Implementing ASME Vision 2030 in a New Mechanical Engineering Program

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Abstract

In August 2016, the University of West Florida started a new Mechanical Engineering program. The program is the first in the country to be started from the ASME Vision 2030 document. ASME Vision 2030 was a national study to recommend changes to Mechanical Engineering education. The key recommendations of the study include the encouragement of more practice-based faculty, increased curricular flexibility, increased student practice-based learning, a greater emphasis on professional skills, and greater diversity among students and faculty. This paper outlines the ASME Vision 2030 and discusses how it was implemented at the University of West Florida. One of the major points of ASME Vision 2030 was to create rich practice-based design experience for students. To address this, the Mechanical Engineering program created a series of four semester courses that lead into a senior level Capstone course. Students form multi-disciplinary teams of different levels on the same project. Thus, students can have up to six semesters of design experience. But there are a number of challenges to creating teams of students at different levels and it can be difficult to assess important learning outcomes using project based learning. The approach can also put a lot of demands on faculty and be difficult to administer. Any program that wishes to create a broader design/build experience should be able to gain insight from our experiences. This paper addresses many of the difficulties we experienced in the first year of the program and how we have addressed them. This paper discusses how the program is trying to meet other key aspects of ASME Vision 2030.

Introduction

The University of West Florida's new Mechanical Engineering program will have its first graduating class in May 2018. The process to produce these graduates began in 2014, when the university started the planning process to create the degree. Early in the process it was decided that the ASME Vision 2030 report[1] would be the blueprint for the new Mechanical Engineering degree. ASME Vision 2030 was first published in 2011 as the culmination of a three year effort of the ASME Vision 2030 Task Force. The goal of the document is to outline critical outcomes that mechanical engineering programs should achieve and make recommendations for changes to current curricula. The task force was comprised of leaders in industry, government and education and was guided by a survey of constituents that had more than 600 responses. The key recommendations of the task force were to create curricula that inspires innovation and creativity, more flexible curriculum, offer more practice-based experiences, strengthen students' professional skills, attract more of a diverse student body, and limit specialization to graduate work.

Vision 2030 addresses significant challenges and changes to the mechanical engineering profession. Global issues are becoming of greater importance to the engineering profession, with

grand challenges that exist related to energy, water, transportation, health, and safety. It is critical that engineering students have a global perspective in their designs. With powerful tools used for analysis, it is more important than ever that engineers have creativity and a capacity for innovation. While a computational tools are quite useful they still need a skilled operator, thus the value of an engineer is truly found in the ability to create and innovate. Students will also need to have experience working in interdisciplinary settings as many companies require engineers to work with colleagues not only in other engineering fields but also people with backgrounds such as business or in the liberal arts. While the emphasis on soft skills is not new[2], the task force stated that focus on communication, teamwork, and systems level thinking are critical for the future mechanical engineer. The task force also recommended rebranding mechanical engineering to better attract women and underrepresented minorities. The ability to better prepare graduates to work professionally, with a greater emphasis on engineering codes and standards, was also another major recommendation of the report.

The paper will examine each key recommendation of ASME Vision 2030 and how the University of West Florida's new Mechanical Engineering program was designed to meet these goals. It is hoped that our efforts will help other programs think of ways in which they can change their efforts to better align with these important findings.

Innovation, Creativity and Practice Based Engineering

Developing creative and innovative skills should be a key component of mechanical engineering programs. Along with this outcome is the need to offer our students experiences that align with engineering practice. The recommendation of the Vision 2030 is to develop a design “spine” which is generally interpreted as a series of courses, or experiences within courses, that offer students a design /build framework. While every ABET accredited engineering program has a “Capstone” or similarly named experience, most programs do not have a connected design experience across multiple years of the degree. To address this need, the new mechanical engineering program at the University of West Florida created the enterprise program, which was inspired by a similar program at Michigan Tech University. The program involves students taking a sequence of six courses, generally taken consecutively, that provide three years of design/build experiences. The last two Capstone courses mirror what is done in other programs. In the enterprise program students are placed into groups (Table 2 contains a listing of the groups) that contain sophomores, juniors and seniors within Mechanical Engineering. The future goal of the program is to expand the project teams to students in other engineering disciplines as well as students from majors across campus. The Mechanical Engineering department is currently in negotiations with other departments about how their students can join in this program. The critical aspect of these discussions is allowing students outside of mechanical engineering to receive credit for their participation.

Course Code	Title	Credits
EGN 2911L	Sophomore Engineering Design I	1
EGN 2912L	Sophomore Engineering Design II	1

EGN 3913L	Junior Engineering Design I	1
EGN 3914L	Junior Engineering Design II	1
EGN 4950	Capstone I	1
EGN 4952L	Capstone II	2

Table 1: Enterprise Design Courses at the University of West Florida

The goal of the enterprise program is to be the design spine for engineering students, to give them a real, hands-on design experience that will align with the goals of the ASME Vision 2030. The program requires two group presentations where different members of the team must speak. The feedback from evaluators is aimed at producing engineers who are able to give professional technical presentations. By having many opportunities to hone these skills, it is hoped that we will be able to measure significant improvement. The program is designed where the senior students will be the engineering managers who have to both supervise lower-level students and also meet regularly with their faculty advisor and our program coordinator. The students are responsible for ensuring that all members of the team have their efforts documented. A 360 degree feedback evaluation instrument (where all levels evaluate each other, including advisors) allows for all members of the team to be evaluated. The students are responsible for the creation of sub teams and a management structure within the overall project team. This intentional, team process focused approach, was developed with the goals of ASME Vision 2030. Each student team is also required to send members to training events hosted by UWF's Center for Entrepreneurship and the Florida Small Business Development Center. Using this training, students are required to write and plan towards a potential commercial development from some aspect of their designs. Many of the projects have a life cycle well beyond one academic year. In this case, the student has the potential to have up to three years of experience on the same project. Students are allowed to change project teams at the start of the EGN 2911L, EGN 3913L, and EGN 4950 courses.

Weather Balloon Project
SAE Mini Baja
Catapult Project
Solar Car Project
Autonomous Water Taxi Project
Design, Build, Fly Project
Smart Home Project

Table 2: Fall 2017 Enterprise Projects at the University of West Florida

The enterprise program began with the start of the mechanical engineering program in the 2016-17 academic year. We learned considerable lessons from the mistakes that were made in the first year of the program. For instance, assigning students to the groups took far too long (groups were not completely set until about week 6 of the semester) and this affected the amount of work these students were able to accomplish. In year two we addressed this by implementing a plan where all students would be assigned to groups by the end of week 2. Students filled out an online survey on their project preference and every effort was made to give them their top choice

or their second choice. We also worked to ensure that students of different levels were on each team.

Managing all of the documents related to the course such as reports, rubrics, records, project data, and other relevant documents became a difficult task. The mechanical engineering department worked with the UWF Information Technology division to create a special cross-listed section of our e-learning platform that all students could access. This platform also contains all of the documents related to assessment and grading of the course. While most learning platforms are focused on the course as a whole, we need to redesign the platform to focus on a system that is project team focused. This does continue to cause us some issues, as the university faculty evaluation instrument is tied to the instructor of the class section that the student is enrolled in, which may or may not be the faculty advisor or the enterprise director. The establishment of an enterprise director was also critical to the success of the program. In year one we had a model that relied too heavily on the faculty advisor. This caused deliverables to be out of phase and expectations to be inconsistent. With over 200 students in this program, it is critical to have someone monitoring the program overall. The faculty member that was hired to oversee the program fits within another ASME Vision 2030 goal – to have faculty "professors of practice". The department hired a local engineer with over 15 years of experience and a master's degree in mechanical engineering. This experience helps to ensure that practical skills related to product realization or codes and standards is a part of the experience. The local connection also helps to bring in new projects from local industry contacts.

OUTCOME MEASURED IN ENTERPRISE	*METHOD*
Recognize, interpret, and apply concepts of mathematics, science, and engineering.	Review of Final Report
Recognize and describe contemporary issues.	Midterm Report – This can be a required section on the report
Identify, formulate, and solve engineering problems.	Review of Final Report
Recognize the need for, and able to engage in, life-long learning.	Midterm Report – This can be a required section on the report
Identify and apply the skills necessary to communicate effectively.	Speech assessment tool on Final Presentation, review of one biweekly report.
Recognize professional and ethical responsibility.	Midterm Report – This can be a required section on the report
Recognize the impact of engineering solutions in a global, economic, environmental, and societal context.	Midterm Report – This can be a required section on the report
Identify and apply the skills necessary to function on multidisciplinary teams.	Peer Assessment and Faculty Advisor assessment
Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social,	Enterprise Director will have a presentation on codes/standards, will be an included section on final report, we will also have a quiz on this or another topic.

political, ethical, health and safety, manufacturability, and sustainability.	

Table 3: ABET Program Outcomes Measured in Enterprise Courses.

After the first semester the department also realized that there was not a clear process to measure the ABET outcomes that were to be assessed in the courses. Design courses like these are often places where programs can measure many program outcomes. Table 3 shows the ABET outcomes measured in our enterprise courses. Each of these outcomes has an associated rubric and instrument that is used for assessment and applied to the product in the right column. In addition to measuring outcomes, the department needed a process to document that students, at the individual level, were meeting these outcomes. We implemented a plan where we are carefully tracking effort in each team and ensuring that each student is responsible for communication in both written and oral forms. It is easy for some students to be lost the crowd and the Enterprise Coordinator works with the project leaders to ensure this does not happen. Project teams can be as large as 20-25 students so this can be a difficult task.

Curricular Flexibility

The recommendation of ASME Vision 2030 was to offer a slightly smaller core of mechanical engineering courses with a larger set of electives. The UWF Mechanical Engineering degree was designed with 21 hours of electives – a number which far exceeds many US programs. These electives can be taken in engineering or in other approved programs. To do this, the thermal systems core was changed from the typical three courses (Thermodynamics, Fluids, and Heat Transfer) to two courses: Thermal Systems 1 and 2. With the 21 elective hours students are encouraged to pursue a concentration of courses that would lead to a minor in another field. Students are also encouraged to find a focus area within mechanical engineering that can better prepare them for the career or graduate program they are interested in.

Diversity and Graduate Education

The ASME Vision 2030 report stresses the need for inclusive mechanical engineering programs that have greater percentages of women and underrepresented minorities. While the degree plan was not designed explicitly towards this goal, the department has been focused on changing mechanical engineering to be more diverse. Inside of the enterprise program we have stressed to students that voices from female and underrepresented minority students must be respected. The department has put a focus on the recruitment of female and minority students and we are currently conducting both a large research effort as well as an NSF proposal aimed at increasing the number of underrepresented graduates. The selection of projects follows the Vision 2030 recommendation that some emphasize real-world applications that help people and society.

The Vision 2030 report recommends that graduate education be used to develop depth and specialization. The University of West Florida is currently developing a graduate degree that will fit this vision. A degree that is a bit less research specific and provides depth and deep technical content would be helpful for many students and early-career practicing engineers.

Discussion

Offering a rich-project based curriculum to meet the needs of the engineer of the future is a significant effort in terms of space, time and money. The department is currently renting a 3500 square foot facility near campus in order to house some of the projects. Plans are in the works for a 5000 square foot building on campus that will hold many of the projects. In terms of financial resources, the department has supported the initial phase of the projects with nearly 100% of the funds needed for materials and supplies. In future years it is expected that local industry will begin to fund some of these costs with some additional costs coming from fundraising and perhaps additional student fees. The projects create great visibility for the department but it is truly an "all hands on deck" effort from both faculty and staff. It is hoped that the student leadership model that is being implemented will help produce projects that can be managed with less faculty day-to-day monitoring. Any program that wishes to implement this type of program needs to assess if they have the available resources – space, money and time.

ASME Vision 2030 is a roadmap for the creation of an engineer that can better serve the needs of society and industry. While the focus is on mechanical engineering programs, the results are applicable to nearly any engineering discipline. The University of West Florida was in a unique position of being the first mechanical engineering program in the United States to be created from these principals. While the continuous improvement process never stops, we are confident that we are on the right track towards a better engineer.

References

1 ASME vision 2030: Helping to Inform Mechanical Engineering Education, 2011 Frontiers in Education Conference, 12-15 Oct. 2011, Rapid City, SD, USA.

2 The Engineer of 2020, Visions of Engineering in the New Century, Washington, DC; The National Academies Press, 2004.

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