

Chapter 5

Lean Manufacturing System Design Based on Computer Simulation: Case Study for Manufacturing of Automotive Engine Control Units

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ABSTRACT

This chapter outlines the possibilities afforded by computer simulation for the design of a lean manufacturing system. The possibilities of making use of simulation are presented in the form of the case simulation study that was performed within the framework of cooperative ventures between the workplace and an industrial partner. A production line in the Continental Automotive Systems Czech Republic company was developed with the use of the Witness simulation environment in order to maximize production efficiency as well as to eliminate waste and production losses already in the system design phase. The main task was to build up a model of the prepared lean manufacture system and, especially, to propose a number of variants for the spatial location of operators in a production line. On the basis of the pre-defined requirements of the user, several simulation experiments are suggested.

INTRODUCTION

Computer simulation is an essential component of every large-scale production process. It is also an auxiliary tool for the design of lean manufacturing systems. One of the forms of computer simula-

tion is the so-called Discrete Event Simulation (DES). DES is the modelling process of systems in which the state variable only gauges a discrete set of points in time. The simulation models are analyzed with the use of numerical methods rather than analytical ones. DES is an extremely valuable

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technique for investigating the behaviour of many business processes ranging from manufacturing layouts to the operation of modern contact centers. With a discrete event simulation model, it is possible to conduct experiments which show the ranges of current and projected outcomes without the need for costly pilot schemes that disrupt the current process.

The aim of this chapter is to outline the possibilities afforded by computer simulation for the design of the lean manufacturing system. The possibilities of making use of simulation are presented in the form of the simulation case study that was performed within the framework of cooperative ventures between our workplace and the industrial partner. A production line in the Continental Automotive Systems Czech Republic company was developed with the use of the Witness simulation environment in order to maximize production efficiency as well as to eliminate waste and production losses already in the system design phase. The installation and getting it up and subsequent running of this production line was prepared for one of its customers. It was intended for the mass-production manufacturing of electronic control units of diesel fuel-injection units. The arrangement scheme for the design of this production line is circular – or, to be more exact, ellipsoidal. The finished product leaves the production line at the same place where it enters it. The production line represents a certain complex in which there are logically arranged individual machines. Machines carry out the assembly process of the product. The individual working operations are linked with each other in a logical manner, upon completion of each individual sub-operation the product progresses to the next workplace where another subsidiary part of the assembly process takes place. This approach thereby creates a certain logical flow of the product in a circular arrangement between the individual workstations and machines in the assembly production line. The individual operators employed in the production line only work in a

pre-determined section of the production line (a finite number of machines).

The main task was to build up a model of the prepared lean manufacture system and, especially, to propose a number of variants for the spatial location of operators in a production line. On the basis of the predefined requirements of the user, several simulation experiments are suggested. Then, a description of the proposed simulation experiments and evaluation of achieved results is presented. These simulation experiments identify further alternatives relating to the allocation of production line operators with regard to the expansion of production capacity itself and the more effective allocation of working duties among the individual operators themselves. At the same time, it is possible to determine the borderline capacity limits of the production line and to determine its bottlenecks which prevent further reductions in the tempo and thereby increase its throughput.

PROBLEM BACKGROUND

Lean Manufacturing is a concept of manufacturing system and philosophy that was originally developed by Toyota and is now used by many manufacturers throughout the world. The term Lean is very apt because in Lean Manufacturing the emphasis is to cut out the “fat” or waste in the manufacturing process. Waste is defined as anything that does not add value to the customer. It could also be defined as anything for which the customer is unwilling to pay (Apply, 2000). Lean typically identifies seven types of waste: overproduction, unnecessary inventory, excess motion, waiting of operators, transportation, over-processing-inappropriate processing, non-right the first time – defects. To eliminate waste, it is important to understand exactly what waste is and where it occurs. Womack and Jones (2003) give the best explanation of Lean. Lean thinking can dramatically boost productivity – from doubling to quadrupling it, depending on the activity—while

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