THE MODERN EVOLUTION OF A CHEMICAL ENGINEERING EDUCATION

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Abstract

In 1987, the Chemical Engineering Department of Manhattan College was featured in the winter issue of Chemical Engineering Education [1]. It was a very different time then: the Resource & Learning Center, a computer center used by undergraduate engineers, was not yet built. The study of chemical engineering at Manhattan College was not as technologically advanced as it is now. Professors did not utilize computers in creating visual aids or exams, students were not dependent on the internet for research, and the curriculum did not include classes that focused on computer-based techniques. In the last 23 years, Manhattan College, like the rest of society, has undergone tremendous shifts with regards to technology. This paper will give the reader insight to the evolution of chemical engineering education at Manhattan College, and how the students, professors, and curricula have been affected by the technological advances of the last two decades.

I. The Chemical Engineering Curriculum

If chemical engineers are to be hired, they must receive the training that will make their expected contributions greater than those expected from other disciplines [2]. In order for chemical engineering graduates to be successful, changes must be made to the engineering curriculum, and these changes must be based on the needs of the recruiting companies.

The changes in the curricula of Manhattan College engineering have occurred in parallel with the changes that have occurred in industry. The rise of the chemical engineering profession in the U.S. was tied to the growth of the oil industry [3]. Chemical engineers have since broadened the application of their technical knowledge to more than just the petroleum industry. Recent chemical engineering graduates from Manhattan College have worked in the environmental, packaging, pharmaceutical, and food industries. Some have broadened their education further by venturing into business and law professions. This expansion of the focus of chemical engineering education occurred in the 1960's with the publication of "Transport Phenomena" by R. Byron Bird, W.E. Stewart and E.N. Lightfoot [3]. This book epitomized the shift in emphasis of chemical engineering education from practical application to fundamental comprehension. Chemical engineers now not only had to understand how to operate engineering equipment, but also the fundamental principles of science which governed that equipment. This allowed chemical engineers to apply their skill sets to other industries.

This shift in focus brought with it the use of any new technologies that would commonly be used in science such as math and chemistry modeling programs, in addition to engineering modeling systems. The significant developments in areas such as computer technology and hybrid unit operations have changed, and continue to change, chemical engineering education dramatically [4]. Computers have drastically affected the way chemical engineering is taught,

studied and practiced. Programs such as Mathematica, MatLab, ASPEN, and HYSYS, have become a vital part of the engineering curriculum. These programs have allowed students to model an infinite variety of engineering scenarios using the computer.

II. Advancement at Manhattan College

Through the use of ASPEN, students at Manhattan College have been able to model their senior plant designs in order to better understand the thermodynamics behind their projects. Paul Marnell Ph.D. is a senior professor at the College and teaches the Plant Design course for students in their senior year. Although he allows the use of ASPEN, he is very clear about the fact that he wants each student to understand the calculations involved with each piece of equipment. Dr. Marnell requires weekly meetings in order to assure that each student understands the fundamental principles of the equipment in the design. Computer programs such as ASPEN give students the opportunity to take vaguely defined problems and generate multiple scenarios from them, thus being able to generate and choose from many alternatives [4]. It is with this assistance from computers that chemical engineers have been allowed to branch out into other fields.

In the fall semester of 2008 at Manhattan College, a graduate level course entitled Food Engineering, taught by the current department chair, Ann Marie Flynn Ph.D., was offered for the first time. The students who attended this course learned important principles specific to various food production processes. Some examples of problems that were solved during the course of the class were: (1) determining the overall heat transfer coefficient required to cook different types of food, (2) learning how to create an aseptic environment for the mass production of canned goods and, (3) understanding the processes of beer brewing and tequila making. Prior to the 1960's the main focus of a chemical engineering education was petroleum, but as technology improved, the field of chemical engineering widened.

III. The Students of Manhattan College

Students of Manhattan College are trained to be well-rounded and open-minded individuals that excel in their professions. Engineering students are required to take a course during their freshman year that exposes them to every discipline of engineering offered at the college. This inter-disciplinary learning promotes divergent thinking, which generates many different possible solutions to a problem rather than just one for the convergent thinker [5]. Inter-disciplinary learning, combined with the advancements in technology, have affected the method that students of the college obtain and convey information.

The primary method of research for students of the digital age is searching the internet through the use of a computer. Although books are still a pertinent source for research, the world wide web allows students to comprehend generalized concepts they are interested in. There are many sites that cater solely to chemical engineering topics, such as CheResources.com, EngineeringToolbox.com, and ChemEngineer.About.com. These sites filter searches down to relevant chemical engineering topics [6].

The method by which students obtain information is not only changing outside the classroom, but inside it as well. At Manhattan College, many chemical engineering professors are choosing to present lessons using different forms of media. This is made possible since classrooms at the college contain projectors that are compatible with laptops. Professors are able

to present chemical engineering concepts through the use of videos or computer generated slideshows. Eric Huang, Ph.D. utilizes Microsoft PowerPoint for his lectures. Through the use of Blackboard, an online resource that allows professors to contact students, Dr. Huang posts all his lectures so that students have complete access to past lessons. This has become an invaluable tool for students.

In addition to these changes, the modes by which information is transferred have also been modified by technological advances. The college offers an electronic mail service that is operated by Google, which features: 7.5 GB of e-mail storage, a chat function to send instant messages to classmates or professors, and a college e-mail database that allows you to search for the college e-mail address of any professor or student. Instant communication allows the student to be a few clicks away from speaking to a professor or classmate at anytime, depending on the availability of the recipient.

The professors in the chemical engineering department of the college often give students the opportunity to give formal presentations. These presentations have been enhanced by utilizing peer-to-peer learning as a method to let students express their creativity and ingenuity through videos. Students were made to explain chemical engineering concepts. Pump systems and heat exchanger principles are made more interesting by students who use creative analogies. Students generally feel safe talking and floating ideas in a small group of their peers, and the freedom they experience usually leads to full-class discussions [7]. This method of teaching lets students generate their own ideas and concepts when forming their video and allowing them to observe different perspectives when viewing the videos of their peers. With a little creativity injected into the video there is a bigger chance to capture the audiences' attention and induce learning.

Technology has truly taken the chemical engineering undergraduates at Manhattan College to the next level. When technology is taught well and the students are allowed to express their own experiences in their learning process, the results are such that employers are pleased and prove to be a successful method of education [8].

IV. Professors' Methods

Old fashioned "chalkboard lectures" are quickly becoming a thing of the past at Manhattan College and at colleges across the country. Examinations are no longer limited to in-class, hard-copy submissions - teachers now give computer-based exams and allow e-mail submissions. It is possible to contact a professor well beyond their office hours. Professors at Manhattan College trust students with their personal cellular phone numbers just in case a student needs help with homework on the weekend or requires clarification on concepts prior to an exam. Manhattan College chemical engineering professors give take-home exams to be done using computer programs such as Microsoft Excel and ASPEN. The advent of household computers has brought about the ability of students to model chemical engineering scenarios at home [4]. Professors of the college no longer need a hard copy of exams except to place the grades of students on them.

Manhattan College is a small school, and the chemical engineering department is an intimate one. It is no surprise that the professors are generous with their time and effort in hopes that the student will do the best they can in order to learn.

Visual aids have become extremely important tools in engineering education. Professors at the college prefer to use analogies in order to better explain concepts to their students.

Through the use of visual aids, the students are able to associate fundamental engineering concepts to commonplace activities. The best visual aid comes in the form of student exposure to an industrial practice [4]. Process flow diagrams and equipment diagrams are easily created by professors on computer programs such as Microsoft Visio and can be shown in class with a click of a mouse.

The dramatic improvements in technology have created a global market, and as such, engineers are now required to know how to perform their duties not only on their native soil, but abroad as well. Because of this, travel has become another important method of teaching. At Manhattan College, Dr. Abulencia recently sent a student research group to the Philippines to attend a conference wherein the students presented their work on cost-effective water filters.

Conclusion

The effect of technology on the curriculum, students and professors at Manhattan College is prevalent. The curriculum now incorporates many more classes that focus on technological assistance. The curriculum is also now more diverse, with classes that cater to many different industries. The professors of the college and the students have also learned to adapt to the times by utilizing the current technology and applying it to the study and practice of chemical engineering. Technology has played a big part in shaping the Manhattan College Chemical Engineering Department and it will continue to, only time will tell where it will take us.

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