Development of Courses in Mechatronics and Mechatronic System Design within the Mechanical Engineering Technology Program

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ABSTRACT

Based upon the feed-back from the industrial advisory board and needs of the local industry, the Engineering Technology Department in the Frank Batten College of Engineering & Technology at Old Dominion University has taken the initiative to develop an option within the existing Mechanical Engineering Technology program in the area of Mechatronics. Under this option, two new courses are being developed to meet the needs of local industry. For this purpose, an Introduction to Mechatronics course was developed and integrated into Mechanical Engineering Technology curriculum in the fall 2012 as a senior elective option choice. A second course, Mechatronics System Design is being planned as a follow-up course. In this paper, we present the motivation behind the development of these courses and the developmental effort that has gone in creating these senior electives for providing new competencies needed by industry and our future program graduates.

Keywords: mechatronics, curriculum development, core competencies.

1. INTRODUCTION

The Department of Engineering Technology in the Frank Batten College of Engineering and Technology at Old Dominion University currently offers four elective areas of specialization: manufacturing systems, mechanical systems design, nuclear systems and marine systems. Mechatronics System Design will be the fifth option offered to students coming from a variety of backgrounds including industry, military and traditional students. The Department of Engineering Technology already offers courses related to the field of mechatronics such as Automation and Controls, Robotics and Computer Integrated Manufacturing within the Mechanical Engineering Technology program and Microcontrollers within the Electrical and Computer Engineering Technology program. In addition, there are various other courses offered within the departments of Mechanical and Aerospace Engineering such as Intelligent Machine Systems: Technologies and Applications and at Department of Modelling, Simulation and Visualization Engineering such as Design and Modelling of Autonomous Robotics Systems.

Students in the Mechanical Engineering Technology program take common courses in areas like computer-aided drafting, statics, strength of materials, dynamics, thermodynamics, fluid mechanics, automation and controls, and computer solid modeling (ODU, 2012). Students complete their senior project in their final year of study, by applying knowledge from their previous courses on a practical problem through an emphasis on a problem based learning, guided by their advisor. The project topic is chosen to match their area interest. Students can work individually or as a part of a team. By doing this, they practice their teamwork and collaborative skills, technical writing, time management and their design and manufacturing abilities. Students have the option to select some of the various Engineering or Science Minors available at Old Dominion University for example, engineering management, motorsports, marine, or select major in some other departments in the college, e.g. Electrical Engineering Technology. Graduates from Mechanical Engineering Technology program are ready to work in application positions in a "mechanical product design, development

and manufacturing, mechanical system operation and maintenance, field operations, and various other technical functions" (ODU, 2012).

2. COMPATIBILITY WITH EXISISTING PROGRAMS AT OTHER UNIVERSITIES

Many universities across the nation (P.M.M.I., 2012; Meek et al., 2003; Purdue University, 2012; Tomizuka, 2002. Giurgiutiu et al., 2002; Ume & Timmerman, 1995) and worldwide (Lima et al., 2002; Akpinar, 2006; Grimheden et al., 2005; Zvonicek, 1982) are offering mechatronics courses. These courses are offered under various names i.e. programming, study about the graphical user interface (GUI), learning about embedded systems, microcontrollers, controls, sensors, electrical motors, encoders, pneumatic and hydraulic systems etc. (Flaxer et al., 2008; See, 2006; Luecke, 2002). These courses are frequently project based with projects related to design, manufacturing and assembly of a mechatronic device based (Flaxer et al., 2008) In addition, they usually emphasize project based learning through hands on activities (Shyr, 2012). These courses are usually offered for mechanical engineering, mechanical engineering technology, electrical and computer engineerign, electrical engineering technology and computer science students. Some times, these courses are also offered for science students or other majors such as chemistry or chemical engineering since many of their experiments are being done with the advanced mechatronics equipment.

Mechatronics was initially introduced at universities with electronic manufacturing technology laboratories. At first, courses in this area were focused on electronic packaging and assembly, adaptive control, and intelligent manufacturing systems (Hirshfeld et al., 1994). Undergraduate degrees in mechatronics engineering and mechatronics engineering technology technology have been introduced at Southern Polytechnic State University, Marietta, GA (SPSU, 2012) ; Purdue University Calumet, Hammond, IN (Keon, 2012); California State University Chico, Chico, CA (CSUC, 2012); Vaughn College, Flushing, NY (V. College, 2012); UNC Asheville - NC State University, Asheville, NC (NCSU, 2012); Central Connecticut State University, New Britain, CT (CCSU, 2012) and others. In the U.S. students are receiving Bachelors of Science degrees in Mechatronic Engineering or Mechatronic Engineering Technology.
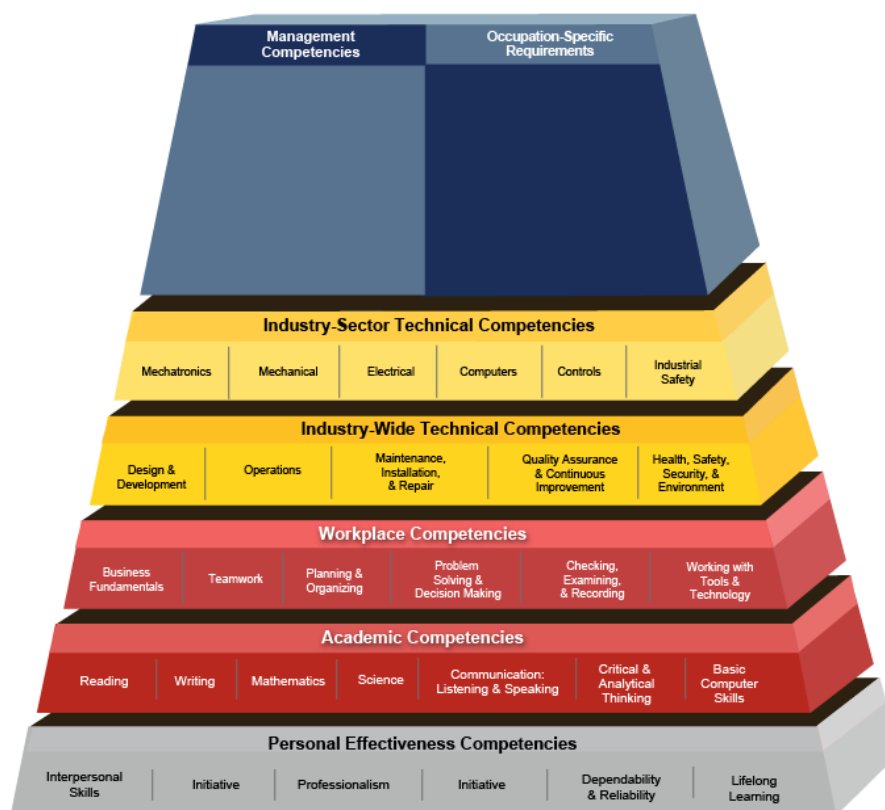

Figure 1: Mechatronics Competency Model [2]

Packaging Machinery Manufacturers Institute (PMMI) Packaging Machinery Manufacturers Institute (PMMI) has adopted the model shown in Figure-1 to define the skill standards, the curriculum, and career paths that lead to a mechatronics engineering technologist.

3. MECHATRONICS SYSTEM DESIGN OPTION IN MECHANICAL ENGINEERING TECHNOLOGY PROGRAM

Currently, two new senior elective courses have been developed in Mechatronics System concentration area in a Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) accredited Mechanical Engineering Technology (MET) program (ODU, 2012). These courses are MET 426 - Introduction to Mechatronics and MET 427 - Mechatronic System Design. Those two courses were designed to be taken in sequence. These electives have the following course descriptions:

1. MET 426 - Introduction to Mechatronics - A study of the mechatronics concepts and their application on actual problems encountered in engineering practice. Includes the basics of electromechanical systems, electrical circuits, solid-state devices, digital circuits and motors, all of which are fundamental to understanding mechatronic systems.
2. MET 427 - Mechatronic System Design - A study of the integrated modelling and optimal design of a physical system, which includes sensors, actuators, electronic components, and its embedded digital control system. Includes simultaneous optimal design practice with respect to the realization of the design specifications related to different engineering domains.

Introduction to Mechatronics should provide students with the knowledge in the following areas: basics about the electric circuits and components used in mechatronic systems; applications of semiconductor electronics in mechatronics; the importance of system response in mechatronic systems; analog signal processing using operational amplifiers; application of digital circuits in mechatronics; microcontroller programming and interfacing; data acquisition in mechatronics; application of sensors and actuators in mechatronics. Students assembled and programmed a Sumo Bot and had competition in class at the end of the semester, as shown in Figure 2.
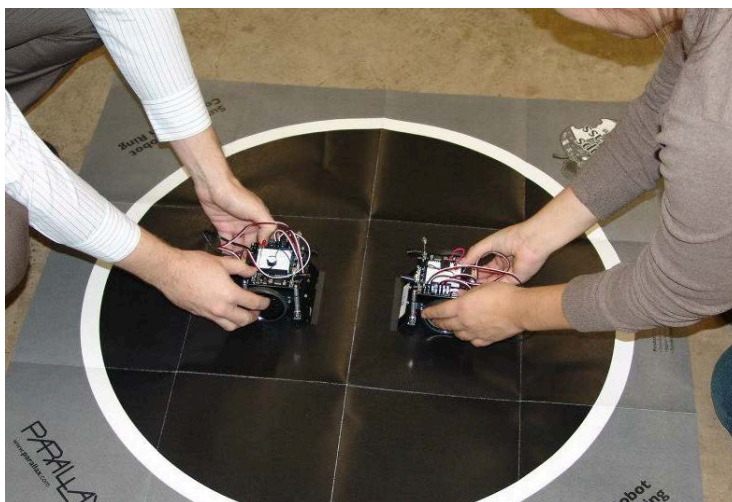

Figure 2: Students in the Sumo Bot competition in MET 426

Mechatronics system design will built upon the things learnt in the Introduction to Mechatronics class and increase understanding about the following: robust design, house of quality; design specifications; components used in mechatronic systems; practical application of hydraulics in mechatronics systems; electrical actuation systems in mechatronics; elements of mechanical system in mechatronics; and microcontroller programming and interfacing.

4. LABROTORY SUPPORT FOR THE NEW OPTION

Laboratory support for the new courses in mechatronics will be provided via upgrade of existing laboratories like the Controls Lab (Kaufman Hall-105), Robotics Lab (Kaufman Hall-116) and Electrical Circuits Lab (Kaufman Hall-202). As part of the project activity, students assembled and programmed a Sumo Bot and had competition in class at the end of the semester. More project activities are being developed in various areas like applications of semiconductor electronics in mechatronics; the importance of system response in mechatronic systems; analog signal processing using operational amplifiers; application of digital circuits in mechatronics; microcontroller programming and interfacing; data acquisition in mechatronics; application of sensors and actuators in mechatronics.

5. CONCLUSIONS

These two courses which were added in Mechanical Engineering Technology curricula were specially designed for students from Mechanical Engineering Technology program who will be working in mechanical product design, development and manufacturing, mechanical system operation and maintenance. The main idea of these courses was to provide students with information about applications of mechatronics strategy in various manufacturing systems, to provide them with necessary skills to understand basic electro-pneumatic and electro-hydraulic principles. Through hands on activities and through an open source microcontrollers and sensors, they learn how to integrate sensors and actuators in mechatronic systems. By using problem based learning and hands on activities in labs, students gained an insight into mechatronic product development enabling them to collaborate with engineers from different disciplines.

6. AUTHORIZATION AND DISCLAIMER

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