Embedding Professional Development Courses in Curriculum

Sabah Abro
Lawrence Technological University

Abstract

Most engineering technology programs' educational objectives (PEOs) describe the capability of their graduates to be able to analyze engineering problems and propose solutions individually, as well as a part of a team. Quality has been and continue to be a pivotal source of issues in Industry and businesses at large and Industries invest in quality to acquire a strongly needed competitive edge. Engineering programs, whether traditional or technology, provide different level of quality awareness and methodologies used in engineering. Basically, the programs share the offering and introduce simple concepts of quality through courses like Probability and Statistics, and Manufacturing Processes. Some of the programs go further and include SPC and similar introductory topics.

As a faculty member in an Engineering Technology Department, a Six Sigma certified at the Master Black Belt level, and with years of experience training industrial professionals in Six Sigma, I studied the curriculum and analyzed quality components of existing programs. This analysis concluded that the abstract approach that most of the graduates have been through during their college education did not help to establish a link to the actual practices of these tools. The concepts learned in their undergraduate education were not incorporated in their jobs. This paper introduces the process of re-engineering of an engineering technology program curriculum and how a cluster of quality knowledge areas was infused in the program. The paper also demonstrates how two new courses incorporating professional quality training were introduced, developed, and offered as part of the undergraduate degree in Bachelor of Science in Mechanical and Manufacturing Engineering Technology. Furthermore, the paper discusses and provide evidence of success by taking the quality cluster in the curriculum to the next professional level by acquiring accreditation from the Council of Six Sigma Certification (CSSC). Finally, the paper explains how accreditation, and several additional tools and processes, helped 26 students to be Six Sigma Certified at the Black Belt level.

1.0 Engineering Quality Courses in Curriculum

After over 20 years of working with and developing and analyzing curricula of engineering and engineering technology programs, it was clear that the components of these curricula had not been updated for many years.

Courses like Probability and Statistics, Statistical Methods, and Statistical Process Control are most commonly present in the curriculum. These courses, as good as they are, cannot create a comprehension of engineering quality concepts, importance, challenges, and practices.

When professional engineers and engineering technology graduates join on-the-job training or professional development sessions, it is clear that a considerable portion of them cannot make the connection between what they studied and what is being discussed in quality training programs. There are few reasons for that:

- Related courses are taught in abstract (purely mathematical) way.
- Instructors are not engineers, or they do not have enough expertise in the industrial applications of the topics.
- Classes are not clustered into knowledge areas in a way that students will make connections.
- Quality related classes are often marked as "Math and Science," which gives them a foundational not applicational status.

As a part of a consultation and training team, I managed to capture these weaknesses in the preparation of engineering and engineering technology students.

When I was asked to lead a re-engineering of the Bachelor of Science in Engineering Technology curriculum, these thoughts and observations were the drivers for out-of-the box thinking in the goals and the process of revitalizing curriculum.

2.0 Reengineering Process

Starting reengineering of a curriculum has to be based on some key questions that translate the ideas and goals of the process:

- What kind of graduates is the curriculum trying to produce?
- How to create a title in Engineering Technology
- Which industry will these graduate work in?
- What kind of positions will the graduates be assuming?

The answers to these questions came from the program learning objectives (PLOs) which were listed as follows:

Within few years from graduation, BSMMET Program graduates will be able to

1. Employ theory and practice learned through their curriculum to propose solutions to technical problems, analyze engineering alternatives and perform leading tasks in their field.
2. Become effective team collaborators, leaders and innovators, supporting efforts to address technical, business and social challenges.
3. Assume management, entrepreneurial, and leadership roles in manufacturing and related industries.
4. Engage in life-long learning through professional development opportunities and graduate programs in engineering and business.

To achieve these objectives, we have identified three cores, besides the general education core, that have to be included in order to prepare such graduates: engineering technology, quality, and management.

While it was not necessary to create these from scratch, they needed to be well-defined and their components identified. This also means that new courses should be considered, based on the needs of the reengineering process. These three cores are not and cannot be mutually exclusive. Since we were very interested in creating the quality core, we had to define its components. Based on our expertise, we have set the objective of the core as the graduate of this program will be qualified and work in engineering quality units of industry. Six Sigma training will prepare the graduate for this task. A certification would serve as a testimonial of acquiring the needed skills.

3.0 The Quality Core

We decided that our quality core would be based on the competencies required for Six Sigma certifications. We aimed to provide students enough knowledge and training so they can take a certification test upon graduation and spending some time in the field. The Quality Core was defined as it is explained in Figure 1.

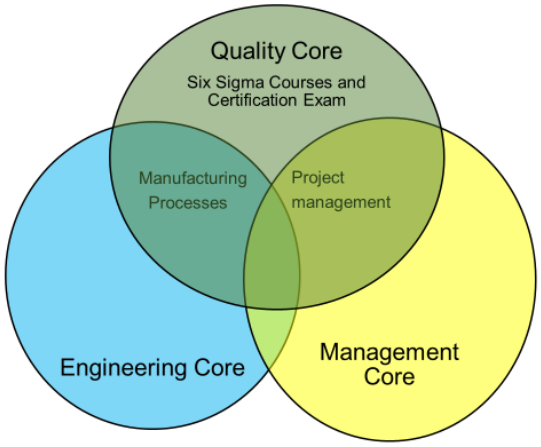

Fig. 1. Quality core overlapping with engineering and management cores.

The core includes Engineering Project Management, Engineering Manufacturing Process, Lean Manufacturing, Six Sigma 1, and Six Sigma 2 courses and was designed as an integration of courses needed to form a profound understanding of quality practices in the manufacturing field.

Based on our experience in the certification and in the training of professionals towards certifications, the two Six Sigma courses and a lean manufacturing course were developed to connect the tools contents with application practices and deviate from the abstract introduction of the courses.

In developing the Six Sigma courses, we embedded the following topics in the Black Belt Six Sigma certification:

1. Statistical Indicators
2. What is Six Sigma?
3. Six Sigma History and Application
4. Other Process Improvement and Quality Methods

5. Basic tools of quality
6. Basic Six Sigma Team Management
7. Introduction to DMAIC
8. Graphical Analysis
9. Normal Probability Distributions
10. Non-Normal Probability Distributions
11. Hypothesis testing and confidence intervals
12. Sample size
13. Control charts
14. Chi-square tests
15. Regression analysis
16. Analysis of variance (1-way ANOVA)
17. Concepts of design of experiment
18. Value stream mapping
19. Process mapping
20. MSA

We know that several of these topics are included in some traditional statistical methods courses. We agree, yet we disagree with way that these topics are taught. We have combined the experiences, examples, and success stories from the field to these topics. And we believe that our students were successful in presenting their competencies, even before graduation, when they were having their internships. Some of them were hired based on their knowledge of the quality and Six Sigma applications.

4.0 The Black Belt Certification

After five years of the development and implementation of the new curriculum, we approached the Council of Six Sigma Certification (CSSC), which is the largest worldwide Six Sigma accreditation provider.

We were asked to submit an accreditation request to become a certified entity and submit required documentations about the program in general and related courses in particular. Courses descriptions, topics, and syllabi were submitted, along with the required resumes of instructors teaching each of the courses.

After complying with all requests, details of the exam, the grading and the certificate were discussed and approved. After the completion of the process, we were recognized to create the certification test and issue a certificate with both CSSC and LTU logos on the certificate. Figure 2 is a certification template:

Fig. 2. Six Sigma Black Belt certification template.

The current process for a student to sit the certification test is that he or she will finish the required courses and take 150-question test with a passing score of 75% or better. The test is usually offered at the end of spring semester in May. So far, 26 students have been certified. Fig. 3 shows the process that was followed.

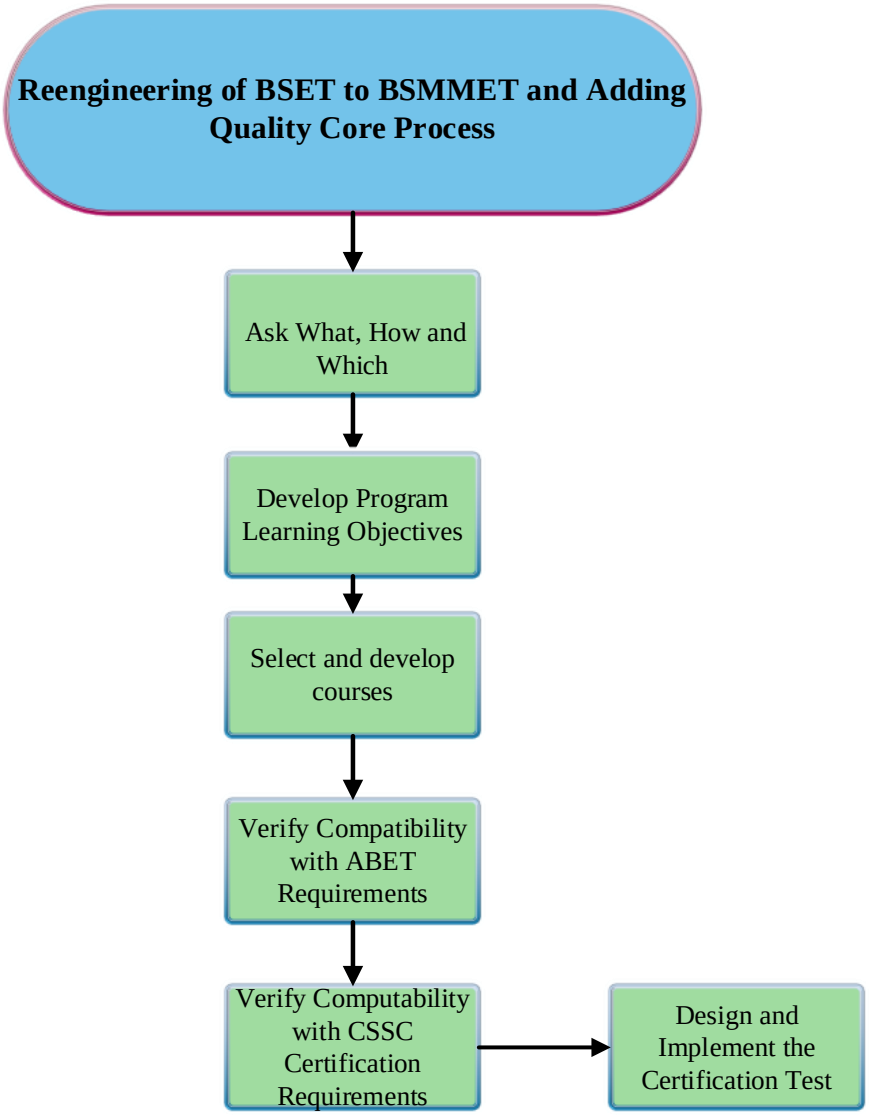

Fig. 3. Process followed to add quality core to program.

5.0 Conclusion

After six years of development and implementation of incorporating a quality core in the Bachelor of Science in Manufacturing and Mechanical Engineering Technology Program and three years after the program being accredit by CSSC, we can conclude that it was a good choice.

It has better prepared our students for industry, and it has expanded the opportunities of employment of our graduate. This addition to the curriculum is helping promote the culture of quality importance as a competitive edge.

References

American Society of Quality, "What is Six Sigma," 2022. [Online]. Available: https://asq.org/quality-resources/six-sigma#:~:text=Six%20Sigma%20is%20a%20method%20 that%20provides%20organizations,employee%20morale%2C%20and%20quality%20of%20products%20or%20services.

Council for Six Sigma Certification, "Three Basics for Six Sigma Certification," 2018. [Online]. Available: https://www.sixsigmacouncil.org/ CSSC.

Sarah K. White, "What Is Six Sigma? Streaming Quality Management," *CIO*, 2018, June 12. [Online]. Available: https://www.cio.com/article/227977/six-sigma-quality-management-methodology.html.

Biography

SABRA ABRO is an internationally educated person with a bachelor's degree from Baghdad University, a master's degree from the United Nations institute in the Middle East, a second master's degree from Britain, and a PhD from Belgium. Dr Abro is also certified Master Blackbelt in Six Sigma from Ann Arbor. He has served in universities in Iraq, Jordan, and also as a visiting lecturer in Kuwait and Morocco. He assumed different positions such as faculty, regional consultant, department chair, and acting dean. Sabah joined the Engineering Technology Department at LTU 2000. He led the upgrading of the curriculum and the ABET accreditation process in the department, served as director of the University Assessment Committee and the chair of the Engineering Faculty Council. He won the Faculty of the Year Award at LTU and was nominated for Teaching Excellence and Using Technology in Classroom Awards.