# Chapter 27
# Technology-Enhanced Learning in Cyber-Physical Systems Embedding Modeling and Simulation

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## ABSTRACT

*Globalization in international research and development is changing the way universities need to educate and train students. As universities prepare their graduates for the needs of the 21st century and the global market economy, they face significant pressure to overhaul their well-established traditional curriculums and adapt the conventional delivery of course materials to new methodologies appropriate for the cooperative environment. Engineering Science is an emerging area with the potential to provide graduates with the skills needed to meet the challenges of complex designs of cyber-physical systems and shorten their time to market window. To ensure that university graduates are prepared to meet the challenges of a global market, the instructional methodology needs to be broadened. Such technology-enhanced learning is required to provide engineering students with the skills, tools, and training needed to verify and validate the details of complex cyber-physical systems designs and to understand the risk involved in development of inaccurate models. The results obtained from the accurate models can be analyzed to ensure the design of a cyber-physical system will be error-free and the system developed will perform according to the design specification and requirements.*

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## INTRODUCTION

As international corporations increasingly transcend national, regional, and continental boundaries, the demand for professionals who are sensitive to the existence of cross-cultural differences and whose education and training has prepared them to understand the needs of international businesses in the technical sector is increasing. This demand is creating new challenges for technology-enhanced learning. Hence, the goal is to stimulate educational excellence by scaling up technology-enhanced learning and developing a strategy for increasing the use of innovative learning technologies and methodologies while raising awareness about methods and technologies which are successful in the global perspective. To achieve this goal, the existing educational technology has to be assessed to determine the adequacy of its digital mode of education and training. Many educational and training institutions and business organizations have found that the conventional approaches used in continuing education and training do not achieve the intended objectives. The lack of motivation demonstrated by participants is also a significant problem. This is mainly because the course content does not always correlate with the needs or interests of the participants. Beyond that, the available knowledge doubles approximately every five years; and education and training solutions struggle to keep up with this pace.

Developing education and training solutions which can meet both corporate and individual needs is very challenging. They must be relevant to the participants' needs as well as keep pace with knowledge acquisition that requires learning objectives. This raises the question, "What do we want the outcome of university education and training to be; or more specifically, why are we teaching?" Is the objective to allow free thought in betterment of work lives, or is it for the manufacturing of high-tech devices for use in commercial and private environments? One answer is to educate and train a workforce that can look for answers in more experienced ways. This requires the workforce to be educated and trained to be leaders and/or entrepreneurs. Learning objectives are, for the most part, not directly measurable because they require open assessment to achieve them.

Creating one's own educational models requires an open curriculum with regard to learners' activities. In this context, digitization in learning can be seen not as an evolutionary change in learning but more of a new tool set with regard to advances in information and communications technology (ICT), the expansion of the Internet of Things, and the increase in ICT-based applications for education. The role of ICT in education has increased with regard to the ability to offer education and training based on individual needs independent of time and location. This has created a new method of transferring knowledge via online education and blended e-learning in all forms, especially in tailored learning solutions. However, with the increase in the worldwide utilization of e-learning in its blended and mobile forms, its design, development, implementation, and evaluation has been met with serious challenges. Normally, developing good courseware is not a complex task. However, the challenge of developing tailored, flexible e-learning solutions that incorporate blended and mobile methods, as illustrated by the following requirements, is challenging [Wittmann, J., & Möller, D.P.F., 2003]:

- **Requirement No. 1:** *Flexibility in adapting to the learner's background*
  - Course material should be designed such that it is adaptable to a range of learners coming from different educational backgrounds and professional experience. It should incorporate their terminology, organize and label data in the ways with which they are acquainted, and use examples based on their own experiences. In addition, simulation models can be used to