



14th Global Conference on Sustainable Manufacturing, GCSM 3-5 October 2016, Stellenbosch, South Africa

Incorporating Sustainability/Sustainable Development Concepts in Teaching Industrial Systems Design courses

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Abstract

Sustainability/sustainable development (S/SD) is considered as one of the major drivers of next industrial revolution as so called “Industry 4.0”. Incorporating the concepts of S/SD in teaching Engineering courses especially Industrial Systems Design courses is very highly appreciated through discussing, analyzing requirements and assessing the S/SD index for the manufacturing/productive plants. This incorporation was followed by designing process starting from analyzing the product design and architecture among designing the manufacturing system (either processing and/or assembly) and reconfiguration; economic justification and how to make the industrial systems more sustainable through S/SD assessment. The results show that incorporating S/SD concepts in teaching Industrial systems design courses is not difficult and the students are more willing to understanding the new concepts regarding S/SD although the course was offered in the last year (senior students).

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Peer-review under responsibility of the organizing committee of the 14th Global Conference on Sustainable Manufacturing

Keywords: Sustainability/sustainable development, Engineering education, Industrial systems

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1. Introduction

As the requirements and qualifications of future engineers will be the biggest challenge of using S/SD in engineering curricula and programs [1], incorporate the S/SD concepts, analysis and assessment in engineering education is important as one of the key elements. Although the S/SD faced challenges in terms of economic, social and environmental issues lead engineering programs/curriculum relied on math/science/technical skills additional to professional engineering skills such as: behavioral science, generic, a way of thinking and community engagement [2], teaching or learning S/SD concepts in early years in engineering school is highly recommended [3]. It is critical to improve the capacity of the people to address S/SD issues [4-5] as a general and foster to engineering students as a specific [1]. It needs two or three years' worth of academic and practical experience to understand these concepts. This leads to bad impression of students regarding S/SD which they may feel that it is not important as discussed or at least it is just a big show and easy material in media, newspapers, etc. by the way, it was one of the most recommendations suggested by universities forum to incorporate S/SD into all undergraduate engineering courses [6].

The global competitive economy leads to focus on concerns of quality in engineering education. Managing a culture and diversity, increasing the level of globalization in the world between people and push or drive the engineering education to be standardized in evaluation and assessed to improve the quality of education are highly appreciated. Most of the countries around the world try to adopt or develop standards as a guideline to benchmarking their educational organizations for continuous improvement and updating their educational systems.

There are two well-known international agencies which are used to evaluate the educational institutions: ABET and ENAEE. The ABET (Accreditation Board for Engineering and Technology) is an American system and the ENAEE (European Network for Accreditation of Engineering Education) is a European system. These two agencies are professional and non-profit organizations. They are working by volunteers' professors and academicians. Also, there are some agencies used in accreditation in their countries such as engineering council of Malaysia and Japan Accreditation Board of Engineering Education.

In the ABET system, there are eight criteria. student outcomes (ABET 3) is one served as the number three and it of the criteria used to assess what the students achieved in the course. This is a relationship between the student outcomes from learning industrial systems design courses and the program educational objectives (PEOs) of the industrial engineering program. There are two main (PEOs) must be achieved from industrial systems design course beside other courses in the program as follows according to industrial engineering (IE) program.

- PEO1: practice industrial engineering in industries, government sectors and service organizations both nationally and globally or pursue higher studies or business entrepreneurship.
- PEO2: apply knowledge and skills to design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.

The industrial engineering (IE) program at Sultan Qaboos University has been accredited by ABET twice before (2008 and 2013). The main objective of this paper is to introduce the concepts of sustainability/sustainable development in industrial systems design to reflect these concepts on designing manufacturing/production systems to achieve the two out of five student's outcomes (PEOs) in industrial engineering program. Industrial systems design course represents one of the major designing courses in IE program curriculum additional to facilities design and logistics and product design and manufacturing courses. The course syllabus is listed and after assessment of the student outcomes can be modified as a continuous improvement. For these comments and implications, the S/SD

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