# Unintended Consequences

You can tailor case studies and failure analyses for specific grade levels. Case studies are excellent methods for introducing the need for ethical decision making, social responsibility, and systems thinking. You can include an appropriate amount of technical material depending on your class's grade and focus. Some structural failures, such as bridge and building collapses, can serve as focal points for issues related to forces and materials integrity. In addition, many highlight the links and mutual responsibilities between designers, engineers, and builders. The fields of nanotechnology and genetic engineering have given rise to many ethical issues and dilemmas. They incorporate concepts from almost every area of science. A number of resources for background material in these fields can be found in the specific links listed for these topics.

Case studies and failure analyses are conducive to problem-based learning. Students can do much of the background research and preparation outside class. However, case studies are excellent opportunities for learning technical concepts and highlighting ethics and values issues via classroom debates and discussions.

## S.S. Eastland Case Study

The case of the *S.S. Eastland* disaster (www.eastlanddisaster.org) is a classic example of negative consequences that resulted from a well-intended solution. After the sinking of the *Titanic* in 1912 and the resulting deaths, a lifeboats-for-all safety initiative took hold, creating maritime regulations that required vessels to carry lifeboats, rafts, and safety gear to accommodate at least 75 percent of all passengers (Stranahan, 2014). The goal was to improve the outcome of any potential disaster, minimizing the loss of life.

The *Eastland* was originally designed to carry six lifeboats, but by 1915 it had eleven lifeboats, thirty-seven 1,000-pound life rafts, and roughly 2,500 life vests that each weighed over five pounds. In addition, most of the safety equipment was located on upper decks, throwing off the stability of the ship (Stranahan, 2014). The *Eastland* had not left the dock when it toppled over and sank on July 24, 1915. After all the injured were rescued and records were checked, officials determined that 844 of the over 2,573 passengers on board died in the accident (Stranahan, 2014).

The combined factors of the added load of the safety equipment, rapid boarding of passengers, and unstable distribution of weight led to an unintended tragedy. Any one of those factors alone would most likely not have caused the tragic outcome, but the interaction of all of them created an unstable system. The solution that was designed to provide more safety equipment in the event of a sinking actually contributed to the catastrophic failure.

*Stranahan, S. Q. (2014). The Eastland disaster killed more passengers than the Titanic and the Lusitania. Why has it been forgotten?* Smithsonian. *Accessed at www.smithsonianmag.com/history/eastland-disaster-killed-more-passengers-titanic-and-lusitania-why-has-it-been-forgotten-180953146 on August 28, 2019.*

## Challenger Case Study

These resources form a good background picture of the *Challenger* disaster, which has an accompanying case study. Live links to these sites are on this book's landing page.

- Aerospaceweb: www.aerospaceweb.org/question/investigations/q0122.shtml
- "Engineering Ethics Case Study: The Challenger Disaster" by Mark Rossow: www.cedengineering.com/userfiles/ethics_challenger_disaster_2283.pdf
- History: www.history.com/topics/challenger-disaster
- NASA: http://history.nasa.gov/sts51l.html
- NASA: www.nasa.gov/centers/goddard/pdf/450420main_NASA_Case_Study_Catalog.pdf
- ThinkReliability: www.thinkreliability.com/cm-challenger.aspx

You might ask students to consider these questions as they research and discuss.

- "What sequence of events led to the failure?""
- "Explain the specific cause—materials or procedures—for the failure. (Note: Here, you can adjust the technical detail as necessary for your class.)
- "What were some of the pressures that led to the decision to launch?"
- "Who were some key players?"
- "If you were in the position that the Thiokol engineers were in, what would you have done?"
- "Who was most responsible or irresponsible for the decision to launch the space shuttle?"
- "What improvements were made in terms of design, materials, and procedures to ensure that this type of failure did not happen again?"