Chapter 7
Cell Design for Transforming the Job Shop Production Process to Lean

Vladimír Modrák
Technical University of Košice, Slovakia

Pavol Semančo
Technical University of Košice, Slovakia

ABSTRACT

The transformation of production process from batch to flow can be seen as an effective way to optimize material flows in job shop manufacturing environments. This transformation can be successfully adopted only under certain specific conditions, since product layout, typical for one-piece flow production, is not always a better option than the process layout. Accordingly, decision-making rules and principles for this concern are presented in the chapter. Subsequently, a case study on these issues is offered in which methodical procedures for transformation of manufacturing of small to medium-sized lots with aim to reach one-piece flow production are described in detail.

INTRODUCTION

Planning of logistic activities in customer-oriented production environment is currently based on two main methods, Material Requirement Planning (MRP) and Material Resource Planning (MRP II). Even when these tools are used in a systems that supply materials to production facilities in a manner "just what is needed, just where it is needed, in just the right amount that is needed, exactly when it is needed" it is still a system based on classical hierarchical production planning and therefore is only partially suited to production planning in the case of uncertain demand (Zapfel, 1996). That kind of planning-oriented production system, which works on the basis of forecast leads to creation of planned orders. The factory push their outputs to retailers, retailers are returning what they cannot sell and returned products ends up as a dead inventory. The concept of so-called one-piece production (OPF) differs radically from mentioned systems. By contrast, such manufacturing system makes products based on the needs of the assembly processes which are

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driven by customer requirements and just-in-time (JIT) delivery schedules. Many benefits obtained through implementation of OPF production systems were reported in the existing literatures. Chief among them are: keeps the work in progress (WIP) at the lowest level, encourages work balance and better quality and promotes a host of internal improvements (Quintana, 2002; and Stockton, 2005). Although many one-piece flow production systems have been successfully applied in various industries, the number of research works on the creation of OPF production system is rather low. According to Li and Rong (2009) the production line design problem deals with finding the most effective physical arrangement of facilities, personnel and any resources required to facilitate the production of required products, in a manner that is timely, reliable and cost effective.

The problem we present here is the application of one-piece concept by applying the principles of Product/Quantity (P-Q) analysis and Production Flow Analysis (PFA) in transforming the job shop production process to lean. The case study was carried out in Slovakian company, which manufactures bicycle components and is focused on a problem of transformation from batch production to lean production.

RESEARCH BACKGROUND

The subject of material flow optimisation comes under production flow management or logistics management, which includes all aspects of every movement of raw materials, WIP and finished goods within a plant or warehouse (Lambert et al., 1998). Material flows are flows of physical goods, e.g. of transport units, vehicles or load units. Different from the continuous flow of bulk material moving on a conveyor is discrete material flow of single process units (Gudehus and Kotzab, 2009). In JIT production systems, the focus of attention for scheduling is deployed at the final assembly lines. The reason is because it is primarily important to complete units on schedule and produce at a constant level rate so that all operations supporting final assembly are synchronized (Hall, 1988).

An ideal target type of micro logistic chain is a synchronous material flow, where the structural and process issues are fully adapted to flexible reactions to any change in their environment. The material flow is balanced, smooth, without keeping a stock (with the exception of a minimal backup stock). Synchronous material flow design, then, can be defined as a systematic process that determines how to combine, integrate and synchronize material handling systems, manufacturing processes and information systems with the proper facilities layout. Such an operational strategy is also called Cellular Manufacturing that incorporates lean principles, but adds flexibility to the process. Most writers describe the U-shaped production line as the optimal type of cellular manufacturing used in JIT production systems. The U-line workstations can include tasks located on different parts of the production line (Gokcen et al., 2005).

Among the most important as well as the most complex tasks in logistics management pertains planning and scheduling working activities for the wide set of parts to be processed by a flexible manufacturing plant. One of suitable methods for increasing production flexibility and productivity is cell redesign for the transforming the production process with the aim to change planning-centered production on one-piece production. One piece flow originally came from Henry Ford's operations in the United States as it is mentioned by most sources; see for example (Miltenburg, 2001). Sekine (1992) first examines the basic principles of process flow building and offers detailed case studies of how various industries designed unique one-piece flow systems (parallel, L-shaped, and U-shaped floor plans) to meet their particular needs. The basic conditions for establishing one-piece flow systems are: