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ScienceDirect
Int. J. Production Economics 111 (2008) 741–751
international journal of production economics
www.elsevier.com/locate/ijpe

Lot sizing in reverse MRP for scheduling disassembly

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Received 25 January 2006; accepted 27 March 2007
Available online 1 May 2007

Abstract

Gupta and Taleb (1994. Scheduling disassembly. International Journal of Production Research, **32**(8), 1857–1866) presented an algorithm for reverse MRP that can be applied to a product structure in which there is a certain demand for components and a need to know the number of products to disassemble in order to fulfil the demand for those components. However, that algorithm did not consider lot sizing at all. Incorporating lot sizing makes the problem a great deal more challenging in disassembly situations because of the disparity between the number of components present in the product and the demand of the components. This is because the demand for the components is often not in the same proportion as their existence in the product structure causing excess inventories for the components with low demand compared to their brother items. In this paper we present an algorithm for reverse MRP to facilitate the use of lot sizing. An example is presented and its implementation is analysed.
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Keywords: Reverse logistics; MRP; Lot sizing

1. Introduction

MRP (materials requirements planning) is a well established and a widely used production planning procedure. However, MRP is an assembly oriented scheduling system, which cannot be applied to shop floor operations for disassembly scheduling (DS). Panisset (1988) also pointed out that "most MRP logic (and the supporting bill of materials) do not provide facilities to plan disassembly". However, partial disassembly and reassembly for maintaining and repairing complex products have been practiced for a long time. Often, discarded products are disassembled for parts and materials for repairing and remanufacturing products (Lambert and Gupta, 2005). The procedure to accomplish DS is known as reverse materials requirements planning (RMRP), since the procedure is basically a reversed form of the regular MRP (Gupta and Taleb, 1994).

There is an interesting difference between the calculations for a regular MRP tableau and reversing it. A very important characteristic of regular MRP is that it is used for assembly and there is a single source of demand located at the end item (root). One of the problems that arises in reversing MRP is that we can have multiple sources of demands, viz., the components or the leaf items in the disassembly product structure. Besides, these

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0925-5273/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2007.03.017

leaf items are not independent since they all have to be fulfilled by the same root item from which they originate (Gupta and Taleb, 1994). This condition adds a layer of complexity to the calculations as it produces excess inventories for the components with a relatively low demand compared to their brother items (Gupta and Taleb, 1994). This happens because often, the demand for the components is not in the same proportion as the proportion in which they are present in the disassembly product structure.

While several researchers have made use of RMRP (see, for example Inderfurth and Langella, 2006; Kim et al., 2006; Lee and Xirouchakis, 2004), no one has addressed the concept of lot sizing in connection with DS. In this paper, we present an algorithm for RMRP to facilitate the use of lot sizing.

This paper is organized as follows. A brief literature review is provided in Section 2. The proposed algorithm is described in Section 3. An example is also included to illustrate the implementation of the algorithm. Section 4 provides a preliminary experimentation to demonstrate that the use of lot sizing actually reduces the planning costs in reverse systems. Then in Section 5, a simulation study was carried out to test the performances of several lot-sizing rules. The conclusions are presented in Section 6.

2. Brief literature review

As was mentioned before, Gupta and Taleb (1994) proposed an algorithm for scheduling the disassembly of discrete and well-defined product. Since then several other research articles have appeared on planning and scheduling for disassembly. For example, Lambert (1997), Pnueli and Zussman (1997) and Moore et al. (2001) conducted research on disassembly planning. Taleb et al. (1997) and Taleb and Gupta (1997) considered the DS problem for complex product structures with parts and materials commonality, which were extensions of their earlier work reported in Gupta and Taleb (1994). Guide et al. (1997) developed scheduling policies for remanufacturing and Perry (1991) studied the impact of lot sizing in a remanufacturing environment. Neuendorf et al. (2001) considered the application of Petri nets to this problem. Lee et al. (2002, 2004), Lee and Xirouchakis (2004) and Kim et al. (2003) proposed integer programming models to determine the disassembly schedules of used products in order to satisfy the demand of their parts over a planning horizon, considering various situations involving costs and capacity. Brander and Forsberg (2005) developed a lot-scheduling heuristic for disassembly processes with sequence-dependent set-ups. Inderfurth and Langella (2006) address the disassemble-to-order problem, where the yields of disassembly are stochastic, by using heuristic techniques. Kim et al. (2006) suggested a two-phase heuristic for DS for multiple product types with parts commonality to minimize the sum of set-up, disassembly operation and inventory-holding costs using an algorithm incorporating linear and dynamic programming.

Several authors have reported disassembly operations in connection with various practical situations. For example, Gungor and Gupta (2002) considered the disassembly of a personal computer to recover its parts. Torres et al. (2004) described the process of obtaining a non-destructive automatic disassembly system for personal computers. Pan and Zeid (2001) considered several examples of disassembling products such as a lamp, a car, a window fan, and a two-stroke engine. Kuo et al. (2000) presented a graph-based heuristic approach to perform disassembly analysis for electromechanical products. Udomsawat and Gupta (2005) proposed a multi-kanban mechanism for appliance disassembly. Gupta et al. (2004) addressed the disassembly sequencing problem for a cell phone on a disassembly line and Kizilkaya and Gupta (2006) used a dynamic kanban system to disassemble an industrial voice recognition client unit.

For more information on disassembly, see the overview papers by Brennan et al. (1994), Gupta and McLean (1996), Moyer and Gupta (1997), Gungor and Gupta (1999), Tang et al. (2002), Lee et al. (2001) and Lambert (2003). A recent book by Lambert and Gupta (2005) is also helpful in understanding the general area of disassembly.

To the best of the authors' knowledge, no one has addressed the concept of lot sizing in connection with DS (RMRP). In this paper, we present an algorithm for reverse MRP to facilitate the use of lot sizing.

3. Description of the procedure

As mentioned earlier, the purpose of this paper is to present a methodology to include lot sizing in RMRP. Lot sizing is as important in disassembly as in assembly because it not only brings structure to

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