Use of a Courtroom/Trial in a Classroom to Illustrate Engineering Failures

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Abstract

If and when a component or structure fails, resulting in significant loss of life or property, people look for someone (or group) to blame. The assignment of responsibility for the engineering failure may be the task of a prestigious government/industry commission or agency, to be determined over many months using a variety of resources. As the process of determining the cause(s) of this event unfolds, simultaneously, legal actions may commence by injured parties looking for compensation for their losses. As a result, the United States court system, local, state and federal, has been placed squarely at the center of disputes that require sophisticated technical and scientific analysis in order to determine who was responsible for the failure. Naturally, as the level of technical sophistication of failed items continues to increase, it has become more difficult for the non-technical expert (judges, juries) to determine the root causes of these failures. Recent legal decisions (Daubert, Kumho) have been promulgated in an effort to make it easier for the courts to judge whether courtroom engineering experts can be allowed to state their opinions, and avoid spreading "junk science" in court.

Students, regardless of their intended major, have an interest in engineering disasters, the more spectacular the better. The first-year seminar "Learning Through Engineering Failure" focuses on well known engineering failures/disasters as a means to introduce students to engineering. As part of the learning process, the students stage a mock trial, with the subject being a well known example of an engineering failure/disaster. The trial is arranged to simulate a typical product liability action, with attorneys, plaintiff, defendants, expert witnesses, eyewitnesses, and public sector officials. The instructor acts as the judge, and the jury is made up of class members. A two week trial is convened, after which the jury arrives at a verdict. The verdict is then explained to the class. Initial feedback on the trial phase of the course was positive.

Introduction

Within the last few years, many colleges and universities have required freshman to enroll in first year (or freshmen) seminars. Course content varies widely, but a few common themes are apparent:

- College survival skills (time management, library research)
- Computer skills
- Familiarization with intended major
- Develop critical thinking/reasoning skills
- Team work

This paper describes a first year seminar course whose focus is helping students learn about engineering through analysis of classic engineering failures and disasters. Penn State University started a required first year seminar course for all entering freshmen a number of years ago at the University Park campus. These courses are typically taught by full time continuing appointment faculty and have relatively small class sizes. In the fall of 1999, first year seminar courses were first taught at Penn State Abington (a separate Penn State College with an approximate 3000 student enrollment). Requirements/course content for these courses vary through the university community and can be determined by instructors in each academic unit. If a course is one credit (typically meeting for fifteen (15) hours per term), content is generally left up to the instructor and their local academic supervisor. In contrast, a three-credit course must have its content approved by the appropriate faculty senate committees. The course that is the subject of this paper was a one-credit course that met once a week for fifteen weeks. The course has been taught for two terms, with two sections each term. The maximum number of students was twenty (20), who were all freshmen.

The major goals of this course were:

College survival (time inventory and management)
Library/research skills
Computer skills/data acquisition and analysis
Critical thinking skills
Team building skills
Familiarization with engineering through the study of spectacular failures

The students enrolled in this course were first term freshmen, with most planning to enroll in a variety of engineering majors. However, the course was not restricted to engineering students and non-engineering majors could also enroll. As is typical of many of our students, their engineering backgrounds were minimal, and their knowledge of engineering limited. One of the first steps in the course was to introduce the students to basic engineering principles, concentrating on those areas that relate to structural failure. Mechanical properties of materials, strength, and failure modes were covered. The text used (Petroski) made use of many examples of failure, written in a manner that beginning engineering students (or non-engineers) could understand. A videotape (Petroski) also assisted students in acquiring a rudimentary understanding of engineering failures. Simple experiments were conducted to familiarize students with different failure types, such as direct tension, fatigue, and buckling. The data collected from these experiments was analyzed using spreadsheet programs and appropriate conclusions were obtained, by many students.

The class was also required to research assigned failures and write a brief paper. These failures/disasters included classic examples e.g. Tacoma Narrows Bridge, Leaning Tower of Pisa, Hyatt Regency Walkway, and the Challenger Space Shuttle. The information about these failures was obtained from a variety of web sites, some of which contain excellent graphics including video clips. The paper also included an example from their own experience of failed components and possible explanation(s) of that failure, using engineering principles previously discussed in class. One goal of that assignment was to allow the students to use their limited understanding of engineering principles and apply that to the cause(s) of these failures. An important aspect of this assignment was to have students appreciate that failed engineering designs can lead to improved products. Advances in technology are often the result of analyzing earlier failures. While engineering failure is not celebrated in this course, it is undeniable that the study of prior failures has resulted in new improved designs.

To further illustrate engineering failures, and their consequences, a mock trial was included as part of the course content in this class. The engineers/architects, companies and or government officials supposedly responsible for the failure were placed on trial. The student jury, after hearing evidence, was to reach a verdict, and assign responsibility, if any, to the various parties. As part of the background to this legal process, the increased litigation in our society was covered in class. The phrase “I’ll sue you” has become ubiquitous in our modern life. Students were aware of particularly unusual lawsuits, among them the McDonald’s “too hot coffee” to the psychic (in Philadelphia) who sued, after a car accident, when she “lost her psychic powers”. It is clear that more engineering related disputes/controversies are being resolved in a courtroom environment. The courts (whether local, state or federal) have been required to make legal decisions based on highly technical scientific or engineering analyses. A jury, arbitrators, or judges, whose knowledge of the engineering principles involved is limited, sometimes make these decisions based on highly technical information presented by so-called expert witnesses testifying in court (under oath). The Daubert decision (Daubert) in 1993 was an attempt to give a trial judge specific factors to be used in determining whether scientific and technical knowledge as presented by a technical expert (hired by either the defense or plaintiff) is scientifically valid. The focus of this decision is on the principles and methodology used by the expert, not on their conclusions. The trial judges are to be “gatekeepers” against improper testimony and junk science (Watts et al). A later legal case (Kumho 1999) further solidified the trial judge’s role as the one to determine that all experts adhere to the same rigorous standards of intellectual and methodical rigor (in testifying in court) that they use in their professional work (Watts et al).

The Trial

Two different engineering disasters/legal cases have been used in this course (one per class):

Hyatt Regency Walkway Failure

Ford Explorer/Bridgestone (Firestone)

The plaintiff(s) in these trials were fictitious injured parties who had suffered significant harm as a result of the failure. The defendants were the companies involved in the design/manufacture and or installation of the product. Various government officials (building inspectors, highway traffic safety…) were also included as defendants, if applicable. Students were asked to chose what roles they wished to play in this trial: plaintiff (injured party), engineers, production workers, management personnel, architects, government officials, witnesses, attorneys, expert witnesses (for or against the plaintiff) and jury members. Initially many students wanted to be jurors, bur when they were informed that jurors would be required to produce a written report on their decision, the jury became less popular. The instructor was the judge, and ruled on objections from the different student attorneys. The student attorneys were encouraged to be forceful in their presentations, but not to antagonize the jury. Defendant attorneys were neither encouraged nor discouraged from casting aspersions on co-defendants. The expert witnesses had to provide information that could pass the “junk science” test (as determined by the judge). The plaintiff’s story was to be extremely sympathetic and tragic, and would not result in any significant blame being assigned to them.

The class researched the trial topic for a number of weeks (together), and then the individual roles in the trial were “rehearsed”. Attorneys met with their clients, went over trial testimony, and made sure their stories were as accurate as possible. As is the case in Pennsylvania, attorneys were allowed to “interrogate” the witnesses for the other side (the discovery process) in order to ascertain (if possible) what these witnesses would state that could be harmful to their case. Where applicable, trial exhibits were used to illustrate important points (to the jury).

The plaintiff presented their case first, and then the defendants. After closing statements from the attorneys, the jury was instructed on the legal aspects of civil liability, including comparative negligence, and asked to render a verdict. The jury not only was required to arrive at a verdict, but to explain to the class the engineering principles they used, as well as any other reasoning that went into their decision.

Hyatt Regency Walkway Failure

Plaintiff was injured by falling walkway and became a paraplegic.
Defendants were:

Architects; Construction Management Company; Structural engineer; General Contractor; Steel Erector

Kansas City building inspector was called as witness for both plaintiff and defense. Witnesses to the accident were also called to testify.
Attorneys represented all sides. After opening statements, the trial proceeded with each side presenting their witnesses. Experts were called by plaintiff's attorney to attempt to prove that Kansas City building codes were violated. According to these experts, neither the architect or structural engineer apparently inspected the as-built condition of lobby (walkway area). The structural engineer (according to plaintiff's experts) did not properly check the change in installation technique of the walkways reportedly done (on their own) by the steel erector.
Defense experts (architects/engineers) presented information to show the decisions of the architect or the engineers (during the planning and construction stages) were reasonable. A point of contention was whether the steel erectors had communicated with the structural engineers about the change in walkway suspension installation technique. Phone records were inconclusive.
Upon receiving instructions (from the judge) on legal liability, and negligence, the jury began its deliberations and reached a verdict. The architect was held minimally liable, with the major "blame" resting on the structural engineers and the steel erectors.

Ford Explorer/Bridgestone (Firestone)

Plaintiff was a driver on a Ford Explorer whose vehicle had rolled over, after the left rear Firestone tire suddenly blew out. As a result, his children were killed in this accident.
Defendants were Ford and Bridgestone (Firestone)
Ford's attorney attempted to place blame on Bridgestone (Firestone).
Bridgestone's (Firestone) attorney stated that they provided Ford what they wanted in a tire, and Ford wrote all the specifications regarding the tire.
All sides agreed that the tire and Ford Explorer met all applicable Federal Motor Vehicle Safety Standards (FMVSS).
All sides called a representative from NHTSA to help their case. NHTSA was used to show that both the SUV (Ford Explorer) and the tire were not in violation of FMVSS. However, due to budgetary constraints, NHTSA was not able to conduct any significant data analysis on reported tire/rollover problems until it was too late. Bridgestone (Firestone) factory workers and plant managers were called to testify regarding the strike at the Decatur, Ill. plant that made these tires. Questions were raised regarding any effect the strike had on tire quality. A state trooper who investigated the accident also testified as to the traffic conditions, weather etc. at the time of the accident. The state trooper reported that driver error was not a factor in this accident.

Plaintiff's car expert focused on the Ford Explorer's tendency to rollover, while Ford's expert described the vehicle as being particularly stable for an SUV. The recommended tire inflation pressure became an issue for the jury to deal with as did when Ford and Bridgestone (Firestone) became aware of the problems.
Upon receiving instructions (from the judge) on legal liability, and negligence, the jury began its deliberations and reached a verdict. The jury found both Ford and Bridgestone(Firestone) liable for damages.

The trial was conducted over two class sessions, with a third class session devoted to the jury verdict. The classroom was set up as a courtroom would be, with exhibits for both the plaintiff and defense. After the jury read their verdict, a brief explanation was given to the courtroom by the jury foreperson. Initial feedback from the classes has been positive, with a general comment that more time would be useful, and all students should be more familiar with the entire case, not just their own role.

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