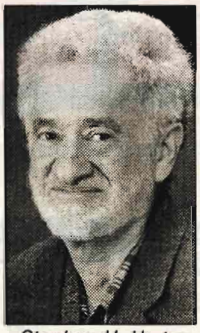
A matter of priorities

BY STEPHEN H. UNGER
Member, IEEE Ethics Committee

Nothing is risk-free. Crossing the street is obviously dangerous. Given the statistics on domestic accidents, it takes courage to stay home. Nothing we design can be 100 percent safe. But the IEEE ethics code requires members "to accept responsibility in making engineering decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment." A provision in the ethics codes of the other principal engineering societies (the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the American Institute of Mining Engineers and the National Society of Professional Engineers) states: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties." What do these rules tell us? A brief digression is necessary before answering this question.



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NECESSARY TRADEOFFS. Tradeoffs are intrinsic to engineering. In any nontrivial engineering task, it is seldom possible to optimize all significant factors simultaneously. Increasing the resistance of an NMOS logic-gate pull-up transistor reduces power supply drain and heat dissipation requirements, and increases noise margin. But it also degrades performance by increasing a key RC time constant. A tradeoff is necessary. Sometimes products are designed with different tradeoffs. Some laptop computers are relatively heavy, expensive and fast. Others are lighter, cheaper and slower.

The safety of a system can often be enhanced at added cost. Consider the hydraulic control systems of jumbo jets. While older jet airliners usually had two independent systems, jumbo jets generally have three. Are three enough? Bear in mind that if all such systems fail, the airplane will almost certainly crash. The Boeing 747 has four redundant hydraulic systems. Is this excessive? How likely is it that three independent hydraulic systems will all be disabled simultaneously? On July 30, 1971 a Pan American 747 took off from San Francisco Airport on a runway that was shorter than expected. The aircraft failed to clear the pier at the end of the runway. Various steel shafts and angle irons ripped through the hull of the plane, injuring several passengers and rupturing three of the hydraulic systems. The fourth survived (by inches), enabling the pilot to land safely.

SAFETY TAKES PRECEDENCE. How much redundancy is appropriate in such situations? Although there are no algorithmic solutions to such problems, the ethics provisions cited above provide guidance. Implicit in the IEEE rule and explicit in the other rule is the notion that safety is not just another factor to be traded off for cost, performance, convenience, etc. It takes precedence over all other design considerations and over profitability. Offering purchasers various laptop computers designed with different tradeoffs between performance and weight is perfectly acceptable. It is not acceptable to release a product with a known hazard if the expected net effect is that more people would be killed than would be the case if the hazard were eliminated. But if the fix is expensive, we must consider whether it might stimulate use of a cheaper competing product even more dangerous than the one with the hazard. (Safety standards embodied in law, often relevant, are not treated here.)

An important reason for not letting the marketplace decide if eliminating a hazard is worth the cost is that the purchaser is often not the only one at risk. Failure of an automobile steering system might kill not just the car owner, but also a friend who borrowed it, a passenger, a pedestrian or people in other cars. The "let the buyer beware" concept, long rejected by our legal system, is particularly inappropriate when new technology is continuously entering the stream of commerce. Should people have to evaluate the safety of all the systems and materials that affect them?

Stephen H. Unger is a Columbia University professor, director of IEEE Division VI and serves on the Administrative Committee, IEEE Society on Social Implications of Technology.

Send suggestions or comments for the Ethics Committee to Cathy Downer, IEEE Ethics Committee, 445 Hoes Lane, Piscataway, NJ, USA 08855-1331; e-mail: "ethics@ieee.org".