viewed by his company's upper management, board of directors, or fellow workers, many of whom were also company stockholders. Happily, Sam was never punished for his unilateral action of halting production. He recently retired from Alpha Electronics as a corporate-level vice president. He was especially gratified by the number of Alpha employees who were veterans of World War II, the Korean War, and the Vietnam War who thanked him for his action.

Sam strongly believed his action was the right thing to do, both for his company and for the public welfare. What ideas typically covered in an engineering ethics course might support that conviction?

CASE 15

Highway Safety Improvements[42]

David Weber, age 23, is a civil engineer in charge of safety improvements for District 7 (an eight-county area within a midwestern state). Near the end of the fiscal year, the district engineer informs David that delivery of a new snow plow has been delayed, and as a consequence the district has $50,000 in uncommitted funds. He asks David to suggest a safety project (or projects) that can be put under contract within the current fiscal year.

After a careful consideration of potential projects, David narrows his choice to two possible safety improvements. Site A is the intersection of Main and Oak Streets in the major city within the district. Site B is the intersection of Grape and Fir Roads in a rural area.

Pertinent data for the two intersections are as follows:

	Site A	Site B
Main road traffic (vehicles/day)	20,000	5,000
Minor road traffic (vehicles/day)	4,000	1,000
Fatalities per year (3-year average)	2	1
Injuries per year (3-year average)	6	2
PD* (3-year average)	40	12
Proposed improvement	New signals	New signals
Improvement cost	$50,000	$50,000

*PD refers to property damage-only accidents.

A highway engineering textbook includes a table of average reductions in accidents resulting from the installation of the types of signal improvements David proposes. The tables are based on studies of intersections in urban and rural areas throughout the United States during the past 20 years.

	Urban	Rural
Percent reduction in fatalities	50	50
Percent reduction in injuries	50	60
Percent reduction in PD	25	−25*

*Property damage-only accidents are expected to increase because of the increase in rear-end accidents due to the stopping of high-speed traffic in rural areas.

David recognizes that these reduction factors represent averages from intersections with a wide range of physical characteristics (number of approach lanes, angle of intersection, etc.), in all climates, with various mixes of trucks and passenger vehicles, various approach speeds, various driving habits, and so on. However, he has no special data about sites A and B that suggest relying on these tables is likely to misrepresent the circumstances at these sites.

Finally, here is additional information that David knows:

1. In 1975, the National Safety Council (NSC) and the National Highway Traffic Safety Administration (NHTSA) both published dollar scales for comparing accident outcomes, as shown below:

	NSC	NHTSA
Fatality	$52,000	$235,000
Injury	3,000	11,200
PD	440	500

A neighboring state uses the following weighting scheme:

Fatality	9.5 PD
Injury	3.5 PD

2. Individuals within the two groups pay roughly the same transportation taxes (licenses, gasoline taxes, etc.).

Which of the two site improvements do you think David should recommend? What is your rationale for this recommendation?

CASE 16

Hurricane Katrina

As we have noted in the text, until approximately 1970 nearly all engineering codes of ethics held that the engineer's first duty is fidelity to his or her employer and clients. However, soon after 1970, most codes insisted that ''Engineers shall hold paramount the safety, health, and welfare of the public.'' Whatever may have precipitated this change in the early 1970s, recent events—ranging from the collapse of Manhattan's Twin Towers on September 11, 2001, to the collapse of a major bridge in Minneapolis/St. Paul on August 1, 2007—make apparent the vital importance of this principle. The devastation wreaked by Hurricane Katrina along the Gulf of Mexico coastline states of Louisiana, Mississippi, and Alabama in late August 2005 is also a dramatic case in point.

Hardest hit was Louisiana, which endured the loss of more than 1,000 lives, thousands of homes, damage to residential and nonresidential property of more than $20 billion, and damage to public infrastructure estimated at nearly $7 billion. Most severely damaged was the city of New Orleans, much of which had to be evacuated and which suffered the loss of more than 100,000 jobs. The city is still reeling, apparently having permanently lost much of its population and only slowly recovering previously habitable areas.

At the request of the U.S. Army Corp of Engineers (USACE), the ASCE formed the Hurricane Katrina External Review Panel to review the comprehensive work of USACE's Interagency Performance Evaluation Task Force. The resulting ASCE report, *The New Orleans Hurricane Protection System: What Went Wrong and Why,* is a detailed and eloquent statement of the ethical responsibilities of engineers to protect public safety, health, and welfare.[43]

The ASCE report documents engineering failures, organizational and policy failures, and lessons learned for the future. Chapter 7 of the report (''Direct Causes of the Catastrophe'') begins as follows:[44]

> What is unique about the devastation that befell the New Orleans area from Hurricane Katrina—compared to other natural disasters—is that much of the destruction was the result of engineering and engineering-related policy failures.

From an engineering standpoint, the panel asserts, there was an underestimation of soil strength that rendered the levees more vulnerable than they should have been, a failure to satisfy standard factors of safety in the original designs of the levees and pumps, and a failure to determine and communicate clearly to the public the level of hurricane risk to which the city and its residents were exposed. The panel concludes,[45]

> With the benefit of hindsight, we now see that questionable engineering decisions and management choices, and inadequate interfaces within and between organizations, all contributed to the problem.

This might suggest that blame-responsibility is in order. However, the panel chose not to pursue this line, pointing out instead the difficulty of assigning blame:[46]

> No one person or decision is to blame. The engineering failures were complex, and involved numerous decisions by many people within many organizations over a long period of time.

Rather than attempt to assign blame, the panel used the hindsight it acquired to make recommendations about the future. The report identifies a set of critical actions the panel regards as necessary. These