tions" — that is, who recalled all the things one could do if only one missing piece of technology were available. When that piece appeared, this employee was ready to move rapidly ahead by using it.

2.4 Problems

2.1 Consider the design problems involved in providing security for a student laboratory room such as the one used in your course. Discuss briefly or list concisely the situations to be detected and dealt with, such as entry of an unauthorized person or removal of equipment from the room. Questions to be considered include detecting that a person *is* unauthorized, detecting that equipment is being *removed*, actions to be taken, false alarms, and the effect of a limited budget on the design. Where could you find information about such systems?

2.2 Assume that you are going to design the ultimate music system for a five-room dwelling. Outline briefly how a superb system would function, and outline a less fancy — and costly — system. Estimate the costs of each system.

2.3 Most of you have probably seen the television ad in which a toy bunny powered by an Energizer-brand battery keeps on going ... and going ..., long after a similar toy powered by the Duracell "coppertop" battery has stopped working. The problem here is to design a sensible experiment (or several different experiments, if you get motivated) to determine whether the Energizer battery really delivers better performance than the Duracell. Feel free to ask anybody associated with your course for further information. If you already work with a partner in the lab you might consider this problem jointly with your partner — this is the kind of problem for which it is good to be able to discuss your ideas with others. Output: Please write up your proposal for the testing to establish whether the TV ad tells the truth about these batteries. You can use the "proposal" template in this text. DO NOT WRITE MORE THAN ONE PAGE ON THIS. Use your computer's word-processor. Be imaginative. Here are some questions to consider (answer):

(a) What does "better performance" really mean to you as a potential battery customer? Longest functioning? How would you factor purchase prices of the two different batteries into the evaluation?

(b) Since you probably don't have a battery-powered bunny toy, what electrical "load" will you use in the evaluation?

(c) How long would your actual testing take in order to produce meaningful results? If the duration is longer than you'd like to spend sitting in the testing lab, how would you be able to get results and still do other things with your life?

(d) Cost (always important!): How much would your proposed evaluation method cost?

Engineering Ethics

Computer Firm Shuts Down Revlon

Giant cosmetics company sues small software maker over incident

By Ken Siegmann
Chronicle Staff Writer

It was a confrontation that could happen only in the computer age. A tiny Silicon Valley software company shut down cosmetic giant Revlon, Inc. last week with a simple telephone call plus a little late night computer hacking.

Logisticon, Inc., a $20 million Santa Clara company that makes software for inventory and distribution control, said its midnight mission was prompted by a contract dispute. In essence, Revlon refused to pay for software, so Logisticon electronically repossessed the program.

Revlon responded this week by suing Logisticon, claiming in its lawsuit that it was unable to ship its products for three days after it lost use of the software.

Logisticon had been working with Revlon since January 1989 to install a system to track the company's $3 billion worth of sales and shipments from various distribution sites around the country.

After complaining on October 9 that the software never worked properly, Revlon told Logisticon that it would make no more payments on the $1.2 million contract until the bugs were fixed. Revlon has paid $420,000 for the first phase of installation.

Logisticon responded by using a phone link and Revlon's computer access codes to shut down its software in Revlon's computer systems early in the morning of October 16.

Logisticon engineers dialed Revlon's computers and gave the software commands to stop its operations and temporarily scramble Revlon's computerized information about its shipments and inventories.

With the computer system frozen, Revlon was forced to shut down its two largest distribution centers in Phoenix and Edison, N.J., and send about 400 workers home for three days. Revlon spokesman James Conroy said Revlon continued to distribute products from distributions centers in Jacksonville, Fla., and Oxford, N.C., but Curry said the company was unable to ship products in the Northeast and West.

Logisticon President Donald Gallagher called his company's actions a "repossession."

Conroy called it "commercial terrorism."

You can see from this newspaper article about an actual event that as a working engineer you may have to make ethical choices. Would you, as a professional engineer whose bill for service had not been paid, have put pressure on your client by taking this technologically easy step — deactivating the client's computer system?

Chances are that this decision was made in a high-level meeting with the top managers of the company. Perhaps they were tired of getting the runaround from this giant corporation, which was violating its contract. If Revlon needed this software to operate the company, then they were obviously relying on it operating on a day-to-day basis. The implication is that the bugs they were complaining of weren't all that critical.

If you say you'd never have done such a thing, consider a slightly different question: If you'd known that your fellow engineer was going to disable the program, would you have reported this? Should you have done so? To whom would you have reported? Would you be acting in a disloyal fashion toward your employer, or just doing the right thing?

Often, the costs of taking the easy course and remaining silent can be very high. In the Challenger spacecraft disaster, seven astronauts died because of a decision to launch in cold weather in spite of evidence that O-ring seals on the rocket would not function well when cold. Reporting unethical behavior is known as "blowing the whistle" on the guilty person; "whistle-blowers" are often subjected to discrimination, transfer to a meaningless job at a distant and unpleasant location, or outright dismissal. So, taking the ethical course of action may entail personal sacrifice.

The rules or standards governing the members of a profession are called ethics. As with the medical ethics governing the actions of physicians and nurses, engineering ethics have been codified. The following statements are from the "Canons of Conduct" of the Association for Computing Machinery (ACM).

> Recognition of professional status by the public depends not only on skill and dedication, but also on adherence to a recognized Code of Professional Conduct. The following Code sets forth the general principles (Canons) ... applicable to each member ... An ACM member shall:
>
> 1. Act at all times with integrity.
> 2. Strive to increase competence and prestige of profession.
> 3. Accept responsibility for own work.
> 4. Act with professional responsibility.
> 5. Use special knowledge and skills for advancement of human welfare.

Under each canon in the complete document are ethical considerations ("ECs") giving specific examples of the conduct called for. For example, these are excerpts from the ethical considerations under the fifth canon:

> EC5.1. ... consider health, privacy, and general welfare of public in performance of work.
>
> EC5.2. ... whenever dealing with data concerning individuals, always consider principle of the individual's privacy and seek the following:
>
> —to minimize the data collected.
> —to limit authorized access to the data.
> —to provide proper security for the data.
> —to determine the required retention period of the data.
> —to ensure proper disposal of the data.

You may have read a statement of student ethics for your school that denounces copying and other forms of cheating on exams. The usual motivation to cheat is simply the urge for survival. This same basic urge also leads to lapses with respect to engineering ethics. Behavior that you as an engineer would shun in good economic times might be quite tempting if your job or your company's survival were "on the line." As you read through the factual descriptions that follow, ask yourself, "What would I have done in this situation?"

Also, try to imagine other ethical problems that you might face in your intended career.

3.1 Case Studies

Ford's Pinto

As an example of an ethical case study, we reprint next the article, "Ford's Pinto" [from *BUSINESS ETHICS, 1st edition*, by Shaw © 1991. Reprinted with permission of Wadsworth, a division of Thomson Learning. Fax 800 730-2215.]

There was a time when the "made in Japan" label brought a predictable smirk of superiority to the face of most Americans. The quality of most Japanese products usually was as low as their price. In fact, few imports could match their domestic counterparts, the proud products of 'Yankee know-how.' But by the late 1960s, an invasion of foreign made goods chiseled a few worry-lines into the countenance of American industry. And in Detroit, worry was fast fading to panic as the Japanese, not to mention the Germans, began to gobble up more and more of the subcompact auto market.

Never one to take a back seat to the competition, Ford Motor Company decided to meet the threat from abroad head-on. In 1968, Ford executives decided to produce the Pinto. Known inside the company as "Lee's car," after Ford president Lee Iacocca, the Pinto was to weigh no more than 2,000 pounds and cost no more than $2,000.

Eager to have its own subcompact ready for the 1971 model year, Ford decided to compress the normal drafting-board-to-showroom time of about three-and-a-half years into two. The compressed schedule meant that any design changes typically made before production-line tooling would have to be made during it.

Prior to producing the Pinto, Ford crash-tested eleven of them, in part to learn if they met the National Highway Traffic Safety Administration (NHTSA) proposed safety standard that all autos be able to withstand a fixed-barrier impact of 30 m.p.h. without fuel loss. Eight standard-design Pintos failed the tests. The three cars that passed the test all had some kind of gas-tank modification. One had a plastic baffle between the front of the tank and the differential housing; the second had a piece of steel between the tank and the rear bumper; and the third had a rubber-lined gas tank.

Ford officials faced a tough decision. Should they go ahead with the standard design, thereby meeting the production timetable but possibly jeopardizing consumer safety? Or should they delay production of the Pinto by redesigning the tank to make it safer and thus concede another year of subcompact dominance to foreign companies?

To determine whether to proceed with the original design of the Pinto fuel tank, Ford decided to do a cost-benefit study, which is an analysis of the expected costs and the social benefits of doing something. Would the social benefits of a new tank design outweigh design costs, or would they not?

To find the answer, Ford had to assign specific values to the variables involved. For some factors in the equation, this posed no problem. The costs of design improvement, for example, could be estimated at eleven dollars per vehicle. But what about human life? Could a dollar-and-cents figure be assigned to a human being?

Do you think Ford's cost–benefit analysis was legitimate or complete? What responsibilities to its customers do you think Ford had? What would you have done if you had been a Ford employee working on this problem?

Inside Intel: The Pentium Glitch

The following scenario is becoming increasingly common in the commercial world of computers and computer chips: A product is released for sale that has a few known "bugs." (See 1947 "Grace Hopper" on page 337 for the origin of this term.) The manufacturer faces a difficult dilemma: Do you hold up the release of a product until you can find and fix its bugs, or do you release the product for sale, hoping that the bugs won't cause many people trouble? The pace of innovation in these fields is so rapid that product lifetimes are no more than a few years, so holding a product back may cause the company to lose much of its share of the market. On the other hand, releasing the product with a bug may anger important customers. So what do you do?

A famous example of a bug in a microprocessor chip is the Intel Pentium incident. Intel, a leading maker of microprocessor chips, developed a new, fast microprocessor chip that it dubbed the "Pentium." In 1994, at just about the time it was running newspaper and television ads built around the theme "Intel Inside" to show which computers contained Intel chips, a research mathematician in Virginia reported that the Pentium could produce wrong answers in complex division problems. The reason was that some numbers had been left out of a table on the chip that contained certain division results. The question was, what was ethical and prudent to do about it?

Apparently hoping that the problem would just go away, the company at first asserted that the glitch would affect very, very few users. The company initially refused to simply replace old flawed chips with new corrected chips. Customers who sought replacements were queried about what kinds of computations they did routinely in order to weed out replacements for those unlikely to trigger wrong results.

After much critical airing in the press, Intel eventually agreed to exchange all flawed Pentium chips. The company also agreed to expand on its previous policy of confidentially informing computer manufacturers about known flaws in its chips; now, after the computer-makers have had the information about flaws for 30 days, the information is released to the general public. Threatened lawsuits were dropped, information about chip and circuit board flaws were posted on the Internet, and the price of Intel stock rose.

To make complex devices that work perfectly is extremely difficult, even though manufacturers use programs that "exercise" their products to ensure that they perform correctly. What was learned from the Pentium incident was that it's important to deal responsibly with flaws as soon as they're found. Was Intel alone in this situation? Not at all. In just the next year, a popular income tax preparation program was found to have a serious flaw, and security on a widely used network access system was shown by outsiders to be easily breached. In this last case, the company took quick action, admitting the problem, generating corrective software quickly, and finally enlisting the aid of its customers by offering a cash payment to anyone who found new bugs in its product.

3.2 Problems

3.1 You are a civil engineer working for your city, and have been asked to spend some of your time on the design of a rapid-transit system. Most of the money for the rapid-transit work comes from state and federal government funds. Your boss asks you to charge all your rapid-transit time on overtime "since it's being paid for by the government and they can afford it." What do you say?

3.2 Suppose you had been a mechanical engineer working for the Morton-Thiokol Company and had learned that the O-ring seals on the space shuttle Challenger's propulsion tanks might fail if a launch occurred when the rings were cold and therefore stiff. How would you have used this information to persuade NASA managers not to launch the Challenger?

3.3 You are asked by your boss to "reverse engineer" a new laptop computer that your main competitor has just featured at a trade show. Do you agree to carry out this unethical task? Explain. (Reverse engineering means finding how to duplicate a product made by someone else, so that your company can avoid the costs of research, development, and preproduction engineering that are borne by the first manufacturer.)