

## Chapter 6

# Virtual Learning Environments for Manufacturing

**Hamed F. Manesh**

*Eastern Mediterranean University, Turkey*

**Dirk Schaefer**

*Georgia Institute of Technology, USA*

### ABSTRACT

*Since the advent of globalization, the manufacturing industry has been subject to continuous pressure of competition. Products have to be developed faster than before, with equivalent or higher quality, and at significantly lower cost. Whilst modern manufacturing systems provide the technological edge to meet these challenges, one tends to forget that education and training of the workforce also has to be kept up-to-date. Only a workforce that is familiar with the latest advancements in the manufacturing sector and well trained in the use of state-of-the-art technology and tools will be able to effectively face the competition. Although fundamental education and training may have been provided by the academic sector, employees need to continue developing their professional skills and competencies throughout their entire professional life. One potential approach to education and training of engineers in the manufacturing sector is the utilization of Virtual Learning Environments (VLEs). Such VLEs are currently widely used for fundamental engineering education in academia, but they also hold a huge potential for successful deployment in distributed corporate settings. Manufacturing-related VLEs may provide employees at all sites of a company across the globe with an affordable and safe environment for education and training, ranging from the fundamentals of modern manufacturing to expert level training in manufacturing process planning and simulation, without any need for, or cost of, physical equipment, materials, tools or travel. In this chapter the authors discuss how Virtual Learning Environments (VLEs) for manufacturing-related education and training can be utilized in the corporate sector.*

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## INTRODUCTION

In his bestselling book *The World is Flat* author Thomas L. Friedman (Friedman, 2006) points out that “*Globalization has collapsed time and distance and raised the notion that someone anywhere on earth can do your job, more cheaply*”. This certainly applies to the manufacturing industry, which is increasingly becoming a commodity. In recent years the manufacturing industry has been strongly impacted by globalization, which has resulted in increased global competition. This manufacturing competition has acted as a driving force for the application of new, related technologies in industry. In order to sustain their competitiveness, companies need to be able to adapt quickly to rapidly changing conditions of both the market and their competitors at reduced cost and at least equivalent or better quality.

While modern manufacturing systems may provide the technological means to face the above challenges, one also needs to bear in mind that the workforce which utilizes these systems has to keep up with the latest advances through education and training. Current students, i.e., the workforce of tomorrow, usually receive fundamental manufacturing-related education and basic training through engineering degree programs. For more senior employees this education and training often has to be acquired through participation in continuous professional development programs. What is missing today is an effective means to provide employees of manufacturing companies with continuous education and training opportunities on-the-job, within their corporations, and around the globe. An interesting question to explore with regard to manufacturing-related education and training is: “*Where are we now, and where are we heading?*”

While some universities may be able to expose their students to the latest manufacturing systems and technologies, others may not be that fortunate, due to lack of financial resources. For the latter, alternative avenues for providing their

students with equivalent education and training have to be developed. A potential response to this call is the adoption of advanced computer technology to facilitate the provision of flexible manufacturing-related education and training programs. To date many studies have shown that the use of computers for teaching and training purposes is feasible and rapidly becoming an integral part of the general learning process. It has also been confirmed that recent advances in information and communications technologies have positively influenced and changed the economics of engineering education (Hashemipour et al., 2009). These advances can be exploited as a powerful vehicle for educators to develop IT-enabled learning environments for manufacturing that utilize simulation, automated data acquisition, remote control of instruments, rapid data analysis, and video presentations. Computer applications related to simulating manufacturing processes have shaped a field which is currently known as Virtual Manufacturing (VM).

An additional Computer Science field that increasingly plays an important role in Virtual Manufacturing, as well as associated educational activities, is Virtual Reality (VR). VR environments are synthetic environments, which provide a sense of reality and an impression of ‘being there’. They have been increasingly employed in various design and manufacturing applications, including computer-aided design (CAD), telerobotics, assembly planning, and manufacturing system visualization and simulation. VR shows great potential for analyzing and investigating manufacturing processes prior to producing any physical artifacts. As a result, such environments help reduce operational expenses through reducing the number of physical prototypes and mistakes made. With regard to training the manufacturing work force, many studies have emphasized the potential of VR technology for education and training purposes. Empirical data has been collected on the relative success of VR in terms of instructional effectiveness, as well as the transfer of

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