Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 26 (2015) 270 – 275

www.elsevier.com/locate/procedia

12th Global Conference on Sustainable Manufacturing

Toward Pull Remanufacturing: a Case Study on Material and Information Flow Uncertainties at a German Engine Remanufacturer

Jelena Kurilova-Palisaitiene*and Erik Sundin

Division of Manufacturing Engineering, Department of Management and Engineering, Linköping University, Linköping 581 83, Sweden

** Corresponding author. Tel.: +46 13 282714; fax: +46 13 282798. E-mail address: jelena.kurilova@liu.se*

Abstract

Together with reuse and material recycling, remanufacturing has emerged as a sustainable approach for used products. Remanufacturing is more complex than manufacturing, due to the uncertainties in material and information flows inside the remanufacturing facility and along the product life-cycle. Therefore, some remanufacturers intend to use lean production principles and philosophies to deal with this complexity and to improve their operations.

The aim of this paper is to identify reasons for possible material and information flow uncertainties and develop lean-inspired solution at a German engine remanufacturer. The empirical data were collected via a Material and Information Flow Analysis workshop. The reasons for missing, late, defective and non-available spare parts as well as disrupted, uneven, chaotic and inaccessible information flows are identified. Finally, a lean pull Kanban reordering system is suggested and recognized to be a proper solution to remanufacturing complexity.

Peer-review under responsibility of Assembly Technology and Factory Management/Technische Universität Berlin.

Keywords: Remanufacturing; Product life-cycle; Lean; Pull; Kanban

1. Introduction

Together with reuse and recycling, remanufacturing has emerged as a sustainable approach to prolong the life of used and worn-out products. Whilst being the most environment-friendly and profitable product recovery option, remanufacturing often consists of several steps, e.g. inspection, cleaning, disassembly, testing, reprocessing and reassembly [1, 2].

According to recent research, remanufacturers struggle to deliver quick and efficient end-of-life solutions and perform below their potential. The remanufacturing process is typically more complex than manufacturing, due to the uncertainties in material and information flows inside the facility and through the whole product life-cycle [3]. Lean production management strategy, inspired by the Toyota Production System (TPS), proved to be successful in solving operational challenges in process, people, product, profit and performance improvement [4, 5].

A great potential for applying lean production principles and philosophies (Lean) to remanufacturing has been noted by several researchers and can be further read about in Kurilova-Palisaitiene and Sundin [6]. According to Sundin [2], lean production concepts are beneficial for remanufacturing since they enable *lowering the inventory* and *work in process* (WIP) *levels* and *improving material movements, product flow and use of space.* The findings of Fargher [7], Jacobs et al. [8], Östlin and Ekholm [9], Hunter and Black [10] and Kucher [11] show that Lean helps remanufacturers to decrease lead time and costs, increase productivity, enhance quality, make a continuous flow and create value in every process. Therefore, some remanufacturers intend to use Lean to improve their operations and reduce uncertainty in material and information flows.

Peer-review under responsibility of Assembly Technology and Factory Management/Technische Universität Berlin.
doi:10.1016/j.procir.2014.07.187

2. Aim

The aim of this paper is to identify the reasons for possible material and information uncertainties and develop lean-inspired solution at a German engine remanufacturer.

3. Data collection method

Data were collected via a Minimum time for Material and Information Flows analysis (MiniMifa) workshop at a German engine remanufacturer. The MiniMifa workshop is designed to discover remanufacturing challenges and improvement opportunities expressed by MiniMifa participants - company's employees, involved in daily remanufacturing operations [12].

During the MiniMifa workshop, 5 to 6 participants develop a remanufacturing process map on a large piece of paper using simple tools, like pencils and post-it notes, similar to the Value Stream Mapping (VSM) method (see Fig. 1) [13]. One remanufactured product is selected and the path it moves on is studied, from one involved actor (department/function) to another and from one process step to the next. In line with following the material/product (cores, spare parts) flow, the information on that particular product's routes is studied. By following material and information flows along the remanufacturing process and beyond the factory borders, a complete picture of the remanufacturing process is constructed.

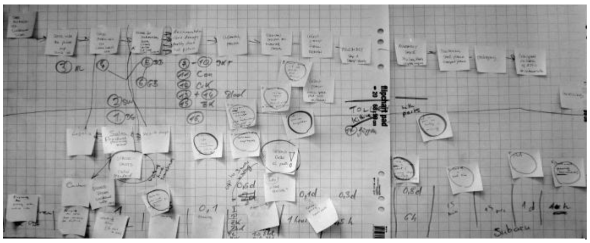

Fig. 1: Map of MiniMifa at the German engine remanufacturer.

The MiniMifa workshop delivers a map of the remanufacturing process with the main remanufacturing operations, organizations, functions and people involved in the process, and quantitative as well as time characteristics. Moreover, the challenges of current material and information flows with possible improvement initiatives are plotted directly on the map. This visual representation of the remanufacturing process is constructed via a dialog with remanufacturing employees working in different departments/functions.

The MiniMifa workshop implies an in-depth analysis of the material and information flows and the challenges that prohibit smooth and efficient circulation. After challenges are collected the improvements' initiatives are developed and prioritized. The ease of implementation and the degree of material and information flow improvements are two criteria that determine which Lean techniques will be applied to the German engine remanufacturer.

4. Company background

In the 1970s and 1980s there were no facilities to remanufacture cars in Germany; moreover, only expensive brand-new spare parts were available on the market. High spare part price implied a complex part acquisition process in Japan, as well as expensive logistics activities and time-consuming storage in German warehouses. The German engine remanufacturer studied used to acquire new spare parts at the same time as the new cars were ordered and transported to Europe. The additional price for spare parts covered the logistics, storage for 3 to 10 years and other additional costs until the spare parts were sold.

Remanufacturing has now solved this problem. Today, selling remanufactured spare parts is profitable. At the same time, remanufacturing fulfils the needs of environment-friendly customers as well as their need for paying a lower price for their car service. In comparison with the new part at 100% cost, the remanufactured part only costs 55% to 65% of that. The same quality is assured through the same warranty conditions. Hence, it makes less sense for end customers to buy a brand new part. Therefore, today's remanufacturing facilities keep expanding. Simultaneously, competition with brand new spare parts is increasing in some markets. However, when the serial production of brand new parts stops, remanufacturers take over an available market since the remanufactured parts replace new parts.

5. Remanufacturing process

The German engine remanufacturer studied is a contracted remanufacturer with the Original Equipment Manufacturer (OEM) for 100 parts at a time. The remanufacturing contract (reman-contract) conditions imply no investments in core acquisition and pre-determined amounts of core demand and supply, while the OEM is a supplier of spare parts [14, 15]). The forecasted monthly demand is for 40 remanufactured engines. The OEM places an order to remanufacture an engine when the final customer wants to replace a broken or worn-out one. However, the supply-demand balance is threatened when the returned engines are not possible to remanufacture. The challenges in core quantity, quality and timing [2] are not relevant to the studied company due to the reman-contract condition. However, the challenges of spare part acquisition disturb the remanufacturing business by causing irregular and unpredictable flows of material and information in the remanufacturing facility and the whole product life-cycle.

When the collected core arrives at the warehouse the sales or product planning team informs the warehouse manager, who gives the command to start remanufacturing. A typical engine remanufacturing process is depicted in Fig. 2.

From the warehouse, the cores are processed for dismantling, where the quality is checked, pictures are taken of the defects, and the damages are documented. There, the core is disassembled into four master parts. Each of the parts follows its own route through cleaning and remanufacturing until they meet at the assembly of the short block. Finally, the spare parts are joined with the short block in a second