The Use of Failure Case Studies to Enhance Students’ Understanding of Structural Behavior and Ethics

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Engineering Failures

- Engineering failures are not uncommon and occur from time to time.
  - e.g. Bridge failures, Building and Roof Collapses.

- Not many undergraduate engineering and engineering technology students are made aware of these failures.
Can Failures be Stopped?

- Failures will always occur for one reason or another, but the goal of Engineers should be to keep engineering failures because of human error, to a bare MINIMUM.
Solution to the Problem

- One of the ways to ensure safe practice in the future is to raise awareness of past failures among students.

- Educate the engineers of tomorrow about the factors which contributed to these failures so they can benefit from the lessons learned from these tragedies.
Solution to the Problem

What is the best way to have students learn about past failures since most students feel overworked or have heavy course loads to deal with in their current college curriculums?

Option A

- Create a stand-alone course going over failures and their causes

Option B

- Insert failure analysis projects into existing classes
What Has Been Done?

American Society of Civil Engineers Survey:

- **63%** of engineering colleges indicated there was not enough information available to include “failure awareness” in their curriculums.

- Only **9%** of the schools surveyed had a course which included “failure awareness”
What Has Been Done?

Rachel Martin:

- In response to the ASCE survey she developed case studies on 4 major engineering failures, for use by professors to explain how ethical responsibilities played a part in the particular failure.
What Has Been Done?

National Science Foundation (NSF):

- Began an initiative involving students from Texas A&M and faculty from around the nation, and the goal was:

  “to develop engineering ethics resource material that could be easily introduced at all levels of the engineering curriculum and in all engineering disciplines.”
What Has Been Done?

Rabbins and Harris:

- Developed a set of engineering ethics cases that are used as self-contained modules in a stand-alone “Ethics and Engineering” course at Texas A&M.
What Has Been Done?

C.G. Rouse:

- Developed a set of failure case studies “not only to establish important links between the classroom and the working environment, but also to help students realize the importance of ethics in their field of interest.”
The R.I.T. Experience

- Dr. Abi Aghayere in his Structural Steel, Reinforced Concrete, and Timber Design classes uses Option B by assigning students the task of reading about and understanding at least one engineering failure related to the course.
The R.I.T. Experience

- Articles on structural failures are posted regularly on the course website by Dr. Aghayere, as well as articles found by any members of the class.

- Discussions about the causes and impact of these failures are held in class and online.
Is It Worth the Effort?

Questions:

- So what do students think about learning with failure case studies?
- Does it give students any type of advantage?

What better way to find out than to ASK THE STUDENTS!!!
R.I.T. Survey Goals

We conducted student surveys to determine:

1. The efficacy of using the failure case studies on students’ educational experiences in an engineering technology program.
R.I.T. Survey Goals

2. To determine the impact of liability issues arising from past engineering failures on students’ interest in pursuing a career in structural design.
R.I.T. Survey Goals

3. To determine the impact of these failure case studies on the students’ motivation to do better quality work in college, and in their future professional life.
Survey Instrument

- The survey included 9 questions designed to measure the impact of failure case studies in the classroom from the students’ perspective.

- Administered to a total of 30 students enrolled in the Structural Steel and Timber Design courses at Rochester Institute of Technology.
Survey Results

DRUM ROLL PLEASE!!!

- 97% of the students believed it was a good idea to review failure case studies because they bring real life situations into the classroom.

- They reinforce the need for strict quality controls on all engineering designs, while also enhancing the student’s awareness of ethical issues and understanding of structural behavior.
Survey Results

Results vs. Expectations:

- 57% of the students felt that the failure case studies had a positive effect on their aspirations of becoming a structural engineer and designer.

- 90% of the students indicated that they were more inclined to produce better quality course work because of reviewing these failure case studies.
Students’ Comments

- “I think it is important to review these cases in order to avoid committing the same mistake again.”
- “It helps us to understand the importance of being an Ethical Engineer and the repercussions that can occur.”
Students’ Comments

- The failures “highlight the seriousness of the engineering field, and reinforces the Engineers’ Code of Ethics”

- One student made the suggestion to: “replace an existing course currently required for graduation with a stand-alone course consisting of civil engineering failure case studies”
Conclusions

- The use of failure case studies enhances the students’ understanding of structural behavior and ethics.

- It exposes them to past mistakes helping them avoid similar mistakes in the future.
Conclusions

- Failure case studies should be incorporated into classes or made into a stand-alone class to raise the awareness of engineering failures.
Thank You!!!

Time for Questions