A few remarks on Baruch

The 2016 37th Annual Conference
of the
Society for Judgment and Decision Making

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Baruch joined CMU in 1987

As the founding Head of our Department of Engineering and Public Policy, I was one of several folks who worked hard to bring that about.

Baruch was the first social scientist to hold a tenure track position in our College of Engineering.

Since then:

Daniel
Armanios

Wändi
Bruine de Bruin

Alex
Davis

Mike
DeKay

Paul
Fischbeck

Baruch's presence…

… has contributed greatly to making our Department of Engineering and Public Policy the leading graduate program in the world that addresses problems in technology and public policy in which technical issues are of central importance.

Baruch has…

…sometimes explained the interaction of social and decision science in the process of policy research and analysis as follows:

> It's too early for social science...it's too early for social science...
>
> *Woops.* It's too late.

One of Baruch's major contributions in EPP has been to make sure that does not happen in the problems we address.

Baruch and I…

…have co-autored 22 papers together:

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M. Granger Morgan, Baruch Fischhoff, Lester Lave, and Paul Fischbeck, "A Proposal for Ranking Risk within Federal Agencies," in *Comparing Environmental Risks: Tools for setting government priorities*, J. Clarence Davies (ed.), 111-148, Resources for the Future, 1996.

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M. Granger Morgan, H. Keith Florig, Michael DeKay, Paul Fischbeck, Kara Morgan, Karen Jenni, and Baruch Fischhoff, "Categorizing Risks for Risk Ranking," *Risk Analysis*, *20*(1), 49-58, 2000.

Cynthia J. Atman, Ann Bostrom, Baruch Fischhoff and M. Granger Morgan, "Designing Risk Communications: Completing and correcting mental models of hazardous processes, Part I," *Risk Analysis*, 14(5), 779-788, October 1994. Also reprinted in Simon Gerrard, R. Kerry Turner, and Ian Bateman (eds.), *Environmental Risk Planning and Management*, Chapter 18, Edward Elgar Publishers, 251-260, 2001.

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Baruch Fischhoff and M. Granger Morgan, "The Science and Practice of Risk Ranking," *Horizons*, *10*(3), 2009.

I'm going to use my few minutes to talk about two large projects we've worked on.

Risk Communication

In the early 1980s, people across government, industry and academia began talking about how important they believed it was to engage in good risk communication.

However, while lots of people were talking about it, and a variety of people had ideas about how it should be done, nobody had conducted the necessary empirical studies to determine how good risk communications could actually be developed.

Finally, in 1987…

…the National Science Foundation issued a request for proposals to develop an empirically based approach to risk communication.

Baruch, Lester Lave, and I were fortunate to write the winning proposal.

This support, together with support from the Electric Power Research Institute, launched us on a multi-year program of studies designed to understand various aspects of risk communication and to create an empirically based approach to developing effective risk communication messages.

This work…

… resulted in a considerable amount of applied social science, five PhDs and over 30 refereed publications.

However, at its heart, it was an engineering enterprise.

We set out to develop risk communications that people could understand and find useful for the risk related decisions they actually faced. While theory and experiments were important, the ultimate measure of success lay in producing real risk communications, testing them, and demonstrating that they did a better job than communications developed using more traditional *ad hoc* methods.

The traditional approach…

… to risk communication had been a simple two-step process:

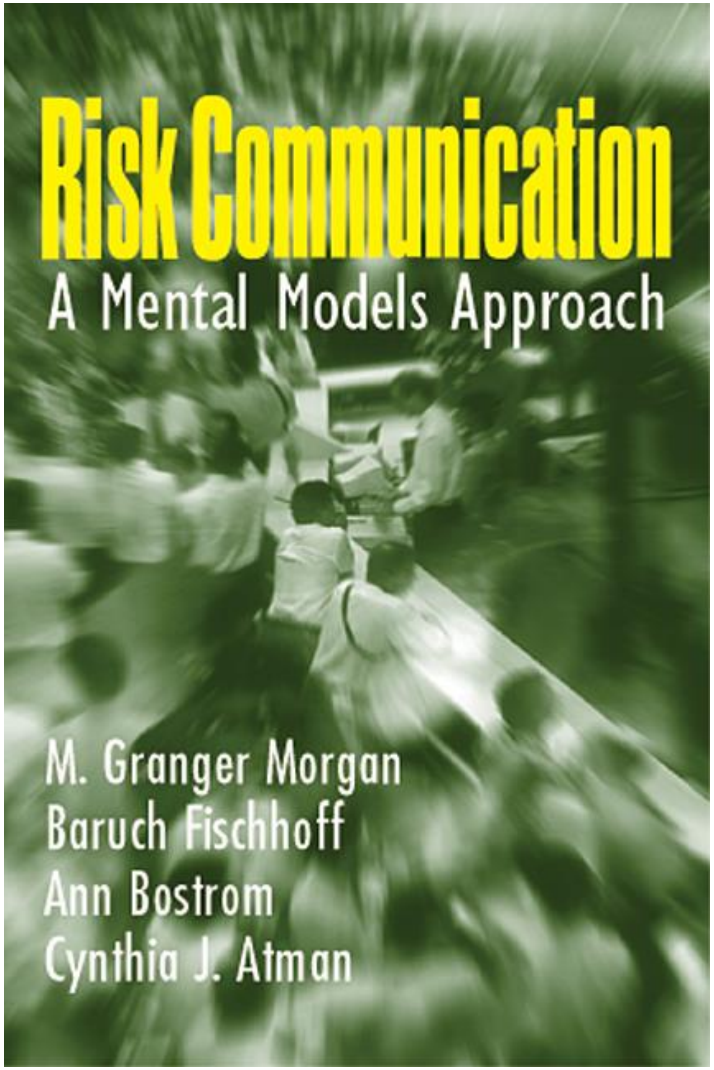
1. Get some health and safety specialist to tell you what people need to know;
2. Give the material to a "communications expert" to package it.

But, doing it this way ignores what people already know. It also (largely) ignores what they need to know to make informed risk-related decisions.

This led us…

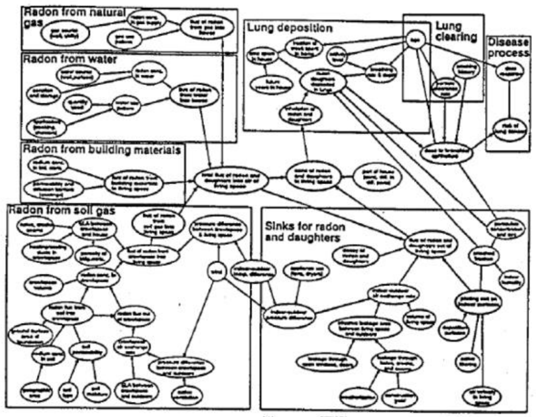
…to develop a five-step "mental model" based approach to risk communication:

Step 1: Create an expert model.
Step 2: Conduct mental models interviews.
Step 3: Conduct closed-form survey.
Step 4: Prepare a draft communication.
Step 5: Evaluate communication.

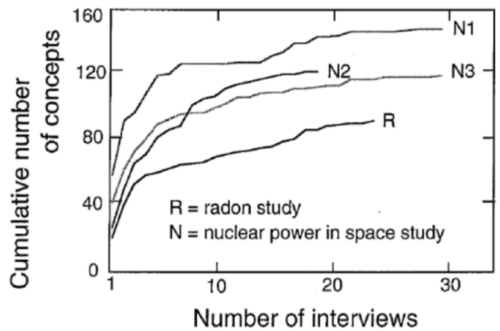


M. Granger Morgan, Baruch Fischhoff, Ann Bostrom and Cynthia Atman, *Risk Communication: A mental models approach*, 351pp, Cambridge University Press, New York, 2002.

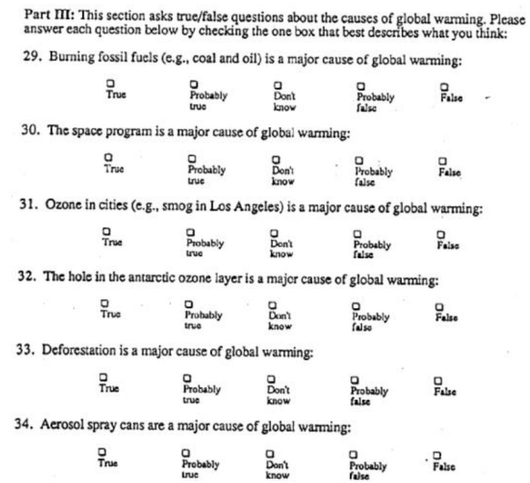
Step 1



Step 2



Step 3



Part III: This section asks true/false questions about the causes of global warming. Please answer each question below by checking the one box that best describes what you think:

29. Burning fossil fuels (e.g., coal and oil) is a major cause of global warming:

☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

30. The space program is a major cause of global warming:

☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

31. Ozone in cities (e.g., smog in Los Angeles) is a major cause of global warming:

☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

32. The hole in the antarctic ozone layer is a major cause of global warming:

☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

33. Deforestation is a major cause of global warming:

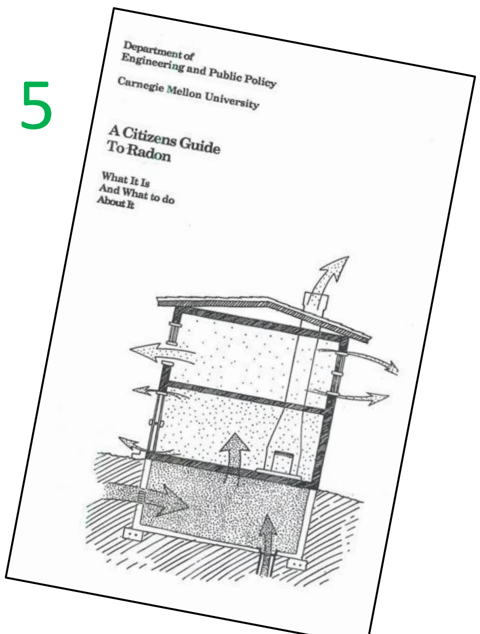
☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

34. Aerosol spray cans are a major cause of global warming:

☐ True ☐ Probably true ☐ Don't know ☐ Probably false ☐ False

Step 4

Step 5



Risk Ranking

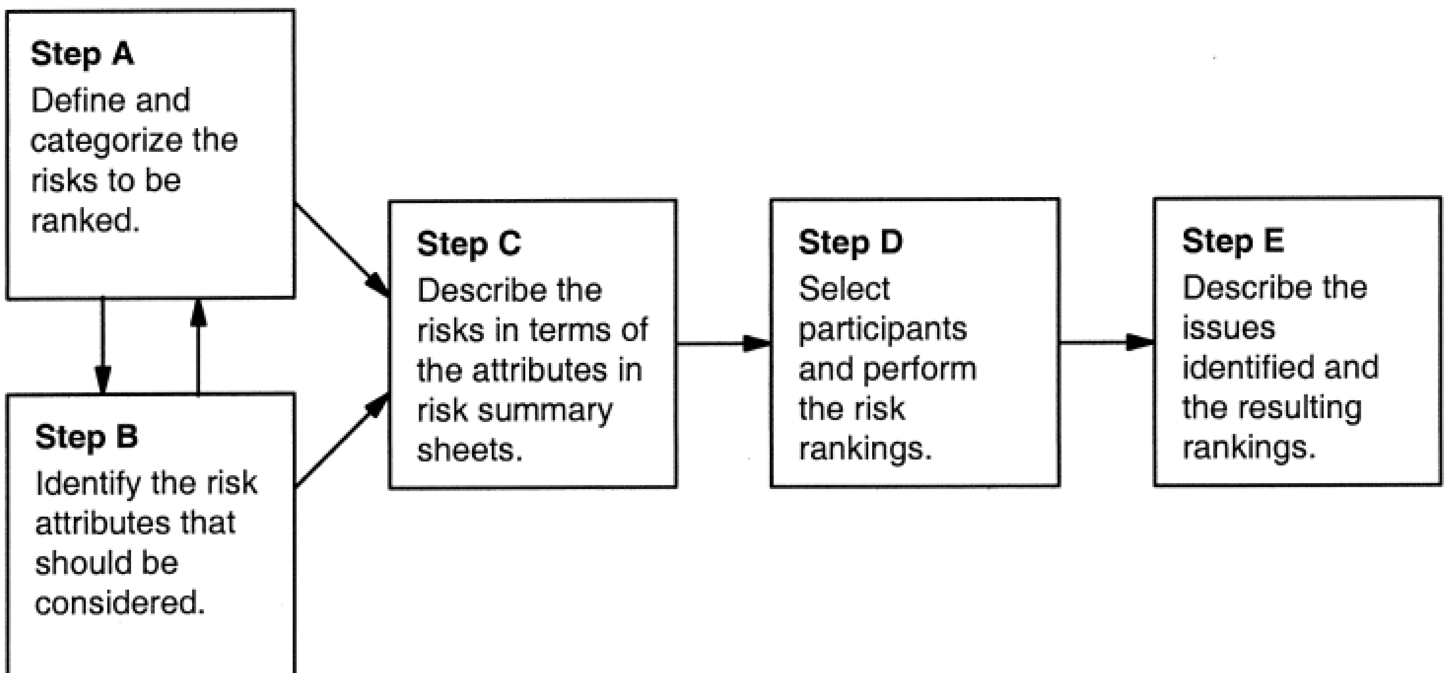
In 1986, the U.S. EPA undertook a study titled *Unfinished Business*, that ranked the various environmental problems that staff believed still needed attention. This was followed by two studies conducted by the EPA Science Advisory Board.

The U.S. EPA's Regional and State Planning Bureau then supported approximately 50 local and regional comparative risk projects in which experts and lay people worked together to develop rankings.

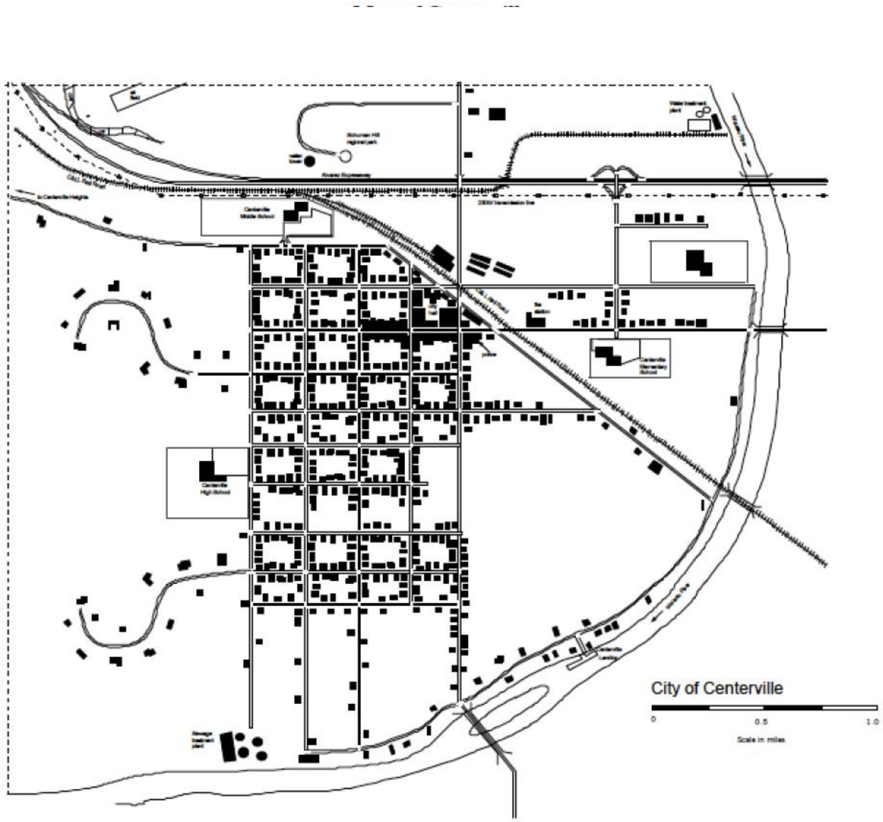
Several other U.S. agencies, as well as agencies in Canada and New Zealand, also engaged in such activities.

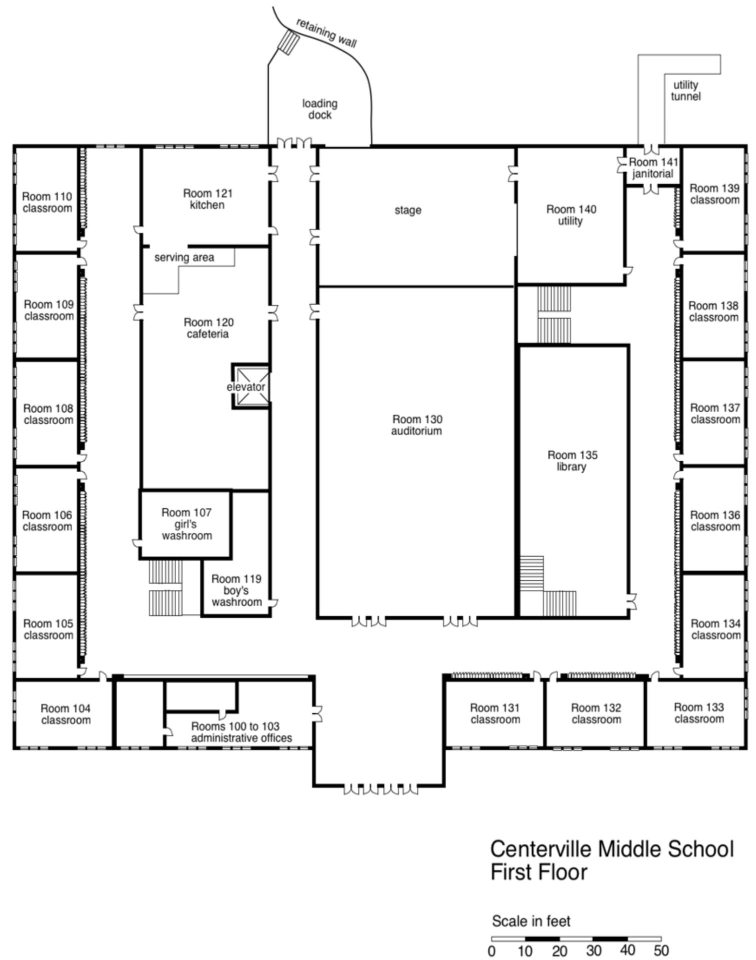
Admirable…

…as these efforts were, the methods employed were entirely *ad hoc*. With support from EPA, NSF and EPRI we developed, demonstrated and assessed a method to perform such rankings.

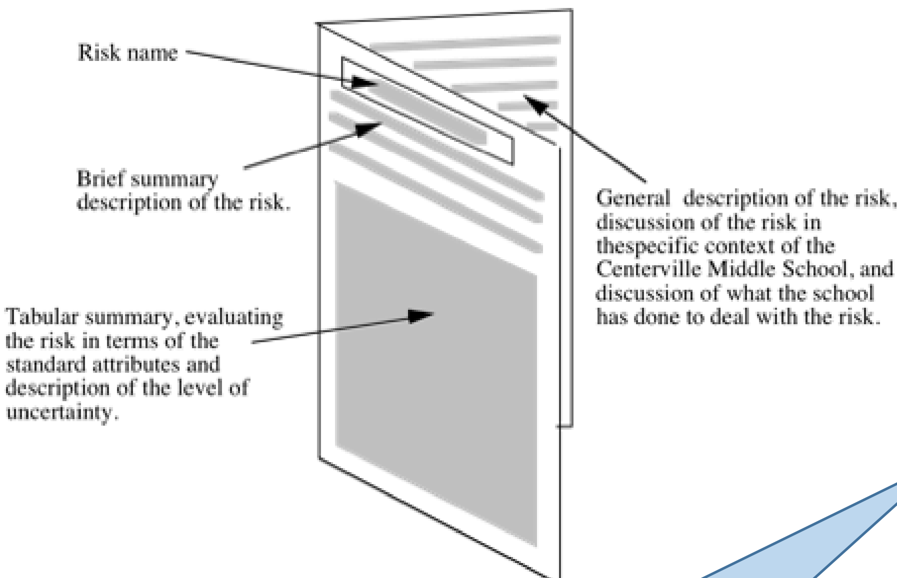


Centerville School Study

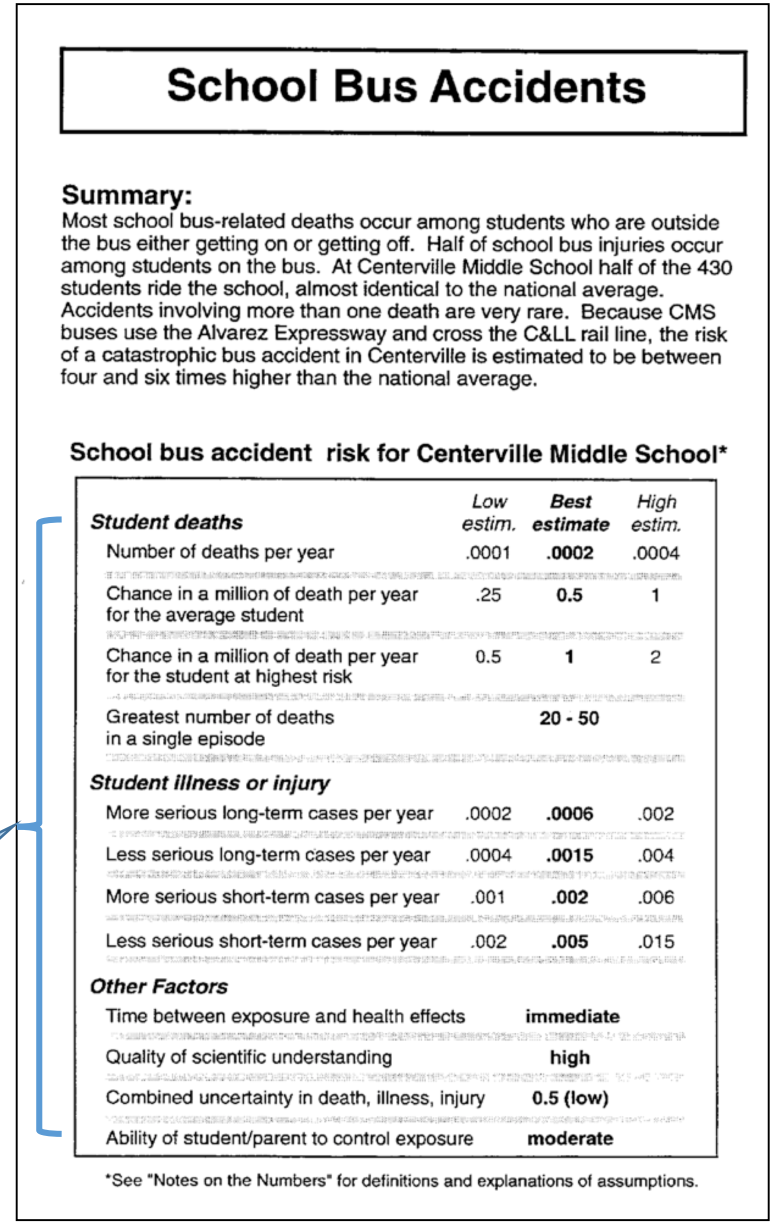




Example of a risk summary sheet



Attributes selected from the Slovic, Fischhoff and Lichtenstein risk factor space.



School Bus Accidents

Summary:
Most school bus-related deaths occur among students who are outside the bus either getting on or getting off. Half of school bus injuries occur among students on the bus. At Centerville Middle School half of the 430 students ride the school, almost identical to the national average. Accidents involving more than one death are very rare. Because CMS buses use the Alvarez Expressway and cross the C&LL rail line, the risk of a catastrophic bus accident in Centerville is estimated to be between four and six times higher than the national average.

School bus accident risk for Centerville Middle School*

Student deaths	*Low estim.*	***Best estimate***	*High estim.*
Number of deaths per year	.0001	**.0002**	.0004
Chance in a million of death per year for the average student	.25	**0.5**	1
Chance in a million of death per year for the student at highest risk	0.5	**1**	2
Greatest number of deaths in a single episode		**20 - 50**	
Student illness or injury			
More serious long-term cases per year	.0002	**.0006**	.002
Less serious long-term cases per year	.0004	**.0015**	.004
More serious short-term cases per year	.001	**.002**	.006
Less serious short-term cases per year	.002	**.005**	.015
Other Factors			
Time between exposure and health effects		**immediate**	
Quality of scientific understanding		**high**	
Combined uncertainty in death, illness, injury		**0.5 (low)**	
Ability of student/parent to control exposure		**moderate**	

*See "Notes on the Numbers" for definitions and explanations of assumptions.

Validation

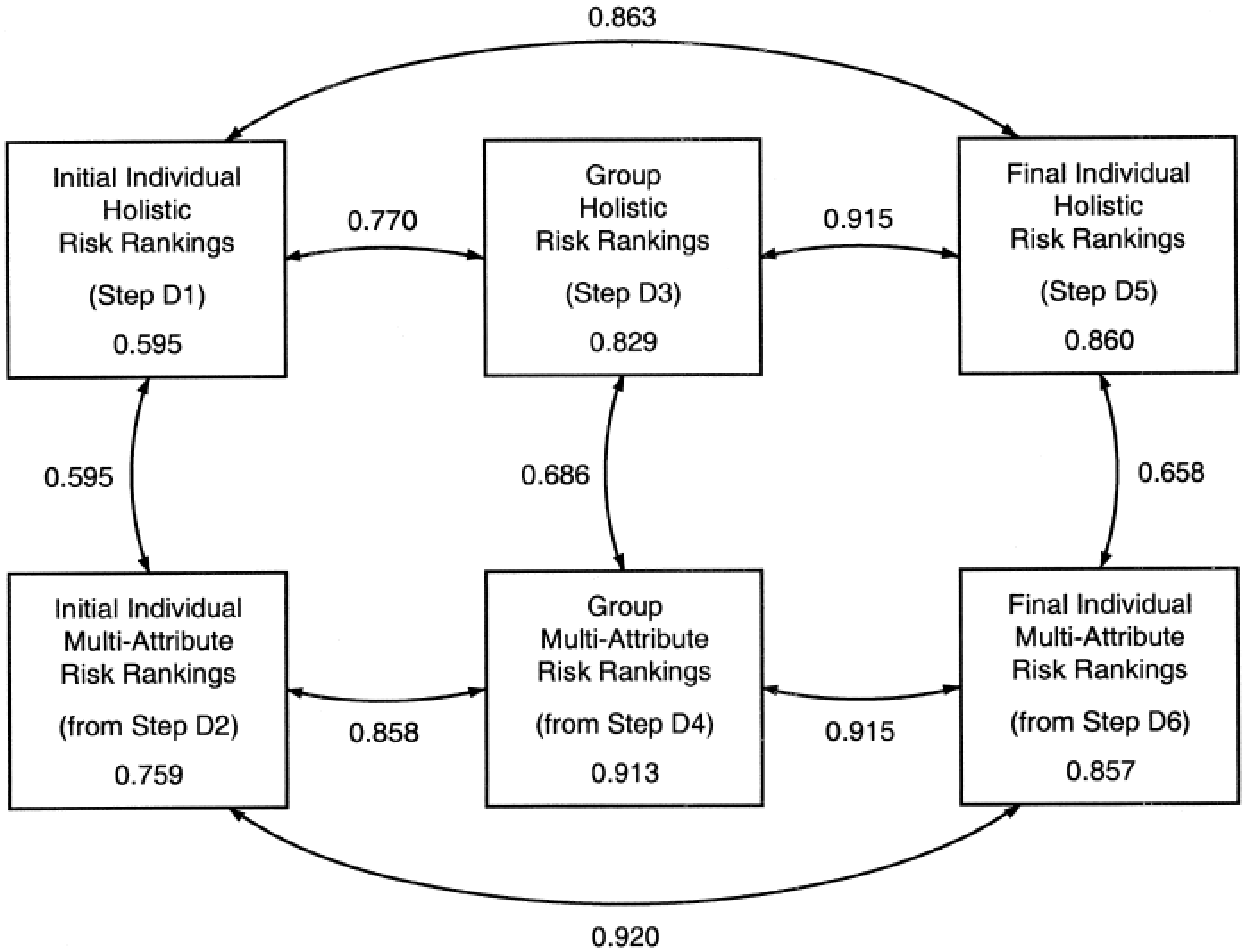


Fig. 1. Results from correlational analyses. Numbers next to arrows are mean Spearman correlations between risk rankings. When individual participants' rankings were involved, correlations were computed at the individual level and averaged within groups; the means reported here are the means of those group means. Numbers within boxes are mean pairwise Spearman correlations among individual participants' rankings (Steps D1, D2, D5, and D6) or among groups' rankings (Steps D3 and D4; see Sections 3.1 to 3.3 for details). Some tasks were not completed in some sessions (see Section 2.3.1 for details). Results of some analyses for individual risk sets are shown in Tables I and II.

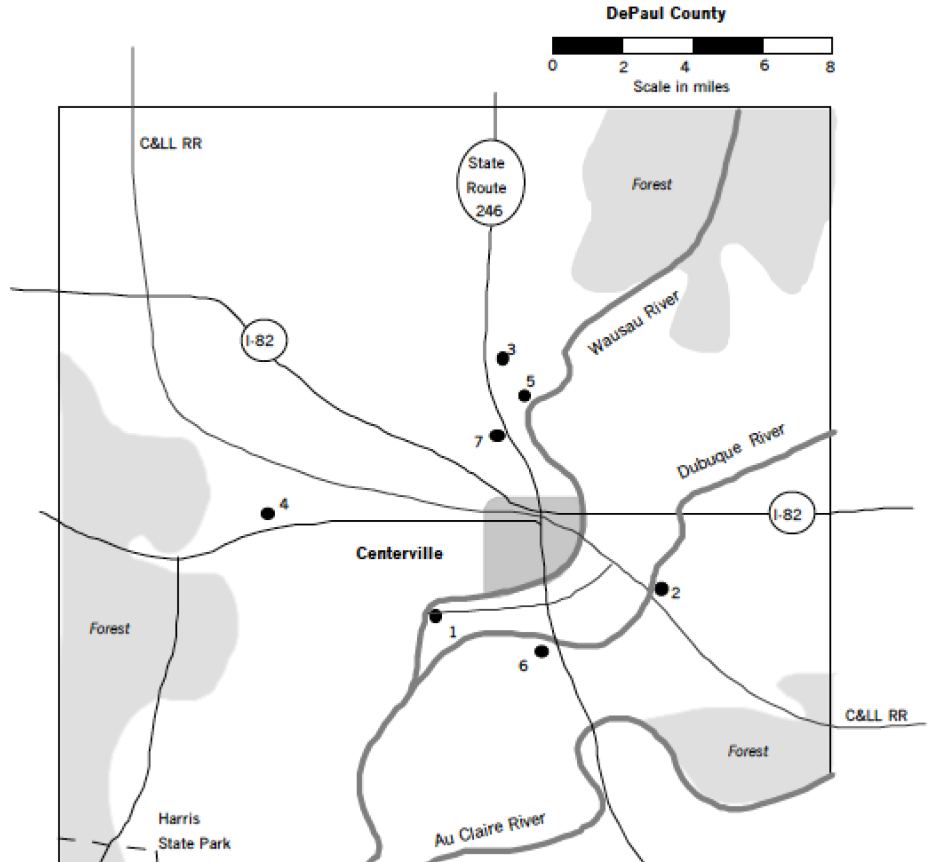
We went on to add ecological risks

Road Salt and Road Salt Runoff

Summary:
As in other parts of the country which experience ice and snow in the winter, the DePaul County Highway Department and the Centerville Department of Public Works use salt as a deicing agent on roads in winter months. Salt runoff and spray can adversely affect plants and some other life forms. In some circumstances, sensitive trees near salted roads can be killed. Salt runoff can contaminate ground water. Salt also contributes to the accelerated deterioration of structural materials such as concrete and steel in structures such as bridges and auto bodies. This deterioration increases the risk of automobile-related injuries and fatalities.

Human Health and Safety Impacts	Low Estimate	Best Estimate	High Estimate
Risk of death			
For the average person –			
Chance in a million of death per year	4	8	15
Expected number of deaths per year	0.05	0.1	0.2
For the person at highest risk, chance in a million of death per year	11	20	35
Catastrophic potential, greatest number of deaths in a single event		5–20	
Risk of injury and illness			
Serious injuries and illnesses, number of cases per year	2	4	8
Minor injuries and illnesses, number of cases per year	4	8	15
Other factors			
Time between exposure and health effects		immediate	
Scientific understanding and predictability of health and safety impacts		high	
Ability of individual to control one's own exposure to health and safety risks		medium	

Environmental Impacts	Low Estimate	Best Estimate	High Estimate
Ecological effects			
Habitat affected –			
Acres	3,000	5,300	10,000
Square Miles	5	8	16
Animals killed or displaced, number		few	
Effects on variety of native species		small	
Ecological significance of affected species and habitat		medium	
Effects on natural processes and cycles		low	
Catastrophic potential, magnitude of worst-case effects		low	
Aesthetic effects			
Changes in landscape appearance		small negative (–3)	
Effects on noise, smell, taste, and visibility		little or no change (0)	
Other factors			
Time between exposure and environmental effects		0–5 years	
Duration of environmental effects, assuming the current activity or stress does not continue, but no other corrective actions are taken		0–30 years	
Scientific understanding and predictability of environmental impacts		somewhat high	
Negative effects on the environment's capacity to provide goods and services to people		small	



1. Fishkill Power Plant
2. Site of former Johnson's Wood Products Plant
3. DeKay County Sanatary Land Fill
4. Cebulka's Premium Chickens
5. Ganley Estates
6. Feldman's Feeds
7. Site of proposed Twin Pines Mall

Finally, two favorites.

Assessing uncertainty in physical constants

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Assessing the uncertainty due to possible systematic errors in a physical measurement unavoidably involves an element of subjective judgment. Examination of historical measurements and recommended values for the fundamental physical constants shows that the reported uncertainties have a consistent bias towards underestimating the actual errors. These findings are comparable to findings of persistent overconfidence in psychological research on the assessment of subjective probability distributions. Awareness of these biases could help in interpreting the precision of measurements, as well as provide a basis for improving the assessment of uncertainty in measurements.

I. INTRODUCTION

Accurate estimates of the fundamental constants of physics, such as the velocity of light or the rest mass of the electron, are central to the enterprise of science.[1] Like any measurements, they are subject to uncertainties from a variety of sources. Reliable assessments of this uncertainty are needed (a) to compare the precision of different measurements of the same quantity, (b) to assess the accuracy of other quantities derived from them, and, most crucially, (c) to evaluate the consistency of physical theory with the current best measurements. Thus, as Eisenhart has pointed out, "A reported value whose accuracy is entirely unknown is worthless."[2]

It is not unusual to encounter individual examples of errors in measurements of physical quantities that turn out to be disconcertingly large relative to the estimated uncertainty. One well-known case was in R. A. Millikan's oil-drop experiment in 1912 to determine *e*, whose result turned out 15 years later to be off by 0.6% or three standard deviations due to reliance on a faulty value for the viscosity of air.[3] A more recent example concerns measurements of $|\nu_{+-}|$, the parameter that measures the degree of violation of CP (charge-conjugation-parity) invariance. The six measurements prior to 1973 agreed reasonably, but more accurate measurements since then differ consistently by about seven standard deviations from the pre-1973 mean, a discrepancy that remains unexplained in terms of experimental procedure.[4] Such extreme cases may be exceptions, but they raise the more general question of how well on the average reported uncertainties reflect actual errors, an issue on which there has been little systematic study.[5] Here we will present evidence from historical measurements of a range of physical constants to illustrate the scope of the problem of underestimation of uncertainty. A wider awareness of such results may help in interpreting reported uncertainties, and may have some important educational implications.

A *comprehensive* assessment of uncertainty cannot rest solely on statistical analysis. Unavoidably, it involves a considerable element of subjective judgment. Therefore, we shall first review some recent findings of cognitive psychology from laboratory studies of human judgment under uncertainty. After examining evidence from measurements of physical constants, we will discuss possible explanations for these problems in the light of the psychological literature, and explore the prospects for alleviating them.

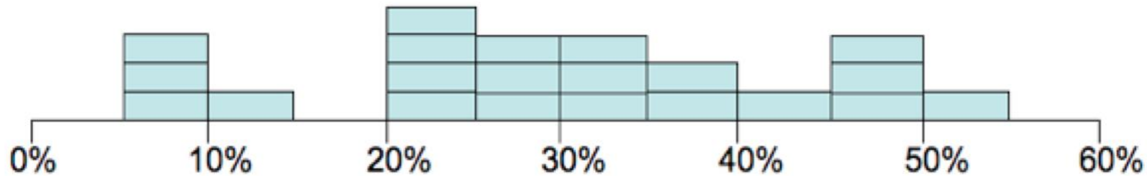
II. THE PSYCHOLOGY OF JUDGMENT UNDER UNCERTAINTY

The premise of laboratory studies of human judgment is that all judgments are governed by a set of core cognitive processes.[6] If those can be understood in experimental settings, then reasonable speculations can be made about human performance in the real world.[7] This literature has revealed both strengths and weaknesses. Where people have the explicit training or where there has been the opportunity to receive clear, prompt feedback, people can assess many aspects of uncertain processes. For example, weather forecasters in the U. S. provide assessments of the probability of precipitation that are probabilistically *well calibrated*: It rains on about 70% of the occasions on which they forecast a 70% probability of rain.[8] They have developed this ability through years of hands-on experience, with guidance from computer models, with ample feedback, and within an institution that rewards them for candor (rather than, say, for exuding confidence or avoiding firm commitments). In less favorable circumstances, however, people often lack an intuitive feel for probabilistic processes, relying instead on mental "heuristics" (deterministic rules of thumb) to guide their judgments. Although often useful, these rules can lead to predictable biases.

In these studies, the intutive asessment of uncertainty has proven to be especially problematic.[9] People seem insufficiently sensitive to how much they know, so that changes in knowledge are accompanied by inappropriate changes in confidence. The most common problem is *overconfidence*. A common way to assess the precision of an uncertain quantity is by a subjective confidence interval, indicating a range within which the assessor believes the true value has, say, a 98% chance of falling. The *probabilistic calibration* of a set of such judgments for different quantities may be measured by comparing the assessed probability for the interval with the fraction of times the true value lies within it. Cases in which the true value (once known) turns out to fall outside the assessed confidence interval, may be termed "surprises." The *surprise index* is the per-

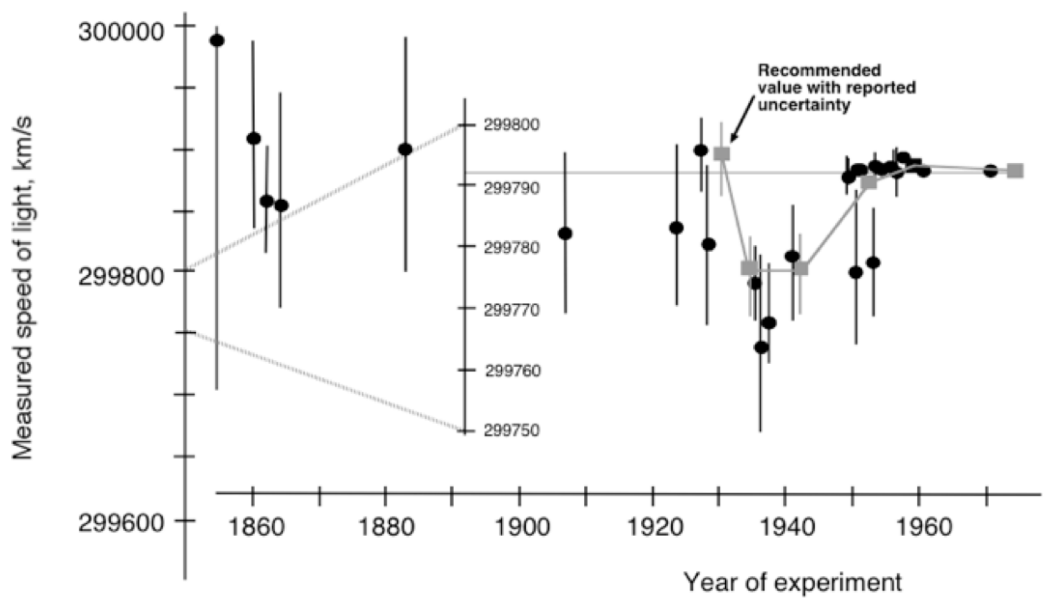
Max Henrion and Baruch Fischhoff, "Assessing Uncertainty in Physical Constants," *American Journal of Physics, 54*(9), pp. 791-798, 1986.

You’ve all seen the compelling evidence on overconfidence:



Percentage of estimates in which the true value lay outside of the respondent's assessed 98% confidence interval.

What this paper showed is that experts are subject to the same problem:



The 2nd of two favorites

Value Elicitation

Is There Anything in There?

Baruch Fischhoff — *Department of Social and Decision Sciences and Department of Engineering and Public Policy, Carnegie Mellon University*

Eliciting people's values is a central pursuit in many areas of the social sciences, including survey research, attitude research, economics, and behavior decision theory. These disciplines differ considerably in the core assumptions they make about the nature of the values that are available for elicitation. These assumptions lead to very different methodological concerns and interpretations, as well as to different risks of reading too much or too little into people's responses. The analysis here characterizes these assumptions and the research paradigms based on them. It also offers an account of how they arise, rooted in the psychological and sociological contexts within which different researchers function.

Taken all together, how would you say things are these days—would you say that you are very happy, pretty happy, or not too happy?

—National Opinion Research Center (NORC), 1978

Think about the last time during the past month that you were tired easily. Suppose that it had been possible to pay a sum of money to have eliminated being tired easily immediately that *one* time. What sum of money would you have been willing to pay?

—Dickie, Gerking, McClelland, & Schulze, 1987, p. 19 (Appendix 1)

In this task, you will be asked to choose between a certain loss and a gamble that exposes you to some chance of loss. Specifically, you must choose either: Situation A. One chance in 4 to lose $200 (and 3 chances in 4 to lose nothing). OR Situation B. A certain loss of $50. Of course, you'd probably prefer not to be in either of these situations, but, if forced to either play the gamble (A) or accept the certain loss (B), which would you prefer to do?

—Fischhoff, Slovic, & Lichtenstein, 1980, p. 127

600 people are ill from a serious disease. Physicians face the following choice among treatments: Treatment A will save 200 lives. Treatment B has 1 chance in 3 to save all 600 lives and 2 chances in 3 to save 0 lives. Which treatment would you choose, A or B?

—Tversky & Kahneman, 1981, p. 454

Problematic Preferences

A Continuum of Philosophies

A critical tenet for many students of other people's values is that "If we've got questions, then they've got answers." Perhaps the most ardent subscribers to this belief are experimental psychologists, survey researchers, and economists. Psychologists expect their "subjects" to behave reasonably with any clearly described task, even if it has been torturously contrived in order to probe esoteric theoretical points. Survey researchers expect their "participants" to provide meaningful answers to items on any topic intriguing them (or their clients), assuming that the questions have been put into good English. Economists expect "actors" to pursue their own best interests, thereby making choices that reveal their values, in whatever decisions the marketplace poses (and economists choose to study).

This article examines this *philosophy of articulated values* both in its own right and by positioning it on a continuum of philosophies toward value formation and measurement. At the other end of this continuum lies what might be called the *philosophy of basic values*. It holds that people lack well-differentiated values for all but the most familiar of evaluation questions, about which they have had the chance, by trial, error, and rumination, to settle on stable values. In other cases, they must derive specific valuations from some basic values through an inferential process.

Perhaps the clearest example of this latter perspective might be found in the work of decision analysts (Raiffa, 1968; von Winterfeldt & Edwards, 1986; Watson & Buede, 1988). These consultants lead their clients to decompose complex evaluation problems into basic dimensions of concern, called *attributes*. Each attribute represents a reason why one might like or dislike the possible outcomes of a decision. For example, the options

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My special thanks go to Robert Abelson, who suggested the juxtaposition that is explored here, and to Charles Turner, who has stimulated concern for nonsampling error for many years. My thinking on these issues has benefited from discussions with many people, including Lita Furby, Robyn Dawes, Paul Slovic, Sarah Lichtenstein, Amos Tversky, Daniel Kahneman, Alan Randall, and Robin Gregory. I have also received valuable comments from participants in the National Research Council Panel on Survey Measure of Subjective Phenomena; the Russell Sage Foundation Conference, "Towards a Scientific Analysis of Values"; and the U.S. Forest Service Conference on Amenity Resource Valuation.

Correspondence concerning this article should be addressed to Baruch Fischhoff, Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, PA 15213.

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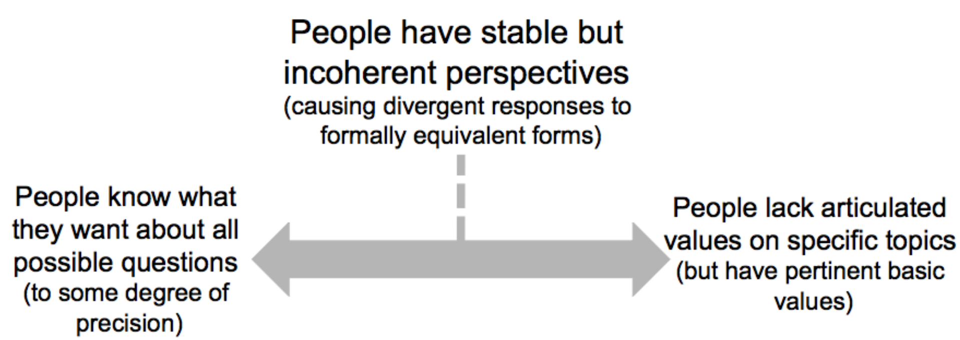
Baruch Fischhoff, "Value Elicitation: Is There Anything in There?," *American Psychologist*, *46*(8), pp. 835-847, 1991.



Images from YouTube and google

Thanks Baruch

- For all your great work
- For your many years of friendship
- For all the fun we have had.

It is time to find something else to work on together!