., 2004. *Material planning for production kits under uncertainty.* Production Planning & Control, Vol. 15, No. 1, 63-70.

[8] De Souza M.C., de Carvalho C.R.V., and Brizon W.B., 2008. *Packing items to feed assembly lines.* European Journal of Operational Reseasrch, 184, 480-489.

[9] Ramachandran S. and Delen D., 2005. *Performance analysis of a kitting process in stochastic assembly systems.* Computers & Operations Research, 32, 449-463.

[10] Som P., Wilhelm W.E., and Disney R.L., 1994. *Kitting process in a stochastic assembly system.* Queueing Systems, 17, 471-490.