Chapter 9
Teaching Circular Economy and Lean Management in a Learning Factory

Angel M. Gento
https://orcid.org/0000-0002-8741-5780
Universidad de Valladolid, Spain

Carina Pimentel
Universidade de Aveiro, Portugal

Jose A. Pascual
Universidad de Valladolid, Spain

ABSTRACT

Traditionally, industries followed a linear process of resources consumption: taking raw materials from nature, transforming them into products, and selling them to consumers (who discarded them when they were no longer useful). Nowadays, due to the sustainable development concerns, there is an increasing awareness on the society for reuse, repair, recycling, and remanufacturing to avoid resource depletion and achieve waste reduction. Following this idea, with the aim to train students and practitioners in lean manufacturing and circular economy concepts and tools, a learning process organized in three sequential phases was developed, starting with the manufacture of a toy car (25 kg and over 100 pieces) using a traditional push system, then reengineering the process to implement pull system and lean manufacturing concepts, and finally, considering a circular economy pull system through the reuse and recycling of parts and components. In this way, the importance of reducing waste in manufacturing and the reduction in the use of raw materials by considering the 3Rs is highlighted.

DOI: 10.4018/978-1-7998-8816-1.ch009

INTRODUCTION

The rapid and continuous changes that are taking place in the business world, due to the Volatile, Uncertain, Complex and Ambiguous (VUCA) environment currently in place in the world demands learning throughout life, becoming essential not only to learn, but to learn how to learn. Thus, the development and maintenance of learning systems becomes a requirement. Furthermore, the emergence of new teaching approaches, putting emphasis on learning by doing and experiential learning, led to the increased use of learning factories, as a mean to simulate authentic factory environments. Although this topic is not new, it gained major importance in academia and industry in the last decade (Abele et al. 2015).

It is in this context that a collaboration between the University of Valladolid and the car manufacturer Renault started, aimed to develop a learning factory for students and workers to learn lean manufacturing concepts and how to apply them in different situations similar to those found in factories (Gento et al., 2016).

But the training does not end there. Nowadays, the European Commission (2011) has identified several critical raw materials and, moreover, some of those materials are widely used in batteries and catalytic converters, and their consumption is expected to increase in the coming years. Therefore, recycling and reusing components and materials is fundamental in the automotive manufacturing industry and has gone from being an environmental consideration to a necessity to minimize manufacturing costs.

Therefore, the initial training in this learning factory has evolved to introduce the concept of circular economy into it, taking into account the awareness of society towards the development of a more sustainable world, and the European directives about end-of-life vehicles and recycling of batteries (European Union, 2000, 2005). In this context, Circular Economy offers resource efficient solutions to keep the planetary boundaries while still creating economic growth (Kirchherr et al., 2017).

Within production operations, lean manufacturing is currently the most successful operations management paradigm, implying high impact on the sustainability of operations. However, Circular Economy concepts are not so emphasized (Kurdve & Bellgran, 2021). Thus, it becomes important to raise the awareness of future engineers on this issue and equip them with the required knowledge.

The objectives of this chapter are threefold. Firstly, it aims to show the importance of the university-industry collaboration as a mean for learning and continuous improvement of engineering students. Secondly, it is intended to present a "learning by doing" approach, embedded in a Learning Factory. This approach combines Lean Manufacturing with Circular Economy concepts, incorporating different levels of difficulty, using e.g. different management tools, and different workers and students. Furthermore, to facilitate concepts assimilation, the "learning by doing" approach is focused not only on learning concepts but also on their incorporation into everyday tasks. Finally, this chapter aims to show how the introduction of the circular economy thinking in a production process helps to reduce waste and to make better use of resources, reducing costs and increasing the efficiency of the overall production process.

This chapter is structured into seven sections. After this introduction, section two summarizes the theoretical background. The third section explores the research methodology, while section four is dedicated to the presentation of the Lean School developed jointly by Renault and the University of Valladolid, while in section five the solutions and recommendations are explored. Then, in section six some future developments are discussed, followed by a conclusion presented in section seven.