Modifying the Curriculum of an Engineering Technology Program to Meet the Needs of a Local Manufacturing Consortium

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Abstract

Northern Kentucky hosts many advanced manufacturing companies, producing high value-added products. Companies such as Mazak, ZF Steering Systems, Johnson Controls, Toyota, and others play a significant role in the region's economy. The availability of adequately trained individuals is paramount to fulfill their human resources needs, as has been repeatedly expressed to the local institutions' faculty and administrators.

In this paper, we describe how we will adopt the CDIO (conceive-design-implement-operate) initiative as proposed by Crawley et al. [1] at the Massachusetts Institute of Technology in response to the requirements and advice from industry and other stakeholders with respect to the desired knowledge, skills, and abilities of future graduates.

The Engineering Technologist

Engineering technologists are the graduates from four-year engineering technology programs. These professionals are most likely to enter positions in sectors such as construction, manufacturing, product design, testing, or technical services and sales. Those who pursue further study often consider engineering, facilities management, or business administration [2]. In the Northern Kentucky area these professionals perform in many areas, such as

- Manufacturing: auto industry, auto parts, appliances, machinery, etc.
- Services: transportation, construction, quality control, etc.
- Public services: water treatment, energy generation, etc.

Undoubtedly, the primary task of higher education institutions is to prepare students to manage those jobs in fast changing markets. Today innovation is paramount in survival in the business environment. In that regard, higher education institutions are required to prepare their graduates to be innovative in ways that contributes to the improvement of the technological efficiencies that US industry must have to maintain a competitive cutting edge [3]. Moreover, in high-velocity industries with short product cycles and rapidly shifting

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competitive landscapes, the ability to engage in rapid and relentless continuous change is a crucial capability for survival [4].

Societies, businesses, and technologies are changing rapidly, and this development has led to the creation of what is today commonly labeled "the knowledge society" [5]. Institutions offering technical education face the challenge of building curricula better suitable to the needs of industries. The curriculum adequacy, at national and/or local levels, is essential to assure the placement of graduates [6]. It is worth mentioning that even with the general success of the engineering technology programs in meeting their learning outcomes, some gaps in the students' industrial readiness and competencies still exist and need to be addressed.

We propose the CDIO initiative in response to requirements and advice from industry and other stakeholders with respect to the desired knowledge, skills, and abilities of future graduates. Therefore, the starting point was a restatement of the underlying need for engineering technology education, as proposed by Crawley et al. [1] for education of aeronautical engineers.

The CDIO Initiative

The goal of the CDIO Initiative is the education of students who will be able to (1) master a deeper working knowledge of technical fundamentals, (2) lead in the creation and operation of new products, processes, and systems, and (3) understand the importance and strategic impact of research and technological development on society. To reach those goals, a framework of best practices in education reform is established, represented by a set of 12 standards (Figure 1), developed in response to requests from industrial partners, program leaders, and alumni for attributes of graduates of CDIO programs [1].

Our approach to cope with the CDIO standards is as follows:

Program Philosophy & Curriculum Development

The results of a survey conducted among industry representatives in the Northern Kentucky area [7] points the general direction curriculum design should take; e.g., towards a more attentive approach in prizing knowledge integration, increasing student responsibility in the learning process, and adding industry-integrated, extracurricular activities. Creating close relations with industrial partners in educating future engineers/technologists would help prepare more skillful graduates [8]. Accreditation bodies also expect graduates to meet outcomes in terms of their technical knowledge, skills, and attitudes, such as the student learning outcomes as defined by ABET [9].

Table 1. CDIO best practices framework

CDIO Standards	Addresses
1 - The Context	Program philosophy
2 - Learning Outcomes	Curriculum development
3 - Integrated Curriculum	
4 - Introduction to Engineering	
5 - Design-Implement Experiences	Design-implement experiences and workplaces
6 - Engineering Workspaces	
7 - Integrated Learning Experiences	New methods of teaching and learning
8 - Active Learning	
9 - Enhancement of Faculty Skills Competence	Faculty development
10 - Enhancement of Faculty Teaching Competence	
11 - Learning Assessment	Assessment and evaluation
12 - Program Evaluation	

Design-Implement Experiences and Workplaces

We use our already established program capstone course, EGT417 Senior Project in Engineering Technology, as part of the CDIO best practices framework. This course is a requirement for all students in the engineering technology program. Students are expected to select a senior project that shows their ability to apply their knowledge and skills to design, manufacture, test, and evaluate their project, based on their proposed performance standards. As part of senior project, students are also required to conduct research and use their problem-solving skills to complete tasks in a timely manner. The projects are usually presented in groups, but individual work is also acceptable. The duration is one semester, with extensions granted in exceptional circumstances.

New Methods of Teaching and Learning

New methods have been experimented, in order to enhance the students' learning experience. Last fall, in cooperation with Mazak Corporation, we implemented an innovative training program aimed to provide students with hands-on industrial experience, as part of graduation requirements through EGT417 [10]. What makes this university-industry cooperation novel is that it is a part of our academic program, being taught by NKU faculty and Mazak management supervision, at their facility. This program incorporates many elements of the case method in experiential learning [11], which has been largely used in a variety of disciplines.

We also offer students the opportunity to participate in service learning initiatives [12]. Students were assigned to work on their senior projects (also through EGT417) by designing and implementing devices and methods to improve the manufacturing capabilities for institutions like BAWAC Community Rehabilitation Center, a non-profit organization whose mission is to help adult persons with disabilities or other barriers to employment to maximize their vocational potential and quality of life [13].

Faculty Development

As part of recommendations made by the ABET Engineering Technology Accreditation Committee, a professional development plan is being prepared to keep faculty members current in their academic fields.

Assessment and Evaluation

Course outcomes are evaluated on a regular basis, following a rotation schedule. This assessment is made by the application of a set of questions, to be answered by students at the end of every semester. Also, surveys are conducted in order to capture additional data from other stakeholders, such as our industry partners and graduates' potential employers.

Conclusions

As the manufacturing industry rebounds from the last economic crisis, companies say they are struggling to replenish the workforce that was cut during the recession [14]. The difficulty faced by industry is to hire graduates with appropriate higher education and expertise in the manufacturing field. The lack of such graduates may pose serious consequences for the US economy in general and for the local economy in particular. By responding to the needs of industry stakeholders who hire our graduates, students going through the bachelor degree programs in engineering technology will be prepared to better meet employers' needs. We use the surveys conducted by the Northern Kentucky Industrial Park Advisory Committee for Continuing Education to assess the needs of local employers. NKIP current membership consists of over 85 companies located in the Northern Kentucky area, in the sectors of manufacturing, aviation, biotechnology and information technology [15]. An estimate of approximately 6,250 skilled positions will need to be filled by employers in the Northern Kentucky area in the next 10 years, distributed as shown in Table 2 [7].

Engineering technologists have the competencies to perform many of those activities [16]. Building relationships with local industries is essential to the process of providing our graduates with the core competencies and skills required to fulfill those positions.

Table 2. 10 years' projected growth

Demand Level	Title	Growth Estimate
High Demand	Manufacturing Technicians	2671
	Machine Maintenance Specialist	695
	Electronic Technician and Repairer	532
	Welders	453
	Engineer - Process/Manufacturing	326
	Engineer - Design	330
Some Demand	Machinists	281
	Machine Tool Operator	260
	Industrial Electricians	180
Near Stable	Applications Engineer	120
	Metal Fabricators	96
	Engineering Technician	94
	CAD Drafters	53
	CNC Press Brake Set-up and Operators	71
	Finishers	49
	Hydraulic/Pneumatic	38

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Biographies

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