Experiencing Failure - Recreating the Hyatt Regency Collapse to Teach Statics, Ethics, and Lifelong Learning

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Abstract

The Hyatt Regency Hotel disaster continues to be an important civil engineering ethics case-study. In engineering statics, this disaster is used to teach students about lifelong learning, the importance of licensure and ethics in engineering design and build. The assignment has evolved over the years and now includes a demonstration, free-body diagram and statics analysis. The demonstration and statics analysis of the original design and as-built conditions are completed before the Hyatt Regency disaster is described. Students are initially provided with schematics of the original and as-built designs and tasked with drawing the free body diagrams, completing the statics analysis and explaining the difference in the two systems. During the following demonstration, students load weight on scale models of both the as-built and original design configurations of the suspended walkways of the Hyatt Regency Hotel. In both cases, the models are loaded to failure and the total weight added before failure is compared. After a short discussion, a video of the Hyatt Regency Hotel tragedy is shown. The in-class assignment is followed up with a reflection paper assignment. In a survey administered to students in the course during fall 2017, 89 percent of student respondents (n = 48) indicated the activity added to their understanding of the topic and indicated in descriptive questions that the activity was helpful and increased their interest in engineering.

Introduction

Due to the nature of civil and mechanical engineering projects, it is vital for practitioners to uphold ethical standards during the engineering design process. As educators, we have a responsibility to expose students to the importance of ethics and consciousness in their decision and design making process. The Accreditation Board for Engineering and Technology (ABET) reinforces the need for teaching ethics in engineering programs with the inclusion of learning outcomes that address ethics. The new ABET Outcome 4 requires students have "An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts" [1]. One method of teaching about ethics in engineering is to use case-studies of engineering disasters where there was room for a different ethical decision to be made. This can be done either in an engineering ethics course or embedded throughout the curriculum. This paper discusses the use of the 1981 Hyatt Regency disaster to introduce engineering ethics in a lower division engineering course: engineering statics.

Methods

This lesson in engineering statics uses the Hyatt Regency failure to integrate ethical decision making into the course and to show students how a simple statics problem was the cause of the tragic event. In the first stage, students are presented with the worksheet shown in Figure 1 and asked to draw free body diagrams and use statics to determine the reaction forces in different components of the system. This is performed in small groups and after most groups have finished, the solutions are worked through collaboratively on the board. The configuration difference between the original and modified design results in a significant change to the internal forces in Nut/Washer B. This difference is highlighted on the board. During the problem

solving, students are not given any further context as to why the change in the design was made or information about the Hyatt Regency disaster.

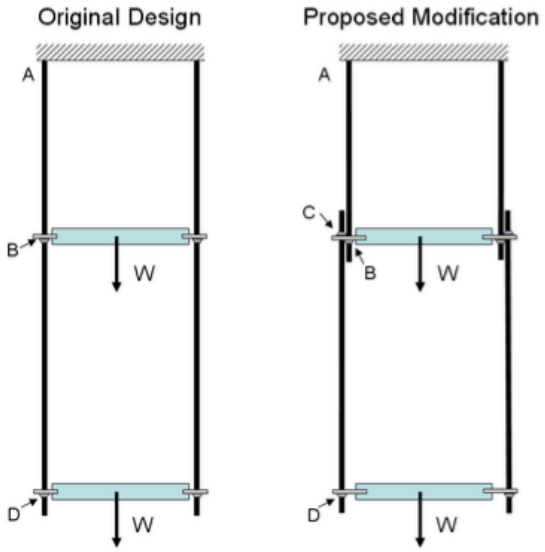
In the second stage of the lesson, students conduct a hands-on demonstration that models their own calculations to destructive failure. A schematic of the demonstration is shown in Figure 2 with a picture of students loading the demonstration shown in Figure 3. In the demonstration, the skywalk cross-beams are modeled with Styrofoam and the skywalk decks are thin planks of wood that bear on the demonstration's wood frame at the ends and on the Styrofoam cross-beams in the center. The demonstration has two interchangeable setups. In one setup, continuous threaded rods connect from the top of the demonstration's wood frame through both Styrofoam cross-beams to model the original design. In the second setup, the rod is discontinuous at mid-span and the washers and nuts to support the rods bear on the center Styrofoam cross-beam. The demonstration was based on a model shown in a YouTube video posted by Ben Unruh [2].

The demonstration is first conducted for the modified design with students loading weights on the skywalks until the threaded rod anchors pull through the Styrofoam. The total load at failure is noted. Once the system fails, the failed Styrofoam cross-beams (labeled B in the schematics), and the rods, bolts and washers are passed around for students to inspect. The demonstration is set up a second time with the original design – one single rod supporting the Styrofoam cross-beams. Again mass is added to the skywalk until failure occurs. Students are able to confirm their own calculations that found the original design requires a larger load for failure. The failed Styrofoam cross-beams, and the rods, bolts and washers and rods are shared with the students to inspect.

In the third stage of the lesson, the video **"**Hyatt Regency Skywalk Collapse 30th Anniversary-KCTV News Special" is played in class [3]. The 13-minute news segment, available on YouTube, outlines the disaster and its impacts 30 years later. The video is very powerful, so time is reserved at the end of class for open discussion where students are able to voice their thoughts and a discussion around ethics and responsibility is encouraged.

The fourth and final stage of the lesson is a homework assignment where students reflect on the disaster and what they learned. A snapshot of the assignment is presented in Figure 4. In particular, the assignment asks students to reflect on the ethical repercussions of the change in the design and how they can and will use ethics and compassion in their careers as engineers.

The intentional order of the stages allows students to first focus on the statics with no knowledge of the skywalk failure. The following destructive testing on the two models is exciting for students and, importantly, gives them a visual confirmation of the validity of their own calculations. The energy and mood of the room dramatically changes when the serious and deadly repercussions of this seemingly simple design change is revealed in the video. The final requirement of a reflection assignment gives students the opportunity to sit with their thoughts and consider the implications of this disaster on their own future careers.



Draw FBDs of the system components to determine the magnitudes of forces in the system under each condition. Since the system is symmetrical, you only need to deal with rods on one side, and here we'll use the left side. Work from bottom to top.

	Original Design	Proposed Design
Nut/Washer B (remember Nut B does not necessarily carry all tension in rod AB, but only the downward force applied on the nut by the Upper Beam).		
Upper beam (at B)		
Vertical rod from B (or C) to D		
Lower beam (at D)		

Determine the tension in the rods and the vertical force exerted on the nuts (B and D) for both cases. **Would you approve the modified design? The original design?**

Component	Force in original design	Force in modified design
Rod AB		
Rod BD (original design) or CD (proposed design)		
Nut/Washer B		
Nut/Washer D		

Figure 1. Image of portions of the handout provided to students during the first stage of the lesson. This handout was modified from an original handout created by Dr. Edwin Maurer.

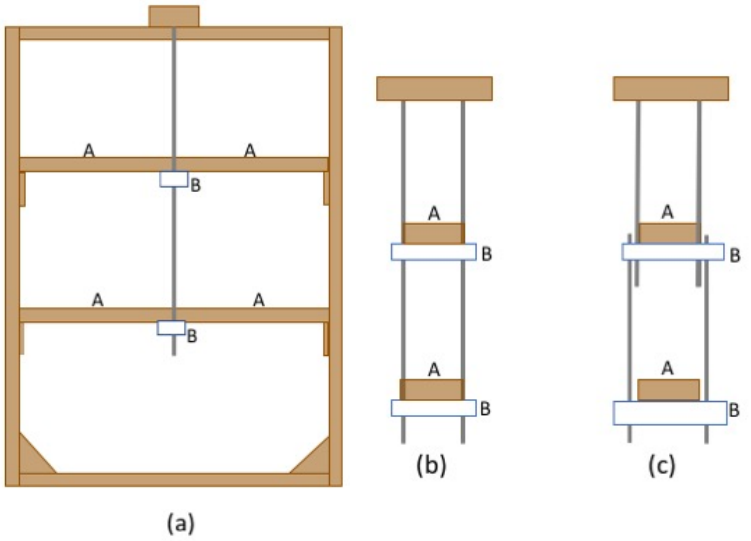


Figure 3. Schematic of the setup from the front (a) and side (b) and (c). (b) is the original design setup with one large rod and (c) is the modified design with two shorter rods.

Figure 2. Photo of students loading the demonstration Two students are used to help support the frame and two students simultaneously load weights - alternating between the top and bottom spans.

Write a ½ to 1 page discussion/reflection of the following:

1. Assuming the engineer in the Hyatt case received the contractor's telephone call requesting a verbal approval of the design change for simplifying assembly, what reasons might make her approve such an untenable change?

2. Go to the web site for your major professional organization (civil engineers: www.asce.org; mechanical engineers: www.asme.org; electrical engineers: www.ieee.org; biological engineers: www.aiche.org/sbe; general engineering or undeclared, pick one of these or find one that fits your interests) and find the organization's Code of Ethics. Which elements of the Code of Ethics and/or Fundamental Principals or Canons for your discipline could have guided the engineers involved in this design? How does your reflection on question 1 appear in light of your Code of Ethics?

3. The mantra of Santa Clara University is that we educate for conscience, competence and compassion. Engineering societies are very good at promoting competence. Go to the SCU School of Engineering web site, and access the Engineering Handbook at http://www.scu.edu/engineering/undergraduate/hb.cfm, and read Chapter 10 on Compassion, especially the Introduction, Sections 10.5, 10.6, and Case 11.4 (in chapter 10). What would wrapping this quality into your engineering practice add to your reflections in question 2? Do you see these three characteristics, and especially compassion, as adding valuable insight, beyond that in a professional ethics code, into how an engineer might handle this case?

Figure 4. Reflection prompt provided to students after the in class lesson. This assignment was modified from an original assignment created by Dr. Edwin Maurer.

Results

This lesson module was implemented using the four stages described in the method sections by the authors and two other colleagues over two academic years (fall 2016 and fall 2017) for a total of 6 sections of engineering statics. During the fall of 2017, a post-course survey was administered to students in the authors' three sections to assess student perceptions of a variety of class activities. One question specifically targeted the Hyatt Regency Failure demonstration asking, "Please rate the following class activities in relation to improving your mastery of the content. [Hyatt Regency Failure Demo]". The options for answering were:

- Made no impact or I don't remember
- Helped, but just a little
- Somewhat helpful
- Helpful, added to my understanding
- Its why I understood the topic

A total of 85 students were enrolled in the three sections in the fall 2017 but only 48 students completed the survey and gave permission for their results to be used for research. Of those 48, 21% (10 out of 48) answered 'Its why I understood the topic', 52% (25 out of 48) answered that the activity was "Helpful, added to my understanding", and 16% (8 out of 48) responded "Somewhat Helpful". Overall, 89% of the students found the activity helpful. Only two students or 4% thought the activity "Helped, but only just a little" and it is not clear for the remaining 7% if the activity did not support their understanding or if they were not in class that day. Figure 5 compares survey results from the Hyatt Regency activity to 11 other activities in the course.

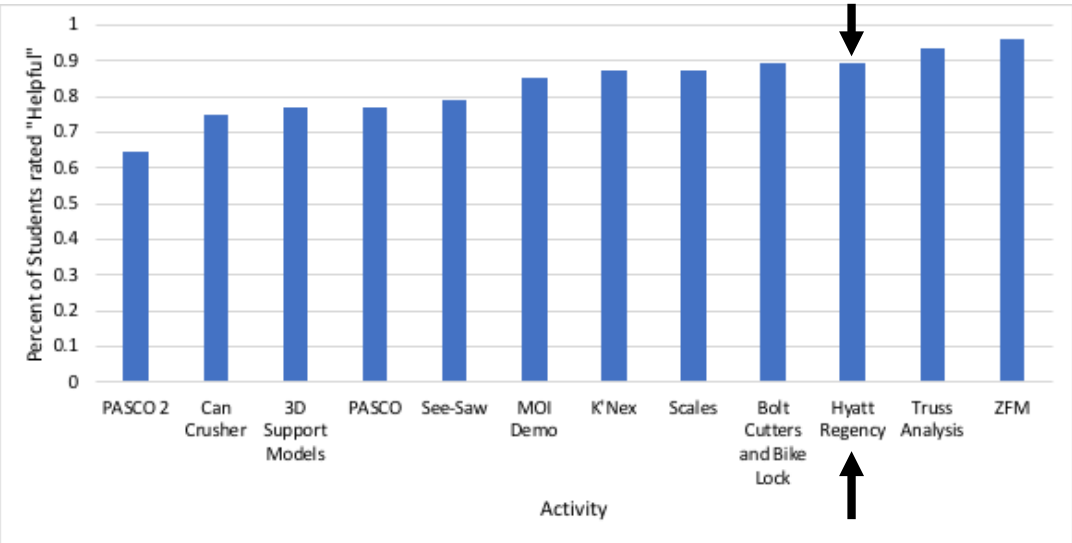


Figure 5. Percent of students who answered that course activities helped their understanding of course topics. Arrows indicate the Hyatt Regency activity. Two activities had higher percentage of students rating that the activity was helpful and the remaining 9 had lower percentages.

In addition, the survey asked students to "Please list the activities that increased your interest in engineering" in a free form response. The following are examples responses that reference the Hyatt Regency Failure demonstration:

- "Seeing real life examples of how our knowledge is important (Hyatt Regency disaster stuff)"

- “I would say that everything that we did in class was interesting. I loved hearing about these physics concepts in the context of real life. The Hyatt story really solidified how important statics is and it was inspiring to keep learning more in my engineering classes.”
- “Hyatt Regency Demo”
- “The Hyatt Regency paper”
- “The Hyatt collapse demo”

Summary

The Hyatt Regency Skyway collapse is an ideal case-study for engineering ethics for two reasons. First, the engineering analysis of the failure mechanism is attainable for sophomore engineering students. This provides students with a solid link between what they are learning and the real world and it allows departments to integrate engineering ethics early in the curriculum. Second, the original and as-built designs do not appear significantly different to the students until a statics analysis is done. This makes it easy for a student to imagine how they could have easily made what appears to be a simple but deadly mistake, which provides for much deeper and richer comments in the reflections. The students appreciate this assignment as it is one of the most highly rated class activities in the post-course survey with a significant majority of the students indicating the activity was helpful in improving their mastery of the topic.

References

[1] "Accreditation Board for Engineering and Technology 2019", *Criteria for Accrediting Engineering Programs Effective for Evaluations During the 2019-2020 Accreditation Cycle*, Nov. 2018 [online]

[2] Unruh, Ben. “Hyatt Regency Skywalk Collapse Loading Demonstration” *YouTube*, 2 Dec. 2012, https://youtu.be/zfxalU1y_OE

[3] McCoy, Bernard. “Hyatt Regency Skywalk Collapse 30th Anniversary- KCTV News Special” *YouTube,* 20 Jul. 2011. https://youtu.be/eKFcUZbO1vk