

Fundamentals of Engineering Design - A Freshman Measurements Laboratory

by

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Chemical Engineering concepts in flow measurement, pressure drop in pipes, pressure drop in packed towers, pressure drop in fluidized beds and efflux time from tanks were introduced to students ranging from eleventh grade in high school to college sophomores. The course is a part of the new Fundamentals in Engineering Design (FED) course at New Jersey Institute of Technology (NJIT) aimed at introducing normal senior design concepts to freshmen.

Class size was kept small and was about 15 - 18 students. More students would not be effective since a maximum of 5 -6 groups of three students each were involved in the experimentation. Each section was assigned a teaching assistant to aid in the effort and each laboratory had two assistants and the instructor. This aspect of the course is very important since the freshmen need much individual attention. In addition, a course manual was prepared which included two parts. The first part on the theory of measurements, definitions, basic concepts, units, dimensions, standards, conversions, dimensional analysis, correlations, linearization, statistical analysis, and written and oral communication, provided the students with the necessary background. The second part was a detailed explanation of the various experiments that the student groups performed.

The new Fundamentals of Engineering Design course using the Chemical Engineering Unit Operations Laboratory was first introduced in the summer of 1994 to a group of high quality eleventh graders for advanced college freshman credit. In the Fall of 1994, this course was taught for the first time to a group of freshmen and sophomores at NJIT. Students are assigned to various FED areas by the Dean's office.

First, measurement concepts were discussed and the related calculations were taught. Correlations of data in graphical and tabular form were stressed including dimensionless numbers and extraction of key constants from slopes and intercepts by linearization techniques.

Statistical methods including regression analysis and correlation coefficients were stressed. Concepts of Pollution Prevention were incorporated into the lectures through problems.

In teaching the course, it was soon learned that it is better to expose the students to the laboratory immediately and discuss topics related to their experiments. This approach was more successful than a block of lectures followed by a block of experimentation. Students understood the lecture topics better because they could relate the topics to their measurements.

All students worked in groups of three. Teamwork was stressed and cooperation with each other throughout all aspects of their study was encouraged. Throughout the experiments pollution prevention was stressed and the concepts of pollution prevention were shown as a part of each study. An attempt was made to develop a student mindset about pollution prevention early in their formative years. It is hoped that this mindset will develop as pollution prevention is stressed throughout the curriculum and approach the pollution prevention mindset that prevails in industrial America today.

At the end of experimentation, students were required to submit individual written reports similar to those written by seniors in the chemical engineering laboratory, and were required to make a group oral presentation.

Finally, at the end of each course the students were surveyed about their reactions. A total of 111 students were involved in these surveys. Various reactions to the course were surveyed and these were:

- Field of study and did this course help you to decide?

About 25-30 percent of the freshmen and sophomores stated that the course helped them decide on a course of study. The remainder did not change. For the eleventh graders, however, the majority were influenced by the course which helped them to decide. They knew less about the nature of engineering, in general, and chemical engineering in particular than the freshmen and sophomores.

- **Were you inspired by what you learned?**

About 60-70 percent of the students were inspired by the course. This inspiration was highly instructor related. One hundred percent of the eleventh graders were inspired. This is understandable since they are more impressionable.

- **What did you enjoy most in this course?**

The overwhelming majority enjoyed the hands-on laboratory experience during experimentation.

- **What did you enjoy least?**

The overwhelming majority least enjoyed the oral presentations.

- **Do you recall the term "Pollution Prevention" being used in the course?**
- **Do you know what the term means in general?**

About 60-70 percent had heard the term and knew what it meant. However, this was very instructor related indicating some stressed the subject and others did not.

- **Do you recall the term "Pollution Abatement" being used in the course?**
- **Do you know what the term means in general?**

Less had heard this term and many were not familiar with the term. Some students had heard and knew about pollution prevention and pollution abatement before taking the course.

- **Was your experience enjoyable?**
- **Would you recommend this course to others?**

Roughly 75 percent enjoyed the course and would recommend it to others. This subject was again very instructor biased. Those students that did not like the course felt it was too difficult, it was too much work and they had no interest in chemical engineering. This was not their field and they resented the fact that they

were made to take the course. Many suggested ways of improving the course.

All of the high school juniors liked the course and would recommend it to others.

Conclusions:

The conclusions are:

1. The course did not make students change fields. The high school students were more impressionable.
2. Most students were inspired by what they learned. This aspect is very instructor related.
3. The hands-on laboratory experience was enjoyed most.
4. The oral presentations were enjoyed least.
5. Pollution prevention and pollution abatement need more emphasis if the objective to begin a mindset is to be realized.
6. Most students enjoyed the course and would recommend it. This aspect is very instructor related. Students who didn't like the course felt it was difficult, it was too much work, and it was not needed because they had no interest in chemical engineering.
7. The best instructors in a department who can establish a rapport with these young students are necessary for the success of this program.

Deran Hanesian served as chairman of the Dept. Chem. Eng., Chem., and Env. Sci. from 1975-88 and is Professor of Chem. Eng. He came to NJIT in 1963. He received a bachelor of Chem. Eng. in 1952 and a Ph.D. in Chem. Eng. in 1961, both from Cornell Univ. Dr. Hanesian worked for Dupont from 1952-57 and 1960-63. He taught at the Algerian Petroleum Inst., Yerevan Poly. Inst., Armenia as a Fulbright Scholar, the Univ. of Edinburgh, Scotland, and Rutgers, the State Univ. of NJ. He was the recipient of the Robert Van Houten Award for Teaching Excellence in 1977 at NJIT, the ASEE, Midlantic AT&T Foundation Award for Excellence in Instruction in Eng. in 1986, the John Fluke Award, ASEE, 1994, and the Outstanding Tenured Faculty Award, NJIT.

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