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Chronic Disease, Homeland Security, and Sailing to Where There Be Dragons

In 2005, then newly appointed U.S. Secretary of Homeland Security Michael Chertoff established a new emphasis for his agency. Concerned that responses to natural and man-made hazards had been ad hoc, inconsistent, and disorganized, he called for a risk-based approach. Rather than react to threats, or prioritize hazards based on probabilities or worst-case scenarios, he committed to integrating threat, vulnerability, and consequences into a combined, easily comparable metric of risk [1]. To many in the risk analysis community, this was welcome news, consistent with the growing notion that risk analysis can improve a broad range of societal decisions. To others, though, it was cause for concern.

From its origins helping wealthy Londoners estimate how much to invest in sending ships through seas "where there be dragons," risk analysis now appears in contexts spanning individual health,

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military planning, electricity production, and parlor games. We are regularly asked to "consider the risks," whether they come from imported foods, novel medicines, high school fertility education programs, or the release of carbon dioxide from fossil fuels. We are often told that we worry too much about one thing or too little about another, given the real risks involved.

Advocates of particular technologies often implore us to consider risks in context. It is irrational to reject genetically modified crops that can feed the world's hungry and starving. Nuclear power will save us from climate change, and nuclear weapons will maintain our freedom. Yes, they say, there are risks, but these are more than offset by the benefits.

Risk analysis now appears in contexts spanning individual health, military planning, electricity production, and parlor games.

Opponents of those technologies likewise rely on risk information. Nuclear power presents an unacceptable risk; we should avoid both it and fossil fuels. Nuclear weapons threaten life on Earth and undermine freedom. Genetically modified crops are poorly understood and threaten both democracy and small farmers' livelihoods. Each side in these issues concludes that the other is irrational, ignoring what science has to tell us about these trivial/devastating risks.

Presumably, risk analysis could help us with these dichotomous choices. At its best, risk analysis provides a systems perspective on complex decisions: we can estimate the probabilities that various bad things will happen, how bad those things are, and how much good will come from accepting those risks. The unspoken assumption is that, if we get the numbers right, the decision about nuclear power, nuclear weapons, or genetically modified crops, will be obvious.

The harder one looks at "risk," however, the more ephemeral it becomes. Population risk may help us think about the number of lost lives, cargoes, or other units that we should expect to associate with some offsetting benefit. But at the individual level, probabilistic statements lose any meaning. A captain will or will not lose his ship and crew to dragons on a given voyage. A person will or will not get cancer from a particular radiological exposure. Some fraction of the population may be more susceptible to disease than others, and we may or may not know which fraction.

Further, as we learn more about how individuals choose and process information, we find an even more uncertain role for calculated risks. An individual's preference for a particular risk/benefit tradeoff can depend, for example, on whether he is angry or happy at the time he makes the decision [2]. Preferences can be changed by irrelevant information, or by different framings of a particular piece of information. Describing a chance as "one in one thousand" leads to different choices than does describing the same chance as "0.001" or "one tenth of one percent" [3]. A choice described as "purchasing insurance" is more appealing than the identical choice described as "taking a gamble" (see, generally, [4]).

It often matters to people as well how they lose things. A family may take comfort when a 20 year old son dies trying to save a busload of school children, but would suffer greatly if that same son were killed by a stray bullet shot into the air by an unknown neighbor on New Year's Eve. A millionaire might feel more acutely the theft of the first dollar bill she earned than that of a random twenty dollar bill from her wallet. And as casinos know well, it can take several hours or even days before winnings become accepted as part of the winner's portfolio—and until it is "hers," she is more likely to stake or spend it. Lives may not be commensurable with lives, nor dollars with dollars.

These could be thought of as evidence of individual irrationality, for which the remedy is more skillfully calculated risk analysis. Such a strategy, however begs the question: which preference is the "real" one? The angry choice or the happy one? That associated with 0.001 or one in one thousand? Insurance or gamble? The heroic or the random death? To use risk analysis to make a decision, we must know what the preferred decision is. We often do not…and it may not even exist.

Moreover, one's preference for (or opposition to) a technology can shape whether one believes it imposes risks [5]. Advocates of nuclear power are often as confident that small doses of radiation are harmless — or even beneficial — as opponents are that radiation is dangerous at any level. Each side points to those studies that confirm its beliefs, and dismiss as junk science those that contradict them. In this, they are no different from most people on most issues — they seek affirming information and ignore the rest. And they dismiss those who disagree with them as irrational or antiscientific.

Engineers and actuaries define risk in computational terms, typically as the combined probability and consequence of some event. Anthropologist Mary Douglas countered that to most people risk is more closely related to the idea of sin [6]. To be put at risk, she argues, is a modern equivalent of being sinned against. Yet another perspective comes from sociologist Anthony Giddens, who equates risk with the absence of trust [7]. We feel at risk when those

institutions we trusted to keep us safe fail to do so — or even if we stop believing that they will do so. Gidden's perspective certainly explains American attitudes about flying much better than does expected value calculation: flying was far safer on September 21, 2001, than it had been on the morning of September 11, 2001. But that hardly suggests irrationality among those who were more anxious about flying on the later date!

> We are often told that we worry too much about one thing or too little about another, given the real risks involved.

At a recent Native American Forum on Nuclear Issues, a representative from the Nuclear Energy Institute put up a slide saying that nuclear power in the United States has generated "only a small amount" of nuclear waste, enough "to cover a single football field approximately 7 yards deep" [8]. Anti-nuclear activists in the crowd gasped at this enormous quantity. Both sides agreed that the number was valid. The unspoken question — which well represents the chasm between these two cultures — is "what, if any, amount is acceptable." To the nuclear industry, however much has been generated is obviously trivial. To opponents, none should have been generated, and any is too much. It is, therefore, pointless for either side to argue that knowing the actual amount — however precisely we can measure it — can help us decide what to do with it. Yet those arguments persist.

The examples and conditions above suggest that perhaps the biggest shortcoming of risk analysis is that too often it fails to ask the fundamental question "what is important to us?" Risk analysis — like any analysis — is a tool. It can provide helpful, albeit often uncertain, ambiguous, and incomplete, answers to such questions as "how much property damage will be caused for each 1000 teenage white males in Las Vegas next year?" And "how many lost lives should we expect if we run a 1-GW nuclear power plant for 40 years?"

But risk analysis cannot tell us, and nor should we ask it, how much property damage we should allow teenage drivers to cause, whether we should pursue a doubling of nuclear power, or whether it is right to send sailors to be eaten by dragons. These choices we should make carefully, and openly, leaving dumb analysis as a servant. If we decide that it is acceptable to lose every tenth ship to dragons, then we can use risk analysis to determine whether we expect to lose every fifth ship or every twentieth ship.

This special issue of *IEEE Technology and Society Magazine* explores the ragged role for risk analysis in several technology-intensive public issues. Three articles — those by Bales, Briggs and Carr — look at the occasionally explicit but more often implicit tradeoffs between risks to public health and risks to national security. They find that individual and institutional perspectives can lead to different interpretations of ambiguous data, credibility of purveyors of risk information, and acceptability of risks. Sims and Henke explore how a tight-knit and highly technical culture can shift under external pressure. Smith's work takes him to low lying Pacific islands, many now threatened by something scarier than the dragons once thought to dwell in the area: climate change and sea level rise. His article provides us with a field researcher's sense of what social, cultural, logistical and geographic hurdles a large, developed country should expect when providing vulnerability relief to small island nations. All five papers share the perspective that attitudes toward risk are strongly shaped by social context, and that understanding context can help us understand how risk decisions are made, and thereby how to make them better.

Sadly, this issue contains no articles concerning dragons. Then again, perhaps it does...

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