Chapter 19
Computer-Aided Engineering Education: New Learning Approaches and Technologies

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ABSTRACT

The paradigm shift in engineering education in response to the revolution of the knowledge society has created new challenges for education practitioners. The utilization of Information and Communication Technologies (ICT) to facilitate the teaching and learning in engineering has increasingly raised the interest of the education practitioners throughout the world. In this chapter, the authors discuss the trends and paradigm shift in engineering education followed by the importance and current usage of ICT to support the teaching and learning in engineering. Additionally, the new learning approaches and emerging technologies that have great potential to enhance the learning experience in engineering are recommended. Finally, the authors propose a conceptual framework for the creation of a computer-aided learning environment for engineering education, particularly mechanical engineering.

INTRODUCTION

In the era of knowledge driven society, changes occurs rapidly throughout the industries and the marketplace. Two main factors that drive the rapid change in the market environment and the society are the globalization and the revolution of Information and Communication Technologies (ICT). Knowledge has played an important role as a sustainable competitive factor for survival in the dynamic marketplace (Anantatmula & Kanungo, 2010; Beijerse, 1999; Bogdanowicz & Bailey, 2002; Chong et al., 2009; Havens & Knapp, 1999; Lin, 2011; Pauleen et al., 2004; Soosay & Hyland, 2008). As mentioned by Drucker (1993), the main challenge in the knowledge-based economy is how to make the information and knowledge productive enough to compete in this constantly changing environment. We are moving towards the era of post-industrial knowledge society where the future

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will be essentially determined by the ability to utilize knowledge for unique ideas, products and services that emphasize on innovation efforts for competitive advantage. In fact, the shift from material and labor intensive products and processes to knowledge intensive products and services are the unavoidable major trend in the knowledge driven economy (Duderstadt, 2008).

Concurrent with this trend, the demand for skills and competencies increases significantly (Morell et al., 2008). In addition, "nations are placing a high priority on developing their human capital" as the immediate response to the current trend of knowledge driven economy (Delgado-Almonte et al., 2010, p. 140). Furthermore, as identified by the World Bank, in Organization for Economic Co-operation and Development (OECD) countries, "the investment in the intangibles that make up the knowledge base – research and development (R&D), education, and computer software - is equaling or even exceeding the investment in physical equipment" (The World Bank, 2002, p. 8). There is no doubt that education in general and tertiary education in specific plays a critical and major role in the knowledge driven era. Specifically, tertiary education contributes to the growth of knowledge economy through the following four missions (OECD, 2008, p. 13):

- The formation of human capital (primarily through teaching).
- The building of knowledge bases (primarily through research and knowledge development).
- The dissemination and use of knowledge (primarily through interactions with knowledge users).
- The maintenance of knowledge (intergenerational storage and transmission of knowledge).

In contrast, when any countries lose their base in academic excellence, they will lose the competitiveness in the global knowledge society (Meek et al., 2009). Thus, the shift to a new paradigm of education that expects to foster the development of emerging knowledge economy and the broad knowledge society is a great challenge faced by the education practitioners globally. The next section discusses on the challenges of tertiary education in the context of engineering education.

BACKGROUND

Engineering education is regarded as one of the important educational domains in the tertiary education. As defined by Cheshier (1998), "engineering education for the professional focuses primarily on the conceptual and theoretical aspects of science and engineering aimed at preparing graduates for the practice of engineering closest to the research, development, and conceptual design functions" (p. 36). During the earliest days when the engineering education was introduced, it followed the apprenticeship form with an emphasis on hands-on practical education (ASEE, 1987; Michko, 2007). Later, engineering education was formalized into the academic studies and followed a general pattern of teaching and learning. Currently, engineering education is based on "a combination of theoretical, tutorial and experimental studies of the relevant subjects in the engineering curricula" (Saleh, 2010, p. 25). In general, engineering education involves two distinct learning environments which are the classroom teaching on theoretical knowledge for conceptual understanding and the laboratory sessions to obtain the practical knowledge (Balamuralithara & Woods, 2009).

However, till date, it can be identified that engineering education especially in developing countries (for example, Malaysia) still followed the traditional teaching and learning approach by which it emphasizes more on instructor-centered, one-way delivery mode and passive students' participations. This is considered as the traditional "chalk and talk" approach that has been