UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

Joint Meeting of the Panels on Risk and Performance Analysis
and the Environment and Public Health

Perceptions of Risk and Social and Economic Impacts

St. Tropez Hotel
Las Vegas, Nevada
May 23, 1995

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Dr. John J. McKetta

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Dr. Stephen J. Kraus, Marketing and Planning Systems
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Dr. James J. Opaluch, University of Rhode Island
Dr. Howard Schuman, University of Michigan
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I N D E X

P R O C E E D I N G S

DR. BREWER: I'd like to start the meeting, and do so by welcoming everyone to this joint session of the Risk and Performance Analysis, and the Environment and Public Health Panels of the Nuclear Waste Technical Review Board. I'm Garry Brewer. I chair both of the panels. In my other life, I'm the Dean of the School of Natural Resources and Environment at the University of Michigan.

Basically, what we're doing today is looking at the question of risk from the point of view of perceptions, looking at the question of risk perception, specifically, as it's related to a nuclear waste disposal repository, and significant social and economic impacts, so the chain, as you'll see in the agenda of the day, begins with risk and risk perception, and works its way through behavior, and from behavior to impact, and from impact, in social and economic terms, to mitigation and compensation.

So, we've got at least a logic which is underlying the whole of the presentation today, and that logic will be demonstrated as we go from piece to piece and chunk to chunk, going from the risk perception all the way to the logical conclusion of mitigation and compensation, with stops at behavior and impact along the way.

I would like to, at this time, introduce colleagues from the Nuclear Waste Technical Review Board; John Cantlon, who is our chairman, Vice President of Research and Graduate Studies Emeritus at Michigan State University, and I'll say nothing about Michigan and Michigan State, if you do the same.

Ed Cording, who is here, Professor of Civil Engineering at the University of Illinois. John McKetta is not with us today, although he had planned on being here. We have, as well, Professor Dennis Price, who is a consultant to the Board, former member of our Board, who is a Professor of Industrial Systems Engineering at VPI, Virginia Polytechnic Institute and State University, and to Dennis's left is Dr. Pat Domenico, Professor of Geology at Texas A&M, former Board member, colleague and a continuing consultant to the Board.

Now, a few words for those of you in the audience who need to know something about the Board. The Nuclear Waste Technical Review Board was established by Congress to evaluate the technical and scientific activities undertaken by DOE to characterize Yucca Mountain as a potential site for a high-level nuclear waste repository. That, in about a sentence, is what the Board's function is, technical and scientific oversight and review.

The Department of Energy, under its current program plan or approach, has determined that it will make the formal

determination of site suitability according to its regulations, 10 CFR 960, a regulation DOE promulgated in 1984.

In a December, 1994 letter to Dr. Dan Dreyfus, our Board expressed its views on how the DOE might evaluate some of the physical characteristics of the site, such as faulting and coupled processes, all of these that are important for site suitability.

Under its regulations, the DOE must also make a higher level finding with respect to the socioeconomic impacts of siting, constructing, operating, closing, and decommissioning a repository. Now, this is important, because it describes what we're doing today.

In particular, the DOE, by analysis, must determine that locating a repository at Yucca Mountain would not cause significant social and economic impacts to surrounding communities and regions that could not be offset by reasonable mitigation or compensation. To get back to my opening comments, we go from risk perceptions to behavior, to impact, to mitigation and compensation, trying to explore the territory.

The Panel on Environment and Public Health first convened a session on socioeconomic impacts way back in October of 1990, so this is not a first for us, although getting to the place of looking at risk perception is

somewhat new territory. We've been in the business for at least four or five years of asking questions related to the environment and socioeconomic issues.

At our meeting in January of '95 in Beatty, Nevada --and I see some familiar faces from up at Beatty--the Department of Energy described activities that were underway to look at social and economic impacts that might be connected to population changes caused by repository development. We term these regular effects in terms of social and economic social sciences, which are related and demonstrated here. In a March 3rd letter to Dr. Dreyfus, the Board conveyed its initial views on the adequacy of those efforts, and that, of course, is in the public domain.

Now, today, we're going to be looking at socioeconomic impacts from a somewhat different perspective. Third time. I'm sort of emphasizing the point, because it's important. We want to explore the proposition that perceptions of risk associated with a repository lead to significant adverse social and economic effects. We're exploring the proposition.

The Board recognizes that there is some disagreement about whether a federal agency is legally required to examine perception-based impacts, and I'm going to say this very carefully and slowly to make it really clear: The Board does not take any position on that

question, the question being whether or not we should be examining perception-based impacts.

The purpose of the meeting today is to ventilate the methodological, empirical, and analytic issues, the technical questions that would have to be addressed to reach a grounded and sound conclusion on the validity of the proposition that I stated earlier. By doing so, we hope to provide information that'll be useful to the Department of Energy in making its decision about whether to pursue the question of perception-based impacts in the context of its site suitability decision.

Because, to date, the DOE has not undertaken a substantial effort in this area, this meeting is organized differently from almost any that we've ever conducted before. It's an experiment on our part. We've invited a panel of distinguished social scientists to give their views on what it would take to test the proposition that risk perceptions cause significant adverse socioeconomic effects.

Some of those joining us today have carried out research sponsored by the State of Nevada. Others have conducted research paid for by the Department of Energy. Undoubtedly, the discussion today and tomorrow will draw upon the work that these individuals have published and are working on. It should be noted, however, that most of the panel has not been directly involved in the debate over

perception-based impacts. In other words, they're going to be looking at the issue from a qualified expert scientific basis, but from a disengaged, or disinterested point of view. They won't have a stake in it.

I would also like to point out that everyone serving on this panel is doing so pro bono. No one is being paid by the Board for their services and what they are presenting for us today.

I should also point out that we are really quite honored to have two former presidents of the Society for Risk Analysis, Warner North and Paul Slovic, and in terms of a professional association or affiliation, to get to the topics on the table and on the agenda for today and tomorrow, I would imagine that this is the professional association of record, isn't it? If not, it is now.

So, what's our role, speaking on behalf of the Nuclear Waste Board and my colleagues? What are we doing today? We are operating as honest broker--which is something that we try very hard to do. We are operating as a convener. We are operating in the role of creating a place, a working environment, this workshop, where questions that are quite difficult, technically difficult, difficult from the point of view of the social science, the practical implications of it, where these can be explored, and explored with the help of some of the finest people in the field.

In this particular role, in my role as chairman of the session today and tomorrow, I would like to thank now, and to acknowledge publicly the special efforts of two of our panel members, Paul Slovic and Hank Jenkins-Smith.

Paul and Hank come here today not as representatives of their research sponsors, and this is something that everyone in the audience needs to know, and I'm saying it straightforwardly. They are coming here as consultants to us on the Board. They've helped us frame the questions. They've helped us select others on this panel to help us explore these very difficult questions, and so, I want to acknowledge their role, and, also, right now, we thank them very much for the efforts already expended getting us to this point.

Now, before we get going with the agenda, I want to take a moment and just go around the table and invite each of the panel members to spend a moment or two, identify yourself and explain who you are, where you're coming from--physically, metaphysically.

Would you, please?

DR. BASSETT: My name is Gil Bassett. I'm a Professor of Economics at the University of Illinois in Chicago.

DR. EASTERLING: My name is Doug Easterling. I'm a research coordinator of The Colorado Trust Foundation in Denver. I'm doing private consulting work for the State of

Nevada.

DR. JENKINS-SMITH: My name is Hank Jenkins-Smith. I'm at the Institute for Public Policy in the University of New Mexico, and I've been working for several years now on contracts through the university to study risk perception issues funded by the Department of Energy.

DR. KRAUS: I'm Steve Kraus. I'm an Associate with Marketing and Planning Systems, which is a Boston-based marketing and consulting firm. I was previously a Visiting Professor at the University of Florida, where a lot of my academic research focused on the relationship between attitudes and behavior, which is of some relevance to this issue.

DR. NORTH: I'm Warner North. I'm with a consulting firm called Decision Focus, located in Mountain View, California. I'm also associated with Stanford University as a consulting professor in the Department of Engineering Economic Systems. For the last year, I have been involved in a research project funded by the Department of Energy through Tulane University to develop an overview of risk issues associated with the six largest sites, in budgetary terms, of the nuclear waste, or, rather, the nuclear weapons complex.

Up until a year ago, I was a member of the Nuclear Waste Technical Review Board, and I've had some association with these issues in that context. In particular, I was a

member of the two panels that are sponsoring this particular meeting. It is delightful to be back here and to see many familiar faces in the audience, as well as the Board and staff, and I'm looking forward very much to this meeting.

DR. OPALUCH: Jim Opaluch. I'm a Professor of Natural Resource Economics at the University of Rhode Island.

DR. SCHUMAN: I'm Howard Schuman. I'm a research scientist at the Institute for Social Research, at the University of Michigan, and Professor of Sociology there.

I'm actually from the peninsula of Maine, just south of Maine Yankee Nuclear Plant in Maine, and let me just note that until two or three weeks ago, I had actually no involvement or experience, or even reading in this area. I've tried to get up to speed, and I visited Maine Yankee a few days ago, and I've been reading lots of papers.

DR. SLOVIC: I'm Paul Slovic from Decision Research in Eugene, Oregon, a research institute, and also the Psychology Department at the University of Oregon. My interests are in risk assessment, decision making and judgment of risk perception.

For the last eight or nine years, I've been associated with the socioeconomic impact research program of the Nuclear Waste Project Office of the State of Nevada.

DR. VAUGHAN: My name is Elaine Vaughan, a Professor of Psychology at the School of Social Ecology at the University

of California. My research is on social, cultural, and other factors that influence how lay populations perceive risks of processed scientific information, and adapt to situations of risk.

DR. WILKINS: My name is Lee Wilkins. I'm a member of the Broadcast News faculty at the University of Missouri School of Journalism. My primary research focuses on media coverage of hazards, disasters, and risk, and media ethics. Not only do I not believe that last term is an oxymoron, I actually believe those two topics are related.

DR. BREWER: Okay, thank you very much.

One of the things that the Board conspired to do is to make sure that there is time for public comment on the things that we're doing, and as a matter of procedure, anyone in the public who, at some point, would like to have a moment to inquire of members of our panel, or to make a statement, you'll notice on the agenda, there's a time today at 4:45, and another time tomorrow at 10:15 where this can be done.

For just purposes of orderly process, if you want to make a statement, please sign up in the back with Linda Hiatt. Linda, would you raise your hand? Okay, and then we will be sure that you get your time.

Now, what I would like to do is to turn the meeting over, at this point, to our two main conveners. That's Hank Jenkins-Smith and Paul Slovic, and let them get the ball

rolling. Let the games begin, as they way.

Paul?

DR. SLOVIC: Thank you.

I'm very pleased that we're having this discussion today, and I would like to thank the Board for the meeting.

I was asked to spend about five minutes of opening discussion, and that's a rather challenging task when you think of those of us who are researchers, who have been involved in this, and who have seen over the past eight or ten years, probably 200 research reports and a half dozen or more books written on the topics related to this meeting. Obviously, one isn't going to attempt to get into that kind of material, and, in fact, that would preempt the discussions, so I'd rather just make some very general remarks about the issue of risk perception and what is often referred to as the gap between the public and the experts.

And I would just like to illustrate this gap a little bit by reading a few quotes that I've gleaned over the years from people in the nuclear industry who have commented on the public perception, ranging from a government official, who said that public perceptions of nuclear power and nuclear waste are grounded in ignorance and divorced from reality.

A second quote from Sir John Hill, who was chairman of the Atomic Energy Authority in the United Kingdom, who said, "I've never run across any industry where the public

perceptions of the problems are so totally different from the problems as seen by those of us in the industry. The problem of radioactive waste disposal is, in a technical sense, comparatively easy."

Alvin Weinberg commented on this issue this fall, as he said: "Nuclear waste can be sequestered with essentially no chance of any member of the public receiving a non-stochastic dose of radioactivity. Why, then, is the waste problem the Achilles heel of nuclear energy? Why is the public's perception of the nuclear waste issue at such odds with experts' perceptions?"

Harold Lewis, in his book on technological risk, said that the risk of nuclear waste disposal, if properly done, is "ridiculously low." He went on to say that: "The risk is as negligible as it is possible to imagine. It is embarrassingly easy to solve the technical problems, yet impossible to solve political ones."

I think he was right in pointing to the political aspect of this issue, and I think one can contrast these views of the public's perceptions with what is coming to be a view of many of us in social science who would see risk and risk assessment, risk perception as political processes as much as technical ones, and risk assessment can be seen as the process which reflects value judgments at every stage in the development of an assessment, in which social and

political factors, such as attitudes and world views and questions of equity and gender, race, power, control, trust, all of these factors seem to be playing a major role in shaping judgments of the public, but also, of experts as well, in what might be called the social construction of risk.

So much of the conflict and controversy surrounding risk issues in general, nuclear waste issues in particular, appears to be driven by these social and political issues. It brings us back to Alvin Weinberg's central question: Why is the public's perception at odds with experts' perceptions?

I hope we will also shed some light on the question of the social, political, and economic impacts of these perceptions.

Thanks.

DR. JENKINS-SMITH: Thank you.

I have been involved with this project for some time, and one of the things that has been somewhat fun about it has been the interaction from those of us who have approached the problem from different angles.

About three or four years ago, Paul and Jim and I and a variety of other people met at a--and I guess you were there, too, Doug--met in Boulder to argue about these issues, just in private, amongst those of us who do research on these kinds of questions, and it turned out to be much more of a

collaborative kind of meeting.

We had common questions that we were looking at. We were approaching them from different directions, and, since then, I guess the sorts of research that have been undertaken by people working on this problem have evolved on somewhat parallel tracks, not necessarily focusing on the same elements of the problem, or coming to the same conclusions, but certainly resonating from one another in constructive ways, and this meeting seems to be for following in that spirit.

There are four critical points that I really hope are going to be addressed and pushed around as part of the sub-topics for these questions that we're addressing today, and I'm going to list these not necessarily in order, but these are the things, I think, that are going to shape a lot of our understanding over the next few years that we work on these questions.

Some of the major issues are methodological. As you'll see today, we're going to be describing how we think about public risk perception, its differences from expert risk perception, things along those lines. When we work on those things, we have some interesting measurement problems that are associated with it. It's essentially, we use data that come from stimulus/response experiments. We provide people with a question, they respond in a particular way. We

do this both in qualitative and in quantitative kinds of research. Figuring out what's behind that stimulus response, and relating that to risk perceptions in a way that has a bearing on how we measure impact is a central issue for us.

Now, there's several ways that you try to validate these kinds of measurements, some of which come from construct validity; how well does it relate, theoretically, the way we think it ought to, to other measures; some of which are criterion related; do people actually behave this way, or engage in other activities in ways that comport with the answers that they give us to their survey questions.

Now, we have a lot of construct validity that's been done on these data, very little criterion-related validity, and that's one of the issues, I think, that we're going to have to push on in the next few years, getting some criterion-related validity.

Another central issue is that of stigma; understanding where it comes from, how people pick up images of different kinds, and then, most importantly, I think, how acquiring imagery, negative imagery associated with things nuclear, may be attached to later behavior. How does that connection work?

It turns out, from a lot of the research that we've been working on, that having a negative image doesn't really matter much unless it's related to the other images you have

of a place, and trying to figure out how this mechanism works. I mean, different places may be very differentially affected by having nuclear facilities, and understanding that issue, I think, is going to be important for us.

Another issue which is of overriding importance to me is making sure that we keep the entire question of risk perception, stigma, and potential impact in context. The fact is, nuclear waste is there. It's not going to disappear because we don't put it in one place, and so the question, for us as a society is not, simply: What will be the impact if we put this stuff in a particular place, but what is its relative impact; keeping it in context. I mean, those of us who are trained in policy analysis think in terms of net effects, not simply in terms of gross effects associated with a specific site.

Then there are also implications for how we structure the policy problem. Now, we've been talking about this issue almost entirely as a waste issue. It's actually a larger social question that has to do with how we manage materials of these kinds, how we structure the institutions that do this, what else they do, and I think some of the mitigation potential for whatever sort of a storage process we have for nuclear waste is going to have to focus on the bundles of things that we do in designing a policy to manage nuclear waste, not simply where we put it.

Those are the main issues that I think are going to have to get exposed, ventilated, in Dan Metlay's words, in order to start thinking about this stuff in a reasonably coherent fashion. I think we've been making a lot of progress from the standpoint of a lot of different people working on this problem. We have a long ways to go yet.

DR. BREWER: Good. Thank you very much for good opening comments. Thank you.

What I'd like to propose in terms of procedure, we have general questions and topics allocated over chunks of time in the next two days, and what I would like to do is systematically, simply sort of start at the beginning, by raising the general question, and then I'll direct traffic as it needs to be directed, and, also, opening up the option to my colleagues on the Board to be raising questions as the conversation goes on.

One of the things that really, to start at the beginning, one of the things that really is an issue is, where in the world do risk perceptions come from? Are they primarily demographic? Are they cultural? Are they somehow or another tied to a place of origin? Various competing theories that are in the literature, and I would like just to open the topic up at its simplest.

Why is it that risk assessment, generally regarded to be the scientific determination of the probabilities of

something happening--that's probably an oversimplification, but it's the idea of the science base in terms of risk, the Alvin Weinberg point of view, in Paul's terms. Why in the world is it so at odds and so variant from the way people perceive of events around them? How do we understand where the differences come from?

One part of the issue, and a related question is: How do we close the gap, if that, indeed, is something we ought to be focusing on? Anyone care to pick up on any part of that as a point of departure?

DR. JENKINS-SMITH: I'll take a shot at it.

DR. BREWER: All right.

DR. JENKINS-SMITH: The ways in which we arrive at judgments about risks are really quite interesting from the standpoint of those of us who do social science, because there is so much apparent regularity across different kinds of individuals. There are very different ways that different people from different situations understand risk.

One of the dichotomies that Paul started this off with was the difference between experts and the public, and one way that you might frame that problem would be to think about the members of the public use one set of heuristics or decision rules to decide about how to rank risk, or how to impute meaning to them, whereas experts use something quite different.

Actually, it turns out, it's not quite that simple. A lot of the work that Carol Silva and I and others at the University of New Mexico have been focusing on is looking at how experts think about risk. It turns out that they, too, have rather systematic differences. In fact, the paper that Paul and I just finished a little while ago looks at the differences in the way that scientists think about risk.

Men and women scientists have very different views of the magnitudes or the level of risk associated with nuclear kinds of events. Women scientists, equally well-trained, or at least in terms of equally high level degrees, tend to see risks as being larger than do male scientists. Life scientists tend to see larger risks associated with things nuclear than do physical scientists, and this is based on empirical evidence, which has some of the methodological problems with it that I mentioned a little bit earlier. Nevertheless, these are systematic differences, and they're fairly substantial.

Within the public, these kinds of differences take fairly systematic form. Women, in general, tend to see risks associated with technologies--particularly nuclear risks--as being much greater than men do. Individuals who see themselves in disadvantaged positions in society tend to see the risks as being larger than people who are in relatively more advantaged kinds of positions.

So, looking at these kinds of regularities, somebody who studies this has to ask: When we ask questions, How risky is X? Define a scale. Define a kind of a potential hazard, and somebody answers that question, what are they doing? What are they filtering this stuff through in order to give you an answer? And it turns out that it's fairly complicated.

Part of it has to do with the ideological way people approach the world, the political ideology of an individual, or the way they think social relationships ought to be ordered matters a great deal, and so there's some sort of a relationship between how we think society ought to be structured and where we fit in it that drives part of the level of risk that people are seeing, and some of this is a little--creates some problems for us.

One of the things that has been the case over the last twenty or so years is people are increasingly convinced that they have relatively little control over the major social institutions that drive our society; government. The level of trust in government, as you know, is at an all-time low. The degree to which people think they can meaningfully participate in shaping the major events in their lives has declined, and as this happens, people's propensity to see technologies as risky goes up.

Part of the answer we're picking up is from those

kinds of filters and heuristics that make sense of these kinds of things. Paul and I have talked about this a lot.

Paul, did you have something that you wanted to add to this?

DR. SLOVIC: Well, I think you've kind of opened up a lot of the key issues, the fact that there are sort of cultural and political attitudinal aspects that, you know, how we see the world depends on kind of where we're coming from in a social and political sense. Issues of equity and fairness have been found to be very important in perceptions of risk and perhaps Elaine can describe some of her research in that area a bit later.

So, there are many non-scientific factors that influence perceptions, and they influence perceptions of technical people as well. In addition to the study that Hank mentioned about men and women scientists, we've been studying toxicologists for many years, who are the world's experts on chemical risks, and finding that their judgments of chemical risks are influenced by their kind of cultural views and other non-technical factors, so part of the problem is that risk assessment is still, even in a technical sense, is still a young and emerging science, which is a very value-laden and, you know, uncertain in many ways, so there's room for other perspectives to influence these assessments.

DR. BREWER: One of the issues that's coming out already

in the discussion is the uncertainty about the basis of difference in the risk perception, and the issue of how do you measure it. I mean, you're not quite sure where the differences are coming from. There are lots of things that are, at least hypothetically, accounting for the differences; sex, training, location, culture, ideology.

I'm just wondering if anyone would care to comment on the methodological problems that really follow from that; Howard or Warner, or someone who's been deep into--or Steve--deep into the methodological issues that are really called into question right here. I mean, what do you measure, and do you know what the measurements are all about, is basically it.

Warner, and then Howard.

DR. NORTH: I'd like to put another item onto the agenda. I sit on this panel not as a social scientist, but, rather, somebody who has been exposed a lot to this problem and similar problems, including toxic substances, as Paul Slovic has just been mentioning, and global climate was the issue I was on last night, and I find that as I look over a number of years of activity with the Society for Risk Analysis, there are a lot of common themes as we deal with these big policy issues involving uncertainty.

And before we get too deeply into the social science, and the methodological questions, I'd like to raise

the point that there is a great deal of specialized information involved here, and we have significant differences between those of us who are specialists by virtue of our training and our interests, and those of us who are involved in these problems, but more as generalists, without that kind of specialized training.

The thought experiment I do for myself, since I'm not particularly a sports fan, is to think in terms of understanding the strategy, for example, of the San Jose Sharks as they try to win game two from the Detroit Redwings tonight, and how much there is--I chose an example, Garry--how much there is about hockey that I don't know, and how difficult it is for me to understand some of the subtleties of that particular enterprise.

So, it is very easy for me to leap to conclusions, make hypotheses, and the like, which an experienced hockey fan or player would say are quite off the mark. They are uninformed. They may be naive. On the other hand, once in awhile, my outsider's viewpoint might have some grain of accuracy to it that the insider's viewpoint would not have.

So the example I'd like to use with respect to nuclear waste is going back to, I believe, that first meeting in October, 1990, which I believe was in Reno, and recalling the gentleman who represented the American Association of Retired Persons, who got up in front of our group and said he

was worried about the repository exploding, like Chernobyl, and with a public highway six miles away, that was a definite threat to public safety, and that was a serious problem, and we ought to think about it.

And some of us tried to explain to him that physics suggested that this couldn't happen, that this was inappropriate and not very well informed. I gave a speech at the invitation of the University of Nevada, Reno, about February of this year, at the invitation of Dr. James Seiber, a man I've known for a number of years through the National Academy, and I led off my speech describing that, and describing it as an example of something that I thought, as one educate in physics, was incredible; that a repository can't explode, and within the next week I was confronted in the paper by the announcement of Charles Bowman's work, and asked by a variety of people would I comment on it.

The Board, incidentally, has had a session to look at this in detail, and I have not. I retain my original judgment, that I think having a critical mass of plutonium form in a geological setting such that there can be a nuclear explosion as opposed to criticality stretches my credulity. I would have very great difficulty thinking about science, as I know it, making that possible, but I want to keep an open mind.

And I think the important aspect is to be able to

preserve a way of having constructive dialogue between people that are generalists and people that are specialists, so that we don't get politicized, we can learn from each other, and we can try to separate out issues having to do with what will happen, questions of information from questions of value, question of, let me say, world view or value structure, and, therefore, ideology in the sense that I think things should be this way, and you think things should be some other way.

It's very hard to accomplish that separation, and it seems to me, when I think of what may be going wrong that is leading to this gap, it is both a breakdown in communications, and perhaps a lack of respect between the generalists and the specialists as to what their respective roles can be and how there can be constructive dialogue between them.

DR. BREWER: Okay, Warner. Thank you very much for some good thoughts.

The conversation can take lots of different courses. I propose that we work on sort of the methodological questions to start with. We will inevitably get back to the expert, generalist, lay person in the public, and, particularly, in terms of how people conceive and measure.

I mean, the measurement thing is really tied up here as well. The role of the press, I think, is pretty

clear on all of this as a way of informing. Whether or not simply speaking at the natives, in terms of trying to provide education to make them smart about things experts know is a good strategy is something I think we also probably will have to come back to, because it seems to be a way that, often, those who "know better" try to solve this problem.

Howard, I wanted to get to you next, because you began to respond when we hit on the methodological issues. Your own career and history is in the area of survey research, and we have some very fundamental questions here about measurement, measurement validity, measurement stability over a period of time, what is it we're measuring. I mean, this is a scientific board, and we'd like to hear from your point of view as a well-respected, long time professional, your take on these questions.

DR. SCHUMAN: Well, I actually want to ask a question. As you said, most of my research has been on the question/answer process in surveys and in questionnaires, and, occasionally, in life, and it's led me to be fairly skeptical of the results of surveys, except as one can make crucial comparisons among different parts of the population, or different types of questions. Just the bare findings from a survey seem to me very fragile, very easily changed.

And one thing I noted, in reading the papers, puzzled me. It's by one of the panel participants. It had

to do with the difference in the fear of a nuclear reactor and of nuclear waste repository. A nuclear reactor, by this one measure, at least, seemed less threatening than, say, hazard waste incinerator, and yet, Chernobyl, as somebody mentioned, is probably the most publicized nuclear disaster, after Hiroshima, and that seems to me very strange, that there would be much less fear of a nuclear reactor exploding --or whatever happens with a nuclear reactor, and I'm not at all scientifically expert on this--than of storage of high-level waste, especially when technical experts say that there's relatively little danger, and so forth.

So, I was very curious about that finding, and, also, to just take this in a further methodological direction, I was surprised that there was no follow-up asking why. Again, I'm very distrustful of closed questions. People will answer all kinds of questions that they know nothing about.

We have a long history of research showing that all of us, in fact, to some extent, will give forth with an opinion about something that we have vaguely heard of, and maybe about a third of the population have never heard of at all, and I think it's very helpful to find out what people are thinking when they answer questions, or to get at it in other ways, and there are some other ways; qualitative observation, and so forth.

But, anyway, Dr. Easterling, it's your study, and I thought it was a very interesting finding, and I wonder if you have some reflections on it.

DR. EASTERLING: Absolutely. I completely agree with you. We report some results that talk about how likely a person who had planned to attend a convention would--how likely that person would be to change their mind if they found out certain facilities were nearby, and we presented them with, I think, five or six different facilities; low-level nuclear waste, rad waste repository, high-level nuclear reactor, I think a landfill--he's got the list in front of him--prison, and we found things like 38 per cent said that they would probably or definitely change their mind in response to a repository, compared to maybe 2 or 3 per cent for the other end of the extreme, like a landfill.

And what we tried to say in that article was that we weren't saying that those are magic numbers, that we really predict 40 per cent will change their mind, but we took away the relative standing of a repository compared to other facilities; that somehow, that was telling us that people see that facility in a very different light. It's something that touches a cord, and none of those other facilities do, and maybe it's just the fact that it's a novelty. Reactors have been around. Everything else has been around a little more.

But, I think what we're seeing there is just the tip of the iceberg, and we do need to delve further with things like what Paul was saying, with the imagery studies.

DR. BASSETT: Two quick comments. One on the issue that's just coming up, but just to provide just a little bit more background context on the perceptions of risk, and it's kind of gone without saying that the perceptions of risk not only are different from what the experts think, but they're also different from any sort of statistical, frequentist kind of view as to what the odds are out there with regard to accidents, disease, and so on.

It's interesting for me, as an economist, to compare the kind of perspective that we're going to be delving into when we look at these kind of risk perceptions for just one second to look at economics.

In economics, we don't worry about perceptions of risk, because perceptions of risk, according to current wisdom, conventional wisdom, perceptions of risk will come in line with the frequency of events out there in the world; that if I persistently hold misperceptions about the riskiness of a bond, I'm going to go bankrupt. If I persistently mis-estimate the returns on other sorts of physical assets, I'm going to go bankrupt.

So, in the economic world, in the financial kind of world, there is this kind of mechanism, a kind of

evolutionary mechanism that's going to prune out those people whose views about the frequency of certain kinds of events gets way out of whack with what's actually going to happen in the real world.

Now we enter this world, and we begin to see that large differences definitely do exist. All the social science research shows that they exist, and they can persist, and it's very, very difficult, if, indeed, it should be the case that the public's perceptions, out of whack with the frequencies, should, in fact, be brought in line with that.

So, I'd just like to provide a little bit of background context as to why economists, as a group of people, aren't generally interested in these kinds of issues. They get with the program, or they die a financial kind of death.

To the question of risk perceptions, and what it is that's being measured, one of the things that's motivated the work that Hank and I have done is whatever it is that is being measured, how does it differ across space? This also gets to stability questions, which we haven't had enough time to get to; how does it differ across time? It comes back to the kind of comparative kind of issue.

We've looked at people's risk perceptions in Michigan, around nuclear power plants. We've done a large national survey for people who don't live in nuclear power

plant counties, people who do live in power plant counties, and a third of the sample was Nevada, to try to assess what the differences are in their perceptions of risk on the perceptions that they're going to have with regard to if a repository is put in their locales, so that, in this way, we can, you know, skirt the issue, we can beg the question of what's being measured here to see whether there's systematic differences across the country with regard to these kinds of issues.

And there are some differences which we can begin to get into, but, basically, whatever is being measured, we're seeing, tends to follow similar sorts of patterns wherever we look. The gender differences that Hank alluded to, that we first saw in Nevada, they're showing up in Michigan, in Illinois.

Knowledge questions. We asked people about six or seven knowledge questions that have to do with the information that they have about a nuclear power plant; can it explode, radiation--all cancer is caused by radiation. We give people these kinds of questions, score them on these knowledge questions. Is their knowledge related to their perceptions of risk of permanent storage, temporary storage, power plant generation of electricity? We find out that they are wherever we look.

So that whatever is being measured, it's coming out

the same. You know, we're seeing the same species of being here, and so I'd just like to toss that out. It doesn't get directly--I've begged the question about what's being measured. I don't know what it is, but whatever it is, we all got a little bit of it.

DR. JENKINS-SMITH: I guess I would add to that, too. I mean, there are a variety of ways to measure this. We must have done 20 or 30 focus groups across the country in sort of extended conversations with small groups of people randomly selected from their communities to try to understand what's behind the answers that they give us to these things, and, by and large, they are telling us that they are, indeed, deeply frightened of this.

I mean, we've done some of these focus groups to look at the difference in proximity to nuclear facilities and see what effect that may have on people, and we, a month or so ago, talked a bunch of individuals in Florida, in the Miami area, and asked them about living near a nuclear facility. This was not too far away from some operating nuclear power plants, as many people here will know, and a little while into this conversation, the issue of living in a community not too far from an operating nuclear power plant came up, and some of the folks became quite upset at that. They didn't know that nuclear waste was, in fact, being stored at this facility. They said they didn't vote on it;

that they didn't see it, simply because they lived in this community, they didn't see this as something that they had somehow sanctioned, or would find terribly acceptable.

Now, we see this all over the place. We've seen this in the north, the south, everywhere we've gone to try to talk to people, and there's a great deal of consistency in these one-on-one conversations, and what we find in the survey results, and so we have tried to get at this in different ways.

DR. BREWER: So, in terms of methods, let me see if I'm hearing something. Howard pretty much says that the closed-end questions are not going to tell you very much. The follow-up here is more intensive inquiries in focus groups, one-on-ones, where you're actually in there, able to probe, and figure out what in the world is it that you guys are responding to, so it's a combination of the two methods.

DR. JENKINS-SMITH: That's correct.

DR. SCHUMAN: Could I just ask how you introduced the issue itself?

DR. JENKINS-SMITH: How we introduced the issue of nuclear waste?

DR. SCHUMAN: In the focus groups. I mean, did you ask, "What's bothering you in this community?", or things like that, or what--"How do you feel about nuclear waste?"

DR. BREWER: Yeah, that's a good question. How did you

get into it?

DR. JENKINS-SMITH: We've tried very different ways of actually getting into the question. On some occasions, we start with very general issues about environmental problems. Sometimes we've started just open-ended, about what it is that is concerning people in a particular community. Incidentally, when we approach it that way, drive-by shootings and crime, and so forth, come up the list vastly ahead of any kind of environmental risk like this.

Once the issue turns to environmental risk, these things tend to crystallize and become more prominent.

DR. SCHUMAN: Getting shot is an environmental risk in some places.

DR. WILKINS: I just want to put on the table one other thing that I think was kind of, at least what I heard, sort of an unexamined normative assertion that I think bears at least staring at a little bit more directly, and that is the notion that the experts somehow have some corner on something that lay people don't, and I would like to suggest precisely the opposite; that, in fact, it is the lay people who may not be good bayesian mathematicians, we do lousy base rates, we don't wear out seat belts, all the rest of that sort of stuff, but, in fact, have figure out in some sort of intuitive, heuristic sort of way, a great deal about some central kinds of issues that really do matter when it comes

to risk perception.

And I think that one of the things, at least those of us who muck around in the field of risk communication, have come quickly to the conclusion is, is that if your goal is to convince Ms. Lay Person over here that the expert view is the correct one, you will fail every time, but that if, in fact, you honestly want to sit down and have a conversation where the expert begins to discover that lay people know a lot; that that is a far more successful approach, at least to understanding risk perception, and I think some of these findings really speak to that, that whether or not people can put, you know, mathematical terms on these, these are issues of fundamental concern to them.

And so, I just want to put out there the notion that somehow we're going to convince, or anybody's going to convince a group of folks, you know, that Bhopal was a good thing, or that, you know, the Mississippi River isn't going to flood. I left home, it was raining again this morning. Those things really are not very likely, but, more important, they're not really very likely for some very good reasons, and we need to listen to what lay people are telling us in this area.

DR. BREWER: Okay. Yes, Elaine?

DR. VAUGHAN: If I could follow up on Lee's point, and then also make a point about methodology.

I think Gil's framing of the issue brought up a fundamental conflict that's occurring in society, and that is the terms with which we debate about nuclear waste, the terms that define what are acceptable solutions depends on how you frame or define the issue.

If you define the safety or the risk of nuclear waste repositories in terms of probability, that's actually an irrelevant fact if some other group has defined it in terms of equity, or from some of Paul's work, the catastrophic potential. So, even if the probability of a major accident, let's say a spill in transporting the waste from on site to the repository, even if that probability is small, it doesn't matter if the catastrophic potential is still there.

Chernobyl should have never happened. Three Mile Island was not predicted to happen, and I think we have to look at the contexts within which people are making decisions and coming to perceive of risks. Society has a memory, particularly for negative events, and I think some of the "mistakes" and uncertain outcomes that have occurred are, through the media, especially, can be raised again and make very salient the level of uncertainty or perceived uncertainty associated with these issues.

So, just to give a very clear example of this, if anyone's ever tried to talk with someone who's afraid of

flying, you realize you can talk all day about the low probability of a plane crash, you can talk about the chances of--I'm talking from experience, I hate to admit--but you can tell individuals all day long about the higher probability of a car accident on the way to the airport than the plane crashing, but it doesn't matter if you're focusing on a catastrophic potential, no matter how small, if you're focusing on the severity of the outcome, the fact that you will not have control if something starts to go wrong.

So, I think we have to look at the fundamental clashes between paradigms. The public seems to be defining and framing these issues with a different set of terms than experts, and one will never come to agreement or negotiated understandings or solutions unless we somehow come to a negotiated or common framing of the issues, a realization that perhaps we need to expand our definition of what risk is, expand it from the traditional definition.

And, just briefly, about some methodological issues, I think some problems with methodology and measuring risk perceptions have arisen from the fact that survey results have often been used for situations or purposes other than what they were constructed to do, so people will sometimes use these survey results measuring perceptions in order to predict behaviors, people's protest against the siting of a repository.

And the surveys will not predict behaviors, because behaviors are influenced by factors in addition to risk perceptions. So one has to look at the purposes for which surveys are constructed. That will lower the validity of these surveys, and the reliability of the results if you're trying to use them to predict, let's say, social conflict, and people's response to repositories.

DR. BREWER: Okay. This is an important thread, because in terms of the simplified logic of what we're trying to do today, it's going from risk perception to behavior, and your assertion is that the link is not a very strong one.

DR. VAUGHAN: I think there are circumstances where the link is very strong.

DR. BREWER: But it's not a certainty, is what you're saying.

DR. VAUGHAN: Not at all.

DR. BREWER: It's a very difficult measurement problem.

DR. VAUGHAN: If you look at people's behaviors, it is, because people don't always act based on some abstract ideology, and this was found in the sixties and seventies, a lot of research on, for instance, racial attitudes and society were notorious for being unreliable in predicting how people would actually behave, and part of it was that the attitudes were on a level of abstraction that were far removed from the behavioral situations and circumstances in

which people actually react. How would you really react if someone moved next door to you from a group that you weren't particularly excited about?

So, ideologically, you may say, I'm not prejudiced, I'm not concerned about that, but when someone moves next door, you're concerned about property values or something else. That's a different question. So I think one thing we have to look at is the purposes for which surveys are constructed, and look at that effect on validity issues.

DR. BREWER: Very good points.

It was Jim, and then Gib, and then I want to get back to Howard on this issue, if he would. Jim?

DR. OPALUCH: Yeah. I wanted to just kind of follow up on a number of comments that I've heard people say around the room.

The first one, the risk communication issue, I think, just like risk perceptions differ from experts and the public, I think the term risk communication sometimes is used incorrectly, where the experts say, "Well, risk communication is I come, I tell you what the risks are, and you listen to me," and that's not the right way to do it. It's got to be a dialogue. Communication is a dialogue, not a monologue.

The second thing is uncertainty versus risk. In economics, there's two different concepts of the two, and I'm sure other fields also work with those two different

concepts. Risk is when you can place probabilities on things. There's a probability of .01 that this is going to happen.

Uncertainty, you can't necessarily put probabilities on things. You know that there's a potential for danger, but you can't put a number on that. You can't estimate it. You can't come up with a precise measure of what the probability is, and I think that when you get into notions of uncertainty, you get into what's called fuzzy logic, which is, you know, kind of the basis now of artificial intelligence.

So, if we try and think of the public as saying, okay, we can go out and we can measure what these probabilities are, and we can tell you what those probabilities are, and once you know that, you'll do a calculation like any good computer will do, and come up with --and then determine that, oh, no, I shouldn't make that step. It's the wrong basis. It's just not the way to go about doing it.

You know, it's well known that people use fuzzy thinking, and that's not a pejorative term. In fact, it's a very positive term. If you've had a computer and tried to get it to go downtown and buy a stick of gum or something like that, it couldn't do it. It would never get there, and the reason is because there is not a precise task. You've

got to go out, you come across things, you've got to react to what you see, and computers can't do that, although they can do calculations like crazy, far greater than any member of the public can do.

So, I think you really have to come from that perspective of, you know, uncertainty, fuzzy logic, et cetera.

DR. BREWER: Thank you.

Gib?

DR. BASSETT: Just a quick comment on the expert public opinion issue. It seems like frequently the debate is the experts got it right, and the public are messed up and need to be educated, or the public's got it right, and the experts are not taking into account the values and morals of the public.

I'd like to suggest that it's complicated, more complicated than this. The people that I know who tend to be opposed to nuclear power think that the experts on nuclear power have it all wrong, but those same people say that the experts on global warming have got it right, and they turn right around to them, and how the heck can we convince this public who will not agree to emission reductions, that we've, in fact, got it right, and the converse is also true.

The people who are opposed to emissions on global warming think that those global warming guys got it right,

and they think that the nuclear waste people have it all wrong, so the point of this either/or is to suggest that the issue is more complicated than just the experts always have it right, the public's always got it right.

Depending upon what you've got to take in the debate, each side in this--and we'll certainly hear, you know, other stories on this--can point to particular kinds of events. The event that I could point to that, you know, suggests that sometimes the experts--that there's some kind of weird situation here, is about three years ago, there was a big earthquake scare in the midwest that all of the experts said was completely ridiculous, but the public took it as face value, and schools were closed, people bought earthquake insurance for a risk that, by any stretch of anybody's imagination, was totally unfounded. It's just complicated.

DR. KRAUS: I'd like to start out by pointing out that, much like Howard, I'm certainly not an expert on these issues, and for the last few weeks, I really didn't start to think about nuclear waste-type issues very much, so I hope, maybe, that it will give me some insights into how "uninformed" lay person thinks about them, because I certainly consider myself in that category.

I think when we think about issues of nuclear waste and talk about the gap between perceptions of the lay person perceiving risk and experts, there's some unique qualities to

this issue that sort of lend themselves to this gap. One which we've talked about is that there is, among many people, a real lack of information in that people--I think the lay person doesn't have a good understanding of what exactly radiation is, you know, the different levels of radiation, how much does it take to be dangerous, you know, where are these radiation dangers located.

One survey, I think, found that something on the order of one-quarter of Las Vegas residents said they would be unwilling to live within 300 miles of a nuclear power plant, when, in fact, something on the order of six nuclear power plants are within that radius, and, in particular, you know, radiation itself, you know, conjures up some troubling images in the minds of most people.

I think when there's a lack of information, and people try to make judgments about risk, something known as the vividness effect comes into play, where, when presented with a whole slew of supposedly rational information, and a few very vivid instances, those vivid instances are weighed very heavily.

So, as an example, if you're looking to buy a car, you might go out and get all kinds of information from *Consumer Reports*, and decide to buy a Volvo based on that, but the night before you go out to buy the car, you're at a party and somebody says, "Oh, yeah, I bought a Volvo that was

awful," and that particularly vivid piece of information often carries a lot of weight, and I think that the images that people have when they talk about these issues, whether it's Hiroshima or Three Mile Island or Chernobyl, are particularly vivid, and I wonder if the public's perceptions of risk might be tied to the extent to which they are influenced by these particularly vivid images, so that's one thing that future research could possibly take a look at.

I think another thing that's unique about the nuclear waste issue is there's a real lack of behavioral feedback. If you're a bond trader, you're going to get a lot of very specific feedback about exactly what the risks are, and that feedback isn't going to be here in this situation.

So, to draw two conclusions from this, we've got this finding that there is this gap between public perceptions of risk, and supposedly objective perceptions of risk. The first thing I would point out is just because the public's perceptions of risk don't agree with what the experts are saying, does not mean that the public will not act on those perceptions, and that relationship between attitudes and behavior is something we'll talk about more this afternoon.

But if we're trying to look at what will the economic impacts of this be, we do have to take a look at what are the perceptions of risk among the public, and

whether that agrees with scientific evidence or not, there is the possibility that the public will act on that.

The other thing I would point out, and it sort of ties into Elaine's comments, I think when the public thinks about nuclear waste and the risks that are involved, they're not thinking just about probabilities and how likely is it that something is going to happen. I think they think of it in terms sort of like an expected value equation, where they're essentially multiplying how likely is this to happen by the severity of this, or the valance of this kind of event, and I think the public puts, you know, such an intensively negative valance on some of the possible outcomes from this, that regardless of how probable they think it is, when those two things are combined together, you end up with very intensely negative attitudes.

DR. BREWER: Okay, good points. Other food for thought. Paul?

DR. SLOVIC: I'd like to go back to the very interesting comment that Howard Schuman made when he opened this series of discussion with regard to nuclear waste perceptions versus nuclear power, and to point out that the higher perception of risk from nuclear waste relative to nuclear power has been found with many different question formats, ranging from psychophysical kind of magnitude estimation formats with minimal description of the stimuli, to straightforward

attitudinal questions, questions about how close you'd be willing to live to a facility, and quite a wide range of different content formats, with a very consistent finding, and not that nuclear power is rated as low risk. It's just that nuclear waste is rated higher and often near the top of whatever set of hazards one is looking at, and it's not just in the United States, but the same result has been found in Sweden and France and other countries as well, and I don't feel that we do fully understand why this is. I think the point about this should be followed up is worthwhile.

But there's a couple of elements I'd like to point out that may partly relate to this, and one is that we find in these studies that there's an inverse relationship between perceived risk and perceived benefit, such that if you see something as high in benefit, you tend to see it as lower in risk, and vice versa, and we have some research just beginning which suggests that maybe risk and benefit are sort of derivative judgments to a more fundamental affective evaluation of something as good or bad, kind of a more primitive, visceral response, and to the extent that people see some benefit to nuclear power, which certainly, there is, that may be somewhat depressing their perception of risk relative to nuclear waste, where people see that as providing very low benefit. It's kind of an all bad sort of thing, not that that's the right perception, but that's an element.

There are other issues as well. Even though Chernobyl was obviously a major catastrophe, there are plenty of incidents in the record which are getting considerable publicity, particularly in this country, of contamination of nuclear waste, particularly at former weapons facilities around the country, such as Hanford or Rocky Flats and other places, where we're now facing hundreds of billions of dollars of clean-up costs, and we're not getting that publicity about nuclear power.

The very fact that the nuclear waste program is going at the pace it's going, with all the discussion and debate about the safety may contribute to people's perception that this, indeed, is a very difficult technical project, and a very risky one, so I think all of these elements may be playing a part in this.

DR. BREWER: Good. Thank you, Paul.

Warner?

DR. NORTH: I'd like to pick that up. I'm glad you brought us back to Dr. Schuman's question. I think it's an excellent one.

I find one of the most surprising bits of data that we have is this replicated finding that members of the public perceive a higher risk for a nuclear waste repository than they do for an operating nuclear power plant, and the question I'd like to pose to everybody--including myself--is,

one: What lies behind this? Why is this so? What mode of thinking leads people to this set of perceptions?

And, if we don't know the answer to this, what lies behind it, how might our methodology go about answering this question and find out? I mean, is the path through focus groups, or are there serious problems with focus groups? Do we need to go more into a cultural setting to try to understand this?

One thought that occurs to me is the way we frame the problem with the words we use. If we call the repository a dump, if we talk about time periods of 10,000 years or greater, or if we frame it in a dimension that we are going to manage it as carefully as we can for as long as we can, but it is potentially dangerous for a long time, as are many other things on the planet, do we change the perceptions leading to the last point that was on Hank's list? What are the implications for policy? Is there a way we can take a simple question like this, and track it all the way down to implications for policy, maybe to the level of, can we have a more constructive set of dialogues on this issue than we've had in the past.

DR. BREWER: A very good observation. There were two quick hands when you started talking, Warner, about--Doug, you want to go first, and then Hank?

DR. EASTERLING: Yeah, and Warner asked about four more

questions after I had my hand up, so I'm going to go back to the first one.

DR. BREWER: It's his habit. We who know him have learned to love it.

DR. EASTERLING: But the question I want to deal with is the question of the comparison between nuclear waste and some of the things that sometimes we know are more dangerous, and I want to get back to something Elaine started, and try to pick it up a little further.

I think we're forcing people into answering the questions that they don't want to answer. In some sense, just by virtue of the way we've set up the whole regulatory process, and by the panel that you see today, the whole debate is framed about how safe, how much risk is associated with a repository, and people want to answer things about how moral is a repository, and so that's a lot of what's coming out in the risk perception data.

And I think, to go further, if we look at the whole purpose of the panel, which is to try to predict behavior, I think those perceptions, those broader perceptions about the ethical and moral dimensions of a repository, is it moral to bury something that poisonous underground, those are the things that may be driving behavior, so maybe we need an expanded scope on what we're measuring in terms of perception.

DR. BREWER: Interesting point.

Hank?

DR. JENKINS-SMITH: Yeah. Back to the question of what's behind these statements about nuclear waste versus nuclear energy generation, for example, the focus group work has, I mean, we've gotten extensive comments on things that people think happen with respect to nuclear waste, particularly when they begin worrying about the fact that waste is stored on site at a nuclear power plant, and there are two sides to this.

Quite clearly, risk is a big factor. People talk a lot about the stuff's going to get in the water, it must be getting into the air. We've heard that it's heated up the Great Lakes up there. You know that, Garry. It's warm. There's large fish, too, near the nuclear power plant, and there are many other--

DR. BREWER: But do they glow in the dark?

DR. JENKINS-SMITH: Quite probably. The kinds of things that people are worrying about or thinking about clearly are health-related. I mean, there are many concerns, and these are sort of--they are urban myths, things that people have heard from somebody else, somebody who was, you know, fishing off the shore line, and these are things that people believe, stories that we get about things that are going on in the world.

Tied to that are sort of questions about why is it happening to us? Why hasn't anybody ever told us about this, despite the fact that there's plenty of signaling going on about what is, in fact, happening, but underneath it there are clearly health concerns associated with waste that do not hold for the operation of a nuclear power plant.

I mean, people regularly told us that the operating of nuclear power plants is obviously something that they know how to do. The one in their neighborhood, to the extent that they know about it, hasn't blown up. They knew somebody who worked there, but waste--the waste issue is different in kind.

In replicated work that we have done, operating nuclear power plants are perceived as less risky on a sort of an attitudinal risk scale than driving a car in your own community, but when you get to the notion of storage of waste on site, transporting it, or permanent disposal, you get a very large increase in the way people think about those risks. That happens amongst people who live right near those operating nuclear power plants.

It happens from people who've had no exposure of any significant kind to nuclear facilities, and it happens amongst folks out here in Nevada. This is a very regular kind of finding, with a lot of sort of qualitative sensibility to it when you look at the kinds of things that

people are imagining or thinking about when they talk about waste versus nuclear energy generation.

DR. BREWER: We're touching a lot on a lot of issues, and I'd like to get back to one of the opening questions, by way of trying to get a sense of this panel. I mean, it's your professional life, in varying forms.

We've talked about the demographic causes of risk perception. We've talked about--Doug, just a moment ago--the ethical kind of underlying cause of risk perception. We've talked about political, we've talked about attitudinal, we've talked about ideological.

I wonder if anyone would care to hazard a guess as to what really is going on, or what's most important? I mean, it's a simple-minded question, but from the point of view of measurement, and the point of view of trying to figure out what's worth measuring, and what does it mean? I mean, I think it's a right question, if not the right question.

Anyone care to leap on that one? Paul?

DR. SLOVIC: Yeah. I think it's all going on. I don't think we need to try to single out the most important factor, and it's also, you know, some element of experience to what, you know, what do we observe in the world in terms of what's hurting people, or what do we not observe, but I think all of the elements that you've pointed to, plus issues of trust,

which we haven't discussed much today, are all mixed together, you know, in this complex stew of, you know, maybe a dozen factors that are all contributing to the controversies that engage us so much here.

So, I see it as a very complicated picture, which is great for researchers, but I think that's also the way the world is in this case, that there are many factors. The reflect, in part, social political value issues, which ultimately have implications for how we manage this process, because if you think it's really a matter of the public's technical judgments going astray, or not having the right information, then the management is one-way, it's education and information, and if you think its values and fairness and equity, then it points towards process, and so we'll probably get into that, but I think it really is as complicated as you listed.

DR. METLAY: Doesn't what you just said suggest it's important to get some sense of what is important?

DR. SLOVIC: Absolutely. You have to diagnose the problem. You have to try to understand it in order to deal with it, and I think that's what the efforts of many of the people have been aimed at, is to try to get a fuller understanding, as opposed to the older view of kind of ignorance and irrationality as being the cause of this gap, to try to, you know, understand it better so we can properly

work with it, deal with it.

DR. BREWER: It's really a serious question from the point of view of the Board, our trying to understand and to help the Department of Energy understand where they should be spending their time and attention. I posed the question simply, but I did so on purpose, you know. How good is the science, and how reliable is the science, and how can we set the priorities, basically, in terms of where DOE should be looking when they're trying to reach their own decision about the suitability of this particular site. We get back to the practical issue, which brings us all here in some form or another today.

Warner?

DR. NORTH: Well, this seems like an appropriate place to put on the record a remark I heard some ten years ago, I think, in California, just as the Ward Valley Low Level Waste effort was getting started. A very enlightened chemist of my acquaintance, who'd been on the California Energy Commission, gave a talk for the local chapter of the Society for Risk Analysis, in which he spoke the line, "You can't solve a social science problem using tools from engineering, physics, biology, geosciences. You need to use the appropriate tools from the social sciences."

And as I've watched Ward Valley evolve, and watched this individual's role in it, I have thought, what a

perceptive comment that was at the beginning of a very difficult process. I might add, I asked Al Pasternak recently if he remembered making that remark, and he did not. At this point, in Ward Valley, he's a bit frustrated with a long, very difficult process, just as many involved in the Yucca Mountain Project find these issues equally difficult and frustrating, and I think from what we've said among ourselves in this panel, we don't have any clear insights and revelations that can come out of the social sciences, in response to the very simple question that Dr. Schuman put to us, and a number of others like it.

But it strikes me that there is a tremendous amount of potential in the social sciences to be able to learn about these issues in the same way we learn about biology and engineering and physics, and come to some understanding, why is it that people perceive that the repository is much more dangerous than the operating nuclear power plant?

And it strikes me, as a non-social scientist, that it might be an excellent investment for the Department of Energy and the State of Nevada, and other concerns parties, to bring more social science to bear on these issues. My understanding is that some very promising research started by the State of Nevada, which a number of you participated in, did not continue far enough so that you felt you were really getting good answers to the questions that you were posing in

the research, and, as is mentioned in the opening for this meeting, there really isn't a substantial Department of Energy program that is addressing these issues for Yucca Mountain, although several people on the panel have been working on closely-related, more generic research issues.

So, I would, as one who is no longer on the TRB, I would very much commend you for having this meeting, and urge that you continue to ask this question: What should the Department be doing in this area that it is either not now doing, or is doing differently?

DR. BREWER: Thanks.

Hank?

DR. JENKINS-SMITH: I guess I think that all aspects bear more work, trying to understand, ontologically what this thing, risk perception is, what its correlates are, are all important, but I still think that it's somewhat incumbent on us to try to figure out what's the most important. I liked your question a lot. What are the most important questions that are out there? And I've puzzled on that quite a bit, and used much of the research that I've been doing with Gib and Carol Silva and others as a basis of trying to answer that.

First off, I think we have a set of measures, conventional measures that have become sort of the industry standard for looking at risk. I think that the first step is

to see, when we apply that set of measures to different options before us, when we're thinking about nuclear waste management, we should see how they compare with one another. I mean, we do have that within our control right now.

I think the mistake is focusing on any single strategy. Every one of them is going to come out in a negative in the sense that people don't want to hang around nuclear waste. We're not going to find one that people are going to pay money, or move to, or love and cherish. We're going to find all of them as negatives, so we do have one measure that's had quite a bit of exposure, or a set of measures, different ways of getting at it that are the industry standard that can be used to compare, look at our alternative strategies, and see how they stack up against one another.

But that's not enough. I mean, we do know that there are weaknesses in our measures. For example, when we measure something as simple as voter preference, I can change the sort of results I get just by claiming to be different sorts of things.

In an experiment that I just did recently in New Mexico, we got the permission of different political parties to ask voter preference in their name, and we did a split sample, randomly assigning people to different groups, and said, "Hi, we're calling for the Democrats, the Republicans,

or the Greens, or UNM," my university, and got statistically significantly different responses about voter preference, depending on who they thought was asking the question.

We call this a social desirability distortion in the sense that people are taking cues from the way you ask a question, or who they think you are in asking the question, that leads to differentiation in response. Now, that's not to say that all social science questions in surveys suffer in fatal ways from that flaw, but we do know that there are difficulties.

We see the same thing with sort of a neighboring kind of measurement, contingent valuation, in which we try to find from people how much they would be willing to pay to accept, to avoid, whatever, a particular kind of an outcome, a social good, or a risk.

In that work, one of the things that's most interesting to me is there's a sort of a plausibility threshold that you get to. When people are asked a question that they think creates for them an implausible scenario, they begin to answer in funny ways.

In contingent valuation, if you ask people, "Are you willing to pay $500 next year increase in your taxes in order to avoid something?", they think about that, and they start giving you wild answers. You've crossed a plausibility threshold. They know their taxes aren't going to go up by

five hundred bucks for a specific project, so they give you a funny answer. If people don't think they're going to have to pay at all in these CV studies, they give you very different answers than if they think they will.

The point is, is that there's a lot of mechanisms in our studies that we know are leading to differences in response. We can diagnose many of these problems. We do research experiments trying to understand them, and their magnitudes. What I think has to happen is sort of the second most important kind of focus in this area, is to really develop some criterion-related validity for these measures. We need to be able to get to the point where we understand something about the magnitude of the behavior that's likely to result when people say they will do X.

The same thing has to happen in the contingent valuation research. We just have not invested much in that particular tack, and it's becoming, I think, rather important in this area that we do so. So those are my two top-most important. First off, lateral extension of measures we know to different options; secondly, understanding better the validity, criterion-related validity of the measures that we actually take.

DR. BREWER: Bravo. You answered the question.

Elaine?

DR. VAUGHAN: To follow up on Paul's point, I think Paul

is right, that there are a lot of important things going on in people's responses to this type of situation, but given that, perhaps the best we can do, or something that's very useful is to do something like a sensitivity analysis, and given certain scenarios, when are equity/fairness issues likely to predominate and, let's say, affect behaviors more. When are issues of benefits versus risks likely to dominate?

I think that that would be very useful, to try and identify the context, or the circumstances within which certain issues will become more salient. I think social science research in this area sometimes has seemed to be unreliable, because the understanding of people's perceptions of risk have been taken out of the context of their life-scape.

So, given different circumstances, I think, for instance, if equity issues are going to become important, if the media begins to ask questions about why this community versus others, there are some very important potential conflicts arising from equity questions regarding Yucca Mountain. For example, people can start asking: Why this community? Why should we accept waste from all over the country?

If this is going to be the only approved site for high-level waste, let's say, it seems like there's been so much previous conflict, that getting another site possibility

is going to be just a nightmare, but if the media, for example, starts to ask questions about this particular community, or this particular state, Nevada versus other possibilities, then equity/fairness questions will become important. In that circumstance, we can recommend certain activities that the government might engage in.

For example, process becomes extremely important when questions of equity and fairness are involved, and participatory democracy may become a more important issue. So, community members or other members of Nevada may want to participate in the decision making process, and so trust becomes important, trust in those agents who are involved in a debate will become more important.

On the other hand, if the media begins to cover, let's say, a lot of past mistakes that the government has made, or people perceive mistakes that the government has made, promising this is safe, and then we see accidents, or Hanford was never predicted, the severity of the situation there, then I think the debate may turn in another direction.

So, although social science may seem to present very unreliable results at times, I think there are some answers in the literature, and perhaps we can frame it as trying to identify when certain pathways or certain scenarios are most likely. That could be something very useful, I think, that this panel could do.

DR. BREWER: Okay. Anyone else care to take a whack at the question? Yes, Doug.

DR. EASTERLING: I'll come back with another question. I think you're leaving out what we're trying to predict when you ask that question. I mean, it's sort of--we're looking at the predictor, but we don't know what the outcome is.

DR. BREWER: Right.

DR. EASTERLING: And I think we need to get some consensus--I don't know whether it's DOE or you, as a Board--about what behaviors, what economic impacts really are at risk, and what are the things that we need to be predicting.

DR. BREWER: Okay. At some point earlier--and I think it was Elaine earlier made the comment that it's very, very difficult, tenuous, risky, absent a real sensitive understanding of context, to go from one's best measured sense of risk perception to predicting behavior.

Anyone really care to pick up on that? I mean, it's really--it's the heart of your question, Doug. I mean, if we stop there, I mean, that may be the end of the conversation, or pretty close to it. Anyone care to respond to that?

DR. BASSETT: What's the question?

DR. BREWER: The question is the relationship--two things: What causes risk perceptions, the assertion, sort of strongly stated, that it's very difficult to go from risk

perception, however carefully measured and understood, whether the measurements are reliable and stable in space and time and the things that Hank was talking about, to predicting behavior.

DR. PRICE: I might add kind of to the thought that people are along a continuum of risk avoidance to risk seeking somewhere, and you're looking at risk seeking and this issue of power, and power generation, that produces energy, which has some positive valance to it to people, and has maybe an approach kind of a concept to it, maybe a little bit of avoidance, but it's very useful what's going on in the power plant.

When you talk about waste, that, by definition, is useless, and nuclear waste produces, by concept, illness and maybe death, and so the response is a behavioral response would be avoidance, and that makes a person think that that behavior's going to prevail, because it's difficult to extinguish avoidance behavior, and with the uncertainties about all of this that are so ubiquitous and profound, I think that avoidance behavior cannot be discredited, and illness and death are the common experience of all of is, in one way or another, and, therefore, we desire to avoid it, and perhaps avoid it at all costs, and so, like a dog chasing a car, we bark at it, and it runs off, and we have success.

So, the end result is that we're going to have

avoidance behavior here, and it's going to prevail, and we're going to have to work in an environment in which this is going to prevail.

DR. BREWER: Thanks, Dennis. Hank?

DR. JENKINS-SMITH: I like that way of thinking about the problem, particularly, I think, again, departing from the difference between the way we think about nuclear power and nuclear waste is rather critical here.

In the discussions, one of the things that we were using our focus groups for was to get people to hold sort of mini community meetings to think about, "What should we do with this waste?", and our job, as moderators, was to keep introducing, "Well, what about..." to them, and see how they responded to these kinds of things.

But, the thing that most frequently led to deep-seated opposition to a policy was that it wasn't a solution, that it was stop-gap. What happens when this repository fills up? What do we do next? Is this really a solution, or is it just sort of temporary?

And when we've asked people about this, if you actually connect a repository program with some sort of notion that there is a solution, or at least a potential solution in the offing. The way they think about it ceases to be sort of this single negative dimension, to something that has utility attached to it, and that changes the degree

to which people find it repulsive, and, therefore, something truly fearful.

In an experiment that Gib and Carol Silva and I just recently carried out, we asked people how their level of opposition to an underground nuclear waste repository would change if it was coupled with a research program to find out how to produce--how to store that stuff more safely, or use it for something else later, and there was about a 70 per cent increase in support for that program, and it had to do with connecting it with something positive, something that had a solution attached to it.

Now, that's not to say that that's a program that I would advocate. It's simply to say that when you have singled out a uniform negative dimension upon which to base a policy, you know, what do we do with this awful stuff, you're going to get a very different reaction to it than you would if you're essentially providing something that has positives as well as negatives associated with it.

DR. PRICE: Yeah, and perhaps a positive that isn't being connected is with respect to actual power generation itself, and in Virginia, where I'm from, we have about 52 per cent nuclear power, and I was wondering if there's been any surveys in which the scenarios have posed the loss of nuclear power in a very practical sort of way so that people could respond to the connection between waste and power generation.

DR. BASSETT: Hank just told you about the survey question where the repository feelings were linked to a national laboratory or some sort of organization that will be looking at ways to handle the waste. That was not the only option that people were presented in that survey.

The question before that asked people their feelings about the repository, how they would change in response to the linkage that you just suggested, in which nuclear power would be diminished as a quid pro quo for opening up a repository, and the so-called "Swedish Solution," and I lost money on that bet, because I was betting strongly in favor of the "Swedish Solution" being the one that would most swing people in favor of opening a repository, but that did not do it.

I don't have the exact statistics in front of me. Hank might, but the one that worked, I mean, people's initial responses--we kind of saw a little bit of this in the focus groups, because people's first response in focus groups was, "We're going to link a repository opening with closing down all the nukes," and we said, "Yep, that's a good idea. We've taken them all around a variety of options."

But then, all of a sudden, they begin to pause and reconsider all of the consequences of that, and it didn't do as well in the focus groups, which is just kind of casual information that we're just watching. In the surveys, this

becomes a little bit more systematic. It didn't do as well as linking it to attempts to try to come up with solutions to the waste problem, recycling, or whatever.

DR. BREWER: Jim?

DR. OPALUCH: I just wanted to point out some very similar, which is the positive aspect of it, of course, is that otherwise, you've got this stuff stored in a basement somewhere, and, you know, in another facility, and so, it's the solution to that problem. Of course, it still is a problem in and of itself.

And the other aspect that Dennis had brought up was--that struck me is you really have to think of it as a survival instinct. If you want to understand why it is that people are so frightened of this kind of thing, is you have to recognize how deeply ingrained the survival instinct is in each and every one of us, and how, you know, potentially, we feel threatened. That instinct is threatened by such things.

DR. BREWER: Yes. Paul, and then Howard.

DR. SLOVIC: With regard to this dependence on power that Dennis Price raised, we conducted an identical survey in both the United States and France a couple years ago because France is close--it's either first or second in its dependence on nuclear power. Something like 80 per cent of its electricity is generated through nuclear, and the U.S. is about 20 per cent and dropping, so we wanted to see if we

could figure out what the different attitudes might be that might be related to that.

And we were surprised to find that the perception of risk of nuclear energy was as high in France as it was in the U.S., but we did find quite a striking difference on several other issues.

The dominant one was--well, one was in terms of perceived personal control of risk, and the French felt they had no control over the risks that they faced in their lives. About 80 per cent felt that way, and the Americans were much more likely to believe that they had control.

The second big difference was in where they thought the locus of authority for making decisions should be. France, they thought that the experts and the government should make the decisions, and they trusted those people to make the decisions. In the U.S., they were much more likely to say that the public should make the decisions, and we don't trust the experts and authorities, so I think it did point to some difference, even though there is tremendous difference in dependence and benefit that the country is getting.

We also find that, in this country, people don't see much benefit to nuclear power, nuclear energy. They think we can get our electricity in other ways, through conservation we can, you know, manage things, so...

DR. BREWER: Interesting comment.

Howard?

DR. SCHUMAN: Two comments. First, on the nuclear reactor versus waste, it does seem plausible that maybe it is positive/negative versus just negative, as was said before, that even the term waste, it's not just useless, it's noxious. I mean, even waste in a generic sense is not something anybody particularly wants, and it does seem really worth investigating that further.

The other comment is we're making a lot of distinctions, and I think one important one to make is to try to avoid thinking of the public as some kind of a great homogeneous mass out there. On an issue like this, I feel virtually certain, even though I haven't done much research on it, there are going to be a small proportion of people who feel it is the overwhelming issue, just as there are some militiamen who think that not having driver's licenses is the overwhelming important thing to do.

There will be others who will share some of that, and so forth, all the way to a fairly substantial part of the population that knows little about it, or is confused about it, or is ambivalent, doesn't know who to listen to, so and the studies, I think, then, have got to try to find out, to look at the structure of public perceptions and public attitudes, and recognize that on most issues, it's a

relatively small minority who feel strongly.

Now, they can have a big impact, because, as someone said, if something then happens--and this would be my own guess as to the scenario in the future, is that--I'm probably jumping way ahead, answering a question we haven't been asked yet, but that one could locate a waste repository in Nevada, or some other place, without really a lot of difficulty--that's my own guess--unless something happens, unless something goes wrong which gives credibility to those people who are most frightened and opposed to it, and discredits, of course, all the technical people who've been saying it's fine.

DR. BREWER: Okay. Let me see if I understand what you've just said, Howard, because I think there's some important points here.

One is to guard against, in any kind of analysis that might be done, guard against treating the public as a monolithic thing, first of all, because there's a lot of variation there, there's a lot of differences, and the differences matter. I think that was one point.

A second point is that that is really a researchable question, and that maybe we ought to be taking it seriously and putting some time and energy into figuring out what the publics, in the plural are really all about. Is that basically what you said?

DR. SCHUMAN: Yes. We're trying to get at the structure of this. I think it is important, and to do it, again, I think one has to approach it in a way that avoids suggesting things to people.

DR. BREWER: The closed-end question, probably, then?

DR. SCHUMAN: Right. I mean, there are just all kinds of examples like the one that was given before, of a large majority of the American population seems to support a balanced budget if they're asked about it, but if they're asked whether they support a balanced budget if it's going to reduce health care and all kinds of other things, you get very large shifts.

DR. BREWER: Right.

DR. SCHUMAN: And we've seen that with almost any issue.

DR. BREWER: There was another thing that came to mind in part of your comment, and it's really a question. It's a technical question of sorts. We have been using interchangeably concepts of opinion, attitude, belief, and perception, and I wonder if somebody would just tell me what the differences are.

DR. PRICE: Garry, I'm glad you asked that, because I thought attitudes were predispositions to act, to behave, and yet, I heard from the panel that some attitudes were not related to behavior, and so I was wondering the same question.

DR. SCHUMAN: Well, it used to get defined that way, but I don't think most people would define. Usually, an attitude will be defined these days as an evaluation of some object.

DR. BREWER: The problem with the mike, Howard, is you have to be close, and then he doesn't have to turn it up so high.

DR. SCHUMAN: I'm sorry. The earlier definitions tended to presume a relation between attitudes and behavior, assuming we have some sense of what those two words mean, and, you know, a lot of research which then questioned how strong that--some questioned whether there was any relation, but many more questioned the strength of the relation, and I think nowadays, the dominant definition is that an attitude is an evaluation, positive/negative scale, of some object, and then the issue of what that leads to in the way of behavior is something for research. It can't be built--it shouldn't be built into the definition.

DR. BREWER: Okay. Then how, with that sort of operational, rough-and-ready definition, how does that relate to the whole question of risk perception? Is the perception really driving the attitude? Is it coloring the attitude in terms of measurement? And I'm pointing at Paul, because it's really--it's a basic question, another one.

DR. SLOVIC: Yeah. I wanted to first start by commenting on the term "risk perception," which many of us

have used, and I think, technically speaking, perception is probably not the right word. We use perception where others would say we're talking about judgments or attitudes.

I first encountered this term in use, I think, by geographers who were studying natural hazards, and people's views of earthquakes and floods and this sort of thing, and they talked about hazard perception, and that seems to be the way that most people are comfortable thinking about it, but in terms of, you know, it's not clear what--perception, in psychology, usually refers to something when there's a stimulus out there, you know, that you're, you know, there's some physical impression that you're then responding to, your perception of some stimulus.

One doesn't exactly know what the stimulus is in a risk situation. I mean, you know, it's much more amorphous and abstract and complex, so you could call it perception, but I think, more appropriately, it would be attitude or judgment, but I wonder what, perhaps, Dr. Kraus would say about this, because he's written some really interesting reviews on the attitude behavior link, and attitude construct, and perhaps he could comment on that.

DR. PRICE: Well, excuse me, Dennis Price again before we get to that. That amorphousness and so forth, it seems to me that underlying all of this discussion, there is really a deep question about validity, which I thought we opened with.

Do we really know what you're measuring, and so forth?

DR. SLOVIC: Well, let me respond to that, because I think that question plays both ways in terms of perception of risk and assessment of risk on a technical side. I mean, what is risk is a question that you can go around and around on, because, I mean, I would say that there's no fixed definition of risk, either. We can decide to measure it one way or another. We can say it's the probability of some consequence.

We can decide it's some probability, you know, distribution of outcomes with probabilities, or we can then play off of that. I mean, you've got dozens of different measures of risk, whether you want to look at fatalities, and if you want to look at fatalities, do you count them all equally, or do you weigh them more heavily if a younger person dies than an older? I mean, there's just--once you get into the technical definition of risk, it seems to be as wide open as the social.

I would agree that, you know, it's sort of amorphous on the social side, but I think it's also very complex on the technical side.

DR. PRICE: So risk is sort of whatever you make it to be by operational definition?

DR. SLOVIC: I think that, you know, there is no such thing as real risk. I think that there's danger, okay?

There's things out in the world that can harm us, and we have created the construct of risk to help us think about and manage and deal with threats, and there are many ways to define risk. Some are more accepted than others, and there's, you know, and, you know, a lot of respected science behind it. Others may seems flakier, but I think, all in all, I mean, it's a much more complicated issue of even what is risk than we often assume it to be.

DR. BREWER: I'm going to get to Steve in a minute. Hank, did you want to just follow up quick on Paul's point?

DR. JENKINS-SMITH: Yeah. There are a variety of different ways that we get after this notion of how risky to people something is. I mean, the normal, sort of standard is an attitudinal measure that you ask people to scale from not at all risky to very risky, and we also use a variety of measures having to do with how likely people think an event is, and then what the consequences are, a constructed notion of risk, and while, I mean, there are relationships between what people say the likelihood of an event taking place, and how--and what those consequences are with where they scaled themselves on an attitudinal dimension, so there is some sort of an association people are making between probability times consequence, on the one hand, and their attitudinal scales, and that relationship gets stronger the more aware or more knowledgeable that individual is about the issue at hand.

But it doesn't explain all of that variation. I mean, there is certainly--I mean, a fate worse than death, right, is a phrase that implies that there are things, risks to us that have to do with how things happen, and the context, and whether we lose face, or whether it's a just thing, and all of those play in as well to the notion of how risky somebody thinks a particular activity is, and societies define these in different ways. Different kinds of people would define risks in different ways.

I mean, to me, the threat of the loss of authority in society may be greater or less than it would be for somebody else, because of the way I think of social--of relationships being appropriately ordered in a society, and so the way we pick and impute value to different events as risks, or potential events as risks in our worlds are going to be very much related to a whole battery of social attitudes, in addition to these probability times consequence numbers.

It isn't total chaos. I mean, there is structure and order involved in these kinds of questions. It's just that people think about them somewhat differently, I think, than the simple probability times consequence engineering definition of risk.

DR. PRICE: Some of the material that was given to us to read before this session dealt with significant correlations,

but at the levels of .09 to .11, or something like that, where the variability you're accounting for is so very, very small, that it begins--you begin to wonder, you know, what really is--it's significant, but so what?

DR. JENKINS-SMITH: Well, you have to realize we're working in the social science world. A lot of times we have difficulties both knowing about the reliability of the measures that we employ. That introduces some noise, and, in addition, our models are under-specified. We know that there are things that matter that we can't include, but that's why, you know, in the construction of our experiments, we try to hold as much else constant as we can, in order to be able to look at a set of relationships without being able to be exhaustive in our explanation, and yet, still have something valid and important to explain.

DR. BREWER: Lee, did you want to follow this point? And then I want to conclude this part of the panel discussion by talking about the connection between opinions, attitudes, risks, whatever it is we're measuring, and behavior, and that's Steve's strong suit, and so, Lee?

DR. WILKINS: Well, what was actually where I kind of wanted to go with this comment. The tail end of what you're asking, in essence, is do anybody's attitudes, opinions, or belief matter very much in terms of how they behave? And, like all the rest of us around the table--and I guess we've

all done a little bit of survey research. My most recent experience is with the '93 midwest flood, where seven months after the flood, we asked a bunch of Missourians, "Do you know that driving, or riding your bicycle, or walking in flowing water across the road is dangerous?", and they said, "Yeah, we do. Did you do it?" Forty-five per cent of them said they had.

That's a real typical finding, at least in hazards research, is that people know intellectually that something is dangerous or risky or could harm them or whatever, but that they still choose, for a variety of reasons, to engage in those particular behaviors, and you're right, it's not random, but one of the really not random thing about it is that people are going to behave like human beings, and their decision-making matrixes are incredibly complex, and they will do things that, on the surface, look ill-advised or whatever, for reasons that, at the time, make a great deal of sense to them.

So, part of, I guess I would say the art of social science is understanding that it's not causal, it's correlational, and that's kind of a mind set that we pretty much all have up here, but it's very different from looking at the science of what happens when cesium decays.

DR. PRICE: Yeah. I think this point, regarding our agenda, it says: "Causes of risk perceptions," and what

you're really able to get down to is associations with risk perceptions, is that correct?

DR. WILKINS: I certainly think that's some of it. I mean, it's some of the research that people around the table have done, and that you were asked to read, tries to drive that back to some sort of, if nothing else, some underlying personality traits, some underlying beliefs about how society ought to work, that those would, you know, vary across a wide variety of potential behaviors.

But, you're right, the wording of this, to a social scientist, is a little bit peculiar. We seldom deal with even plural causes, because we're examining things that are just very, very complicated.

DR. BREWER: Okay, Elaine?

DR. VAUGHAN: I think maybe a better question than do attitudes matter is, when do the measured attitudes matter? We're not as, sort of mushy, I think, as we may be implying, but there are circumstances under which measured attitudes or perceptions or judgments really can be predictive of outcomes, and I hope that, eventually, in this discussion over the two days that we can talk about under what circumstances can we predict.

Some of it has to do with methodological issues, about the nature of the items included in a study, or the actual procedures used, but also, it's the level of

specificity of the attitudes compared to the behavior one's trying to predict. It could influence the other kinds of factors that might influence behavior, like beliefs about the efficacy.

If you believe you can have an effect, it's like the barking dog, again, that, Dennis, example is very good. If you believe that your behavior can matter, then you're more likely to carry it out, and so, in some circumstances, you can find very high perceptions of risk, but if the behaviors seem too difficult or incompatible with the other contextual features of your life, then it's likely that behavior will not be manifested.

So, I think, perhaps, a better question is really when do the measured attitudes correlate with, or are predictive of particular behaviors in regard to a nuclear waste repository?

DR. JENKINS-SMITH: Just one thought about this notion of cause that I think, you know, we may be dealing with it somewhat differently amongst ourselves, but, in general, in the social sciences, we have theories that would tell us what sorts of things would cause relationships, and then we use the data to see whether or not the associations are the way we would think they were, if that cause, in fact, was driving the--if that causal pattern was, in fact, happening.

And what we do is, we look for consistency and

inconsistency, and it is the case that because of the multivariate nature and the complexity of many of these things, that we've backed away from cause. That doesn't mean we don't think in terms of what causes things any less than anybody who's trying to explain behavior in the world, and if that distinction between sort of the theoretical explanation, it's unjust, and, therefore, I impute, bless, I mean, I see it as riskier, that is a causal link that we make theoretically, and then we look for associations in the measures of those two kinds of things.

Is that sort of what you were getting at? I mean, I'm not--I do think in terms of causes.

DR. VAUGHAN: I mean, I do, too, Hank, and I think that from some research I've done in diverse communities about risk perceptions, it was interesting with, for example, immigrant farm workers from Mexico. We were looking at their perceptions of pesticide risk, and found these very, very high perceptions of risk, a lot of knowledge about the possible health effects that could follow.

We asked open-ended and closed-ended questions that were very consistent about their level of fear about pesticides, but from a behavioral observational component of our quasi experimental study, if you just looked at the behavior of these farm laborers, you wouldn't see a manifestation of these high-risk perceptions, and we found

that the attitudes were not that predictive of behavior unless you looked at the socioeconomic and cultural context, and organizational context of farm labor work.

So, I think that sometimes we focus the theoretical issues, because we have to. The complexity of the world of social sciences is such that we have to take off a little piece and look at it, but when we put that back in the real world and we're trying to predict how people might actually behave, I think we always have to remember the context of that behavior.

But we can measure that. I don't feel that that is hopeless. We can measure some of the contextual, situational factors that could influence that link between attitude and behavior, but Steve probably knows more about that.

DR. BREWER: Let's go with Steve, and then serve as the closing comment on this. I think it's a good place for us to stop and sort of take stock, and then we'll pick it up again, come back to it, because it's really--it's the crux of much of what we're after here.

Steve?

DR. KRAUS: Obviously, it's very important to define our terms. We've talked a lot about attitudes and risk perception and behaviors. As Howard mentioned, you know, the term attitude has been used for a long time in the social sciences, going back to, you know, the beginning of the

century, and early definitions of the term attitude really focused on attitude as a predisposition to behavior, and that was just kind of the working definition for a long time, up until about--it wasn't really until the fifties and sixties when a lot of people started to look at, empirically, what's the relationship between, you know, stated attitudes and overt behaviors?

And there was a lot of concern and some research that suggested, well, you know, attitudes and behavior may not be particular consistent.

One of the things that happened over time is there was kind of a reformulation of what we mean by attitude, from the old, you know, predisposition to behavior, to, as Howard mentioned, really, you know, an evaluation. An attitude is an evaluation of some object or concept. It's kind of placing that object or concept along a dimension of judgment that kind of ran just from favorable or unfavorable, you know, how favorable are you toward Bill Clinton or nuclear waste, or these kinds of things.

Attitude is really perceived of as kind of this internal, psychological state. It tends to be characterized mostly in affective terms, in terms of feelings or emotions, and, for the most part, it's measured using verbal reports. You ask people what their attitudes are, and then try to correlate that with some kind of behavior, and, typically,

there are a multiple of these kinds of verbal reports in order that they can be combined into one reliable measure of affect or attitude.

So, with that kind of working definition, then, I think that the questions that come up for us is, what are the relationships between attitudes and risk perceptions, and what are the relationships between attitudes and behavior?

I tend to think somewhat of attitudes as kind of being built up from risk perceptions in this kind of expected value formulation that I talked about a little bit earlier, so if you asked someone, well, you know, "What is your attitude toward nuclear power?", to some extent, they're going to think about, well, what are the possible outcomes associated with nuclear power? How likely are those outcomes? And then, how positive or negative are those outcomes?

And by combining those, you know, probabilities of events happening, which is kind of what we've used the term risk perception to mean with, you know, the ratings of those outcomes on a positive or negative scale, those are kind of summed up in a way to form a person's overall attitude or evaluation.

Now, the way I've just described it makes attitudes sound like they are very much cognitively and rationally based, and, to some extent, they are. I think, also, to some

extent, the relationship between attitudes and risk perceptions works the other way, so if you go and ask someone, well, you know, what is your attitude toward nuclear power, and, you know, what are the risk perceptions that go along with that?

I think a lot of people are first going to have kind of a gut level affective reaction of, "I don't like nuclear power," and then when asked to make judgments about risk perceptions, they'll think, "Well, you know, I must think that these negative outcomes are fairly likely, because I have such a negative attitude." I mean, there's kind of a self-perception effect that also happens.

So I think there's definitely, you know, kind of a bi-directional relationship between attitudes and risk perceptions, as we've used the term/

DR. PRICE: And with respect to beliefs and attitudes, as Garry previously asked?

DR. KRAUS: In the social science, in attitude research, beliefs are usually associated more with, you know, what we've called risk perceptions. So, you know, you have a belief about the likelihood to which, you know, some outcome is going to happen, you know. Beliefs are usually framed in terms of, you know, those kinds of probabilistic outcomes, how likely do you think something is to happen, or, you know, how positive or negative do you perceive this particular

outcome to be, is generally how beliefs are more typically defined.

They tend to be more factually-oriented than an attitude which is kind of more of a--more like an opinion.

DR. BREWER: I need to take a break. Why don't we all take a break until 3:25, and reconvene.

Thank you very much. It was a good start.

(Whereupon, a brief recess was taken.)

DR. BREWER: Okay, let's reconvene, if we would, please.

I have a couple of chairman/host duties that I didn't discharge at the beginning. I wanted to acknowledge and greet Ken Dormuth and Sid Whitaker from Atomic Energy of Canada, Ltd. at Whiteshell. Ken and Sid were gracious hosts of ours about two weeks ago, I guess it was, that we were up in Pinawa, and thank you very much. It was a wonderful visit.

The Board does a lot of exchanges with opposite members around the world, and in terms of the international dimensions of this problem, it's been mentioned several times, it's not just a U.S. problem, it's everywhere, and various countries are trying to solve it in their own way.

I'd also like to acknowledge, and this is--I just forgot--the strong sort of background and preparation of Dan Metlay, who's been the senior staff guy responsible for most of what you see here, and thanks a lot, Dan.

Okay. We're going to get on to phase two, the connection between--I'm still confused--opinions, attitudes, beliefs or perceptions and behavior, and I'm going to let Steve Kraus try to un-confuse me, if he would.

DR. KRAUS: Well, I'm going to focus primarily on the relationship between attitudes and behavior, because there's quite a large literature on that in the social sciences, so attitudes, if you recall, are generally defined as evaluations of some kind of object or concept on a favorable/unfavorable scale, usually measured using verbal reports, and there are a large number of studies that have looked at the relationship between attitudes and behaviors.

So, in part of my research, I went out in the literature and tried to find all of them, and set certain methodological constraints in terms of, well, you know, what makes a study a good test of the relationship between attitudes and behavior, and I won't bore you with the details of that.

The bottom line is I came up with 80 or 90 studies that seemed to be good, fairly methodologically sound tests of this question, of do attitudes predict behavior, and the answer seems to be a definitive, sometimes. So, most of what I'm going to focus on is under what conditions do attitudes influence behaviors. What are the methodological characteristics, and the substantive variables that influence

the strength of the relationship between attitudes and behavior.

Before I do that, I will talk a little bit about the overall findings, you know, the relationship between attitudes and behavior is usually measured using a correlation coefficient, which ranges from -1 to .1, and if you look at the average of all these correlations, the average is about a .38.

Now, there's considerable variability, and so I think more of the interest is what drives the variability, and that's what I'll talk about, but when we evaluate that .38, I think there are a couple things to keep in mind. When you're interpreting, you know, how big is a correlation, there are a few ways to do that.

One is to look at statistical significance, which means what's the probability that you would have found a relationship of this magnitude if, in fact, out there in the real world there is no relationship between them? And the results show that, you know, there is no doubt that it's a statistically significant relationship, you know. The P value is extremely small, but that's not particularly informative, because significance testing is very much influenced by your sample size, and when you have 80 or 90 studies, you end up, you know, looking at very large sample sizes.

So, instead of focusing on statistical significance, it's probably more informative to look at the absolute magnitude of that correlation, and one way of interpreting correlations, which has been hinted at here this afternoon, is what's called the R-squared approach, where you square your correlation and arrive at the proportion of variance accounted for, and I think in some ways that can be a misleading way to interpret effect sizes, and I think one reason for that, which Hank alluded to earlier, is that when you've got an attitude measure and a behavior measure, there's error associated with both of those, error associated with unreliability of measures and other things like that, and those serve to attenuate correlations.

If you corrected the correlations for that attenuation or that unreliability, statistically, you can go through and say, "Well, you know, what if our measures were perfectly reliable?" You would get very much larger correlations.

The other thing I would point out about the R-squared approach to interpreting correlations is you can get a correlation of, say, .7, which, in this line of research, I would consider to be very substantial. If you square that, you end up with .49 as an R-squared, and so people would say, "Well, you're not even accounting for half of the variance in the behavior."

I think you sort of have to look at it in a different context. If you measured, say, an attitude on one occasion, and went back and measured the same attitude a month later, and looked at the correlation, and you got a .7, many social scientists would say, "Well, I would consider that to be an acceptable level of test, re-test reliability." So, in other words, I would consider a correlation of that magnitude to be reasonable evidence that I've measured the exact same thing twice.

So, in that sense, I think it's a little misleading to square a correlation and say, "Well, that's the proportion of variance accounted for," when you look at, you know, how correlations of that size play out in a reliability context, and in looking at attenuation due to reliability of measures.

So, having said that, I think, as I said earlier, that the more important issue is under what circumstances do attitudes predict behavior? And there a lot of variables that moderate the attitude behavior relationship, and some of those are methodological in nature, so, obviously, the better job you do at measuring the constructs that you're trying to get at, the higher your correlation is going to be.

So, one factor, obviously, is when you're measuring attitude, you want to get multiple measures of attitude. Simple asking, you know, one item, you know: How do you feel about X?, tends to be an unreliable measure of an attitude,

and, in general, a single item measure of anything tends to be unreliable, so using multiple measures both on the attitude and on the behavior end is going to give you substantially larger correlations.

Another methodological factor which kind of parlays into the more substantive variables that influence the relationship between attitudes and behavior is what's been called the principle of correspondents, so, to give you an example, a specific attitude will generally do a good job of predicting a specific behavior. So if you want to predict a very specific behavior; is someone going to go to church in two weeks, you want to measure a very specific attitude, you know, even down to the level of, well, you know, what's your attitude toward going to church in the next two weeks?

On the other end, if you want to predict a general behavior, which, you know, say a broad pattern of church attendance and other religious-type behaviors over a long period of time, a general attitude will tend to predict that, so a general attitude toward religion will predict a kind of general outcome measured like that, but you should not really expect a very general attitude, like attitude toward religion, to do a particularly good job of measuring a very specific behavior, like are you going to go to church in two weeks.

This notion of correspondents also plays a role,

when you talk about the length of time between the attitude measurement and the behavior measurement, and it's not surprising the literature shows that, you know, the closer in time you measure behavior after you measure attitudes, you're going to get a stronger relationship, and I think that plays a role here in that if the goal is to measure someone's attitudes toward a nuclear waste repository now, and to use that to try to predict their behavior in terms of, you know, social and economic impacts, and are people going to move, and things like that, when a repository is actually built ten years from now, I think that's a phenomenally difficult thing to do, you know, because of the time gap.

There are so many things that could happen in that period of time that just can't be predicted right now. I mean, there's no telling what kind of political events there could be. There could be events of a nuclear nature in other parts of the world. We know that the accident at Chernobyl had some effect on attitudes towards nuclear power in this country, and, similarly, even if you looked, you know, specifically at the repository, if it were built here and everything went smoothly, what you might see is kind of a systematic desensitization, where people become less concerned about it over time because it's not being brought up over and over again.

If, on the other hand, there were accidents or some

kind of problems, you could see kind of a social amplification, where there's more media attention, you know. All kinds of things could happen that could dramatically change attitudes before we get to the behaviors that we're interested in predicting, so I think to measure attitudes right now and to try to predict behaviors down the road is a phenomenal difficult thing to do in this particular circumstance.

There are a few other substantive variables that influence the relation between attitudes and behavior that I'll just kind of touch on quickly. The literature shows that some attitudes are more predictive of behavior than others, so, for example, if you hold your attitudes with a great deal of certainty, then those attitudes tend to be more predictive of behavior than attitudes that are held less certain, with less certainty.

There's a concept in the literature that's been called affective cognitive consistency in your attitude, which, in simple terms is, you know, to what extent are your feelings closely tied to your thoughts and your beliefs and the amount of information that you have about the issue, and, you know, I don't know of any research specifically looking at affective cognitive consistency in terms of nuclear waste, but one could certainly imagine that the public would have very highly affectively charged attitudes and, in some sense,

they would be strongly held, but, on the other hand, you know, we know that these attitudes do not seem to be very closely tied to a lot of knowledge and a lot of in-depth cognitive processing about that knowledge. So, in that sense, you might expect attitudes toward nuclear waste to be rather low on this dimension of affective cognitive consistency.

And, finally, another attitudinal variable is a direct experience. If you have direct personal experience with the attitude object, or the attitude concept, then that attitude is going to be more predictive of behavior than something with which you do not have direct experience, and you can certainly imagine that, you know, nuclear waste, by its nature, the average person is probably not going to have a tremendous amount of direct experience with this construct.

So that kind of sums up, you know, what sort of attitudes tend to be more predictive of behaviors. I'll just briefly touch on what kind of behaviors tend to be more predictive than others, and, in general, you can sort of think of behaviors as sort of being on a continuum in the extent to which they are constrained by situational factors, and so, if you think about, you know, all the possible behaviors that would be of interest, and thinking about the social and economic impacts of a repository, you think about, well, are people going to move? Are conventions going to

want to come here? Are businesses going to want to come here?

I think those behaviors differ quite a bit in the extent to which they are constrained by other factors. You know, to my mind, moving is a phenomenon constrained by factors, in that people are in their houses, they've got family, they have friends, they have kids in school, and just, in general, moving is one of the major life changes in our culture, and there are a lot of situational constraints that tend to keep people where they are, and so I would think that that behavior would be probably less likely to be influenced by attitudes than some other behaviors.

If you look at a behavior that's more like, you know, a convention choosing where to locate, there, they're really, you know, choosing among alternatives. We could pick Las Vegas, or New York, or Los Angeles, or all of these other options, and when there are more options, and the behavior itself is less constrained, we know that attitudes are more likely to predict those kinds of behaviors.

So when we get down to, to what extent are attitudes going to predict social and economic behaviors that are of relevance to this issue, I think we have to ask, what is the behavior, and take a look at how that plays out in terms of these situational constraints.

So, there's my lengthy monologue on attitudes and

behavior.

DR. BREWER: That was a great monologue. It summarized many of the major issues that we were trying to get at.

I think now would be a good time for the panel to respond to Stephen's sort of lengthy summary of a range of terribly important topics. I'm going to go Doug, and then Paul.

Doug?

DR. EASTERLING: Just the focus has been, so far, on the relation of attitudes to behavior, and as we did the research, I mean, our intent with the Nevada research was to try to predict particular behaviors, avoidance behaviors, in terms of conventions, visitors, moving and things.

We thought that the attitudes were a bit distal, that we could get closer to the behavior by asking things about people's intention. That gets us more to what you were saying about the more specific the attitude, but I just want to draw a distinction between attitudes and stated intentions.

So, if you ask a person a particular, do you expect to do behavior X in situation Y, there you're getting a very specific prediction of that behavior, and, in that case, the question isn't so much the correlation between intention and behavior, but just the actual correspondence in terms of almost a two-by-two matrix of, you know, they said yes, they

did yes, they said no, they did yes. You can actually do some like tau coefficients or something to get a better sense how well your intentions predict behavior, and, again, there's a whole literature that kind of goes below the attitude that's real common in marketing, and Steve probably knows a lot about.

DR. KRAUS: In general, in the literature, there is often talked about kind of a link between your attitudes will drive your intentions, and your intentions will then, in turn, drive your behavior, so intention is often thought of as kind of the mediating variable between attitudes and behavior.

DR. BREWER: Good point. Paul, did you want to--

DR. SLOVIC: Yeah. I'd like to just underscore a point that Steve made about correlation. He pointed out a few reasons why it's difficult to interpret the size of the correlation in terms of the strength of behavior, and, actually, in his paper, he made another point which I don't think he commented on, which I would like to elaborate, because I think it's illustrative.

And that is, you may get a correlation between, say, an attitude scale and another behavior or another response or judgment or perception of, say, .3, like the dependent variable in some of the studies we've used as, you know, if your community was short of electricity, would you

vote to have a new nuclear power plant built in your community? That's the dependent variable, and say the predictor might be an attitude scale measuring, say, your attitude towards an egalitarian versus a hierarchical society.

You typically get a correlation of about .3 between that attitude and that voting intention, which, if you then square the correlation, use 9 per cent of the variance, it's trivial. But if you look, then, at the distribution of scores on the attitude measure, and you look, say, at the lower quartile versus the upper quartile, the upper and lower parts of the distribution, you may find in the lower end you get like 20 per cent of the people saying they would vote for the nuclear power plant. At the higher end, you get 75 per cent, so a correlation of .3 translates into a difference in response intention of 55 per cent, which is immense.

So I would say that that should indicate that you really have to be careful, for this reason, and the other reasons that he mentioned, about using correlation itself as a measure of strength of the relationship.

DR. BREWER: Okay, good point.

Anyone else want to follow up? Howard, and then Gib.

DR. SCHUMAN: Just to add to that, the best correlations we have in social science, which we take pretty seriously,

like using high school grades to predict, to make admission decisions, or the relations between father's occupational success and son's occupational success don't account for any more variation than these larger sizes, but they're the ones on which there is some leverage, and we think of them as, really, of some importance, even though, in the real world, things are complex and there are all kinds of reasons, particularly if you don't live in a totalitarian society, where someone can force someone to move or not move, that the correlations will be quite imperfect.

On the other hand, I'd like to just mention two other things. I think one of them is related to the point that was made about people having behaved in this way in the past, and that's going to make their attitude more predictive in the future, and, in fact, I think that came out in one of the studies we read about. I thought that was a good point.

Perhaps the first, and, to me, the most profound critique of attitude behavior relations was done long ago in 1934 by Richard LaPierre, and LaPierre argued that the distinction that is crucial here is between attitude as a verbal measure, or a measure to a verbal symbol, and behavior is usually not verbal. It means somebody moves or doesn't move, or they express a behavior in some other way, and that's a very difficult gap to bridge.

Now, in some cases, it is bridged, and our best and

strongest relations between attitudes and behavior are in predicting voting, and it's fairly easy, if you think about it, why that should occur, because voting is a largely symbolic action. I mean, you answer on a questionnaire, or to a survey person, who you favor. Then you go in the voting booth and they give you a piece of paper, and you indicate who you favor, so there's very good correspondence there.

As you go from that sort of thing, for example, asking about attitudes toward a ethnic or racial group, to actual behavior with real people, there's a much bigger gap, and I think that's really very important to keep in mind.

Finally, on the question of moving, I'm of two minds. On the one hand, clearly, there are all kinds of constraints on moving, but if one looks--but if there is a real extreme fear--and several people on the panel have mentioned that survival instincts, and so forth--then I'm not sure if, over time, one shouldn't see that; that, for example, the population of California shouldn't have decreased considerably after earthquakes both in the south and the north.

Are constraints overwhelming? Well, consider what's happened to the white populations of central cities of the United States. Those have decreased very substantially over the last three decades or so. Nobody easily moves, and also of middle class black populations, so movement does

occur. It can't happen tomorrow, because people have jobs and they own houses, and so forth, but there are large movements that take place, and I would think that, given the survival instinct that we've emphasized, that that would produce such a movement if, in fact, people do have an extreme fear.

I don't know what the results are for California. I'm curious as to what's happened.

DR. BREWER: Anybody have the results? Nobody has the results.

Jim, and then Hank.

DR. OPALUCH: Yeah, a couple of quick thoughts on what Howard just said, one on the survival instinct. I think, in many cases, the survival instinct might--and I'm just speculating here--be with respect to the threat. When they hear something's going to happen, they say, "Oh, my God, this is just awful." On the other hand, if the thing actually came, you know, they wouldn't move today, they wouldn't move tomorrow. They start getting used to it and they say, "Geez, maybe this wasn't so bad," or, you know, they just ignore it.

And I keep thinking of some of our experience in northern California at Fort Bragg, where people were very upset with the idea of having OCS platforms off the shore, and how terrible those things would look off the shore, and I looked to the shoreline, and all I could see was this huge

lumber mill. I couldn't even see the shoreline, basically, from Fort Bragg itself, and nobody said anything about the lumber facility there.

I suspect what happens is, people get used to it being there. It just becomes part of normal life. It's not the same thing, so because you don't move immediately, you might become used to having the facility there and, you know, then not respond.

DR. BREWER: Yeah. Steve mentioned this whole business of being desensitized as a consequence of experience as being an important thing to consider.

I should mention for the benefit of the colleagues, Jim and I did hard time years ago looking at the environmental impacts of offshore oil and gas drilling, and that's what he's referring to. Fort Bragg is in Mendicino, California, and the citizens of Mendicino were underwhelmed by the prospect of having oil rigs offshore, and Jim's comment's exactly right. They've got this monster lumber mill right in the middle of town.

One other thing while I've got the floor. I'd like to acknowledge my distinguished colleague from the University of Texas, Professor John McKetta, who's just joined us. Welcome, John. You missed really great discussions.

Let's see, Gib, and then Hank.

DR. BASSETT: One of the most interesting things that I

read in this area, in addition to Steve's paper, is a report that was done by the State of Nevada. I think it was done by Doug and Howard Kunreuther on this question not of attitudes and behavior, but this much closer link between stated intentions and actual behavior, something which we would expect to be very highly correlated, and one of the interesting things that they pointed out was that the correlation here depends strongly on the type of good, that when we're talking about buying a new car in the next 14 months, 12 per cent said they would, and 16 per cent actually did, a pretty good correlation.

When the question was a pump toothpaste in the next six months, stated intent, will you do it? Fifty per cent said they would and 41 per cent actually did. When they get to novel goods, though, when they get to novel goods, will you buy a touch lamp in the next six months? Twenty-seven per cent say yes and two per cent do. Will you buy a cordless iron in the next six months? Twenty-nine per cent said they would, one per cent actually did. Will you buy a shower radio? Sixteen per cent versus two per cent.

The point here--and it's an interesting and a useful point, I think, is in an area where we would expect a very, very close link between behavior and some verbal expression of something, not just attitudes, but will you actually do it, as we move to different kinds of goods, we

see different kinds of correlations, just kind of reiterating Steve's point that it's all a definite maybe as to what's going to happen, attitudes versus actual behavior.

DR. BREWER: But, there again, there is this important issue of experience, familiarity, being sensitive or not. That seems to be the common thread here, the point you've just made.

Hank?

DR. JENKINS-SMITH: Yeah. There's yet one other sort of degree of complexity that enters on these questions, and that has to do with which attitudes one thinks are operative in a particular case.

And I note that when we go out and we measure attitudes that may be associated with risk perception, or with behavior about moving, about vacationing, we're asking--we tend to ask these questions all at the same time of the same individual. It's a cross-sectional design, so we ask a variety of attitudes. We see that they're--we then can measure the relations amongst them, and that's how much of the hypothesis testing is conducted. We see whether or not people's perceptions of risk are associated with different kinds of intended behavior, and we see that there's a relationship, and confirm that.

Now, there's an interesting literature that has grown up over the last, say, five or six years, the best

example of which is a book by Sniderman, Brody, Tetlock, and others, called, "Reasoning and Choice," and it really tries to get at how it is that we apply reasoning to come to decisions, and that this is applied in the case of politics, and race politics, in particular, but it's important here, because the book concludes on the basis of a whole array of different types of research designs that we tend to come to conclusions about major things like race policy, and perhaps like a nuclear waste repository based on some relatively straightforward heuristics, and then go back in and fill in the chain of reasoning that would get us to that conclusion.

And the difference between highly cognitively sophisticated people and less cognitively sophisticated people is that the most cognitively sophisticated folks, those with the highest education levels, are simply better at going back and filling in the chain of reasoning.

Now, the case becomes somewhat important for us when we're thinking about what it is that causes people to be opposed to a nuclear waste repository, because I've seen some very interesting research done on this, that has looked at the relationship, for example, between trust and opposition. Trust has been shown, if you take a cross-sectional dataset, you can find that trust is correlated with perceived risk, which, in turn, is associated with opposition. There's a very interesting paper that some of the panelists here worked

on on that.

The difficulty is, again, it's cross-sectional data. We asked the answers to these questions all at the same time, and it's quite possible that something else is driving the answers to all of those questions, and I would submit that there is one thing out there that's quite important, and that comes back to the justice question, how we make decisions, whether or not something is fair.

In one of the experiments that we have underway right now, Gib and I and Carol and some others, we're measuring perceptions of states' rights, and the degree to which people think that it's appropriate that the State of Nevada take a nuclear waste repository when they don't want it, even if the majority of the rest of the country, or senators and congressmen and the rest of the country want to do that, and it turns out that there's a very powerful relationship between perceptions that states ought not to be forced to take these things, and the perception of risk, and opposition to the policy of, you know, putting in Yucca Mountain.

Now, the point behind all of this--and I apologize for getting kind of long-winded here--is that if it's the case that it's really opposition to the way we went about making the decision that is causing people to go back and fill in, in a chain of reasoning, that there's high risks and

they distrust these people, then, you know, we have to worry about which correlation is important, which attitude is connected to behavior, and if we miss, and if we're looking at what are, perhaps, spurious correlations, or the filling in of the chain of reasoning after the fact, then we may not get as strong a relationship between the attitude and behavior, because we've mis-specified the model.

I mean, this is a real challenge for those of us who try to do social science. We're dealing with a complicated world. Our ability to measure and control for things is limited. That contributes to some of this fuzziness in the relationship between attitudes and behaviors.

DR. BREWER: Warner, do you want to pick up on that?

DR. NORTH: Well, I was going to see if I could encourage more discussion of what do we do for going into depth? Maybe that's longitudinal as opposed to cross-sectional, but it strikes me that when I, as an amateur in this area, look at a lot of the survey data on nuclear waste, it has the pattern of a lot of people have an impression that seems reasonably superficial, but some people have a very deep passionate conviction about this, and act on it, and, in doing so, often convince a lot of other people who have the more superficial attitude.

Now, it strikes me that understanding, how did

those people who feel so passionately get that way, is it justice, is it the trust issue, is it a sense of being lied to, is it something that comes from their early childhood, is it something having to do with egalitarians' hierarchial mind sets, et cetera, it strikes me that that is a very interesting and important area of research, because it strikes me that the social dynamic of this kind of issue is that a relatively small group of people who are passionate and determined can often sway a much larger group on issues over a period of time, and that we ought to try to understand the dynamics of that process, and see, essentially, what we can do to determine that there is a storm brewing, when it is one small cloud on the horizon, and the nuclear waste issue is only one of many where we failed to do that.

DR. BREWER: You know, this might be the time, just to pick up on that thought, Warner, the media really has an important role in all of this in terms of the conversion of the storm cloud into something which is really quite significant.

I wonder if anyone would really care to talk about what I think is called in the literature, social amplification of risk. Is that what it's all about? Are you responsible for that term?

DR. WILKINS: No, Paul is, but I'll at least do a five-minute primer on what you may or may not be able to expect

from the media.

The first thing I want to emphasize is that media is a plural noun. *The New York Times* is not the *National Enquirer*, despite the fact that *The New York Times* is quoting the *National Enquirer* over O.J. Simpson. NBC is not CNN, so just as we have complexified for you the concepts of attitude, belief, behavior, all of that sort of stuff, I'd like to complexify for you the notion of media, and what you can and may or may not be able to expect.

The second distinction I want to make for you, and it's made in one sentence in one of the readings that we were given. When we have been talking here, we have been talking about--my term is the news media. I want to emphasize a couple of things to you. The experience that most people have with nuclear waste is what, in my end of racket, we refer to as a mediated experience. What they know about it is not first person. It is from what they take in from the media.

But I would suggest to you that it is a mediated experience that is not merely mediated by the news media. We live in a mediated culture that includes fictional portraits of nuclear waste and their impact, as well as the portraits that are prevalent in the news media. Let me give you one example.

About ten years ago, the National Science

Foundation asked the people who run the Children's Television Workshop, those producers of Sesame Street, to help them develop a risk communication campaign for hurricane warnings for kids. They thought that was real essential in Florida, because children really didn't know how to react when they got the warnings.

CTW does a number of things well, but one of them is, is it does pretty good research before it puts together any programming, so they had the brilliant idea to go out and ask a bunch of children what they thought a hurricane was. The answer they got was the kids thought the hurricane was the cyclone from *The Wizard of Oz*. Their image of a hurricane came to them not through personal experience--most of them were under five--but through a fictional film.

So, one of the things that I want to sort of emphasize is when you're talking about this social amplification of risk in the media, you need to keep in mind that people get their mediated information from lots and lots and lots of places. Most of them aren't called *The New York Times*.

When we talk about the accident at Three Mile Island, one of the things that's very seldom mentioned, but which I truly believe is significant, is that six days after that accident happened, the film, "China Syndrome" was released, and was very, very popular. There have been actual

studies done by folks who do disasters, who've gone back and looked at film portraits of things like, you know, floods and hurricanes and tornados, and even things nuclear. You'll be delighted to know that, you know, you can see on your television, I think within the last week, at least in the market where I live, "Planet of the Apes", which is about things nuclear, or, "The Thing", which is about things nuclear.

We have these fictional portraits that have been in the popular culture for a long, long time, and one of the things that social science is very unclear about is what it is that people take away from these fictional portraits, but they're clearly there, and, at least in some specific cases, like CTW and hurricanes, we know they're significant.

The second thing I need to emphasize is that the role of journalists in the news media is very different, sometimes, from a--particularly what technical people would like. In their study of risk communication, about environmental hazards, Krimsky and Plough come up with the phrase that I think best describes what the media do, which is that they become equalizers of perspectives on risk.

That has an up side and a down side. The down side is, is that the respected nuclear scientist, the person who really does have a handle on the technical information, will be quoted right alongside your friend, who thinks that it's

going to explode, and, in most stories, the journalist isn't going to tell you which way the National Academy actually feels about those two things. We call that the dueling scientists scenario.

The up side of that is, is that sometimes your friend who thinks it's going to explode may actually have a legitimate point, and the media, in some sense, will air that. In that sense, news coverage of many issues of risk is really a two-way form of communication, and one of the things that mass communication scholars know is that *The New York Times* is not written for people who live and work in New York City. My understanding is if you're a New Yorker, you read *Newsday*. *The New York Times* is written for policy makers, most of whom live in the Boston, New York, Washington, D.C. access. What *The New York Times* says about risk is going to have a much different impact in a much different audience than what *Newsday* says, or what *The Los Angeles Times* might say.

A couple of other things, I think, are real important. One of them, particularly when you're dealing with issues of the news media, is the definition of news itself, which I think you're going to have a terrible time getting away from when you talk about the social amplification of risk. Most of us came here on airplanes. The fact that most of us are here indicates to me that those

airplanes didn't crash. This is not a news story.

When an airplane crashes, it is news. If a nuclear waste repository were to be built at Yucca Mountain or someplace else, and it worked perfectly for 50 years, you probably wouldn't see a lot of news coverage. I can argue from an ethical perspective that maybe you might, but, in fact, the way journalists go about doing their jobs, you won't. If there are accidents associated with that facility, you're going to see a lot of news coverage, and I think that is inevitable.

The last sort of point I want to make--and then I'll let everybody else on the panel loose to bash--is in several of the articles that we were given, there was a discussion of the Tylenol case, and I want to give you a little bit different spin, the spin that at least comes from communications.

When we look at that case, what we say is that Tylenol was an absolute success story in terms of communicating risk. Why? Because today, Johnson & Johnson and its product, Tylenol, has a bigger share of the over-the-counter pain relief market than it did before those accidents occurred.

There have been significant studies of how and why people think that happened, but the bottom line on all of it is that this was a corporation that decided to take a short

term, big time financial loss, pull the product off the market, tell people the truth about what had happened, had the great good fortune of having an external bad guy to blame for what happened. The result was that, at least in survey data and other sorts of data that I've seen, people trusted the product, trusted what the manufacturer said, and, therefore, were willing to once again buy Tylenol when it was deemed safe.

That brings me to the very last thing I want to say about journalists and journalism. This whole issue of trust which we really just touched on, I think, is very key when you talk about the social amplification of risk. Journalism and journalists, particularly, even in this post-Reagan/Bush era, I think, are, to some level, rightly viewed as an adversary of government, and if not an adversary, at least a skeptic.

That isn't helped by the fact that there have been systematic real and documented cases of government mismanagement and coverup in having to do with things nuclear. That fact, to me, indicates that whatever scrutiny this process gets by *The New York Times*, as opposed to the *National Enquirer*, will have a critical edge. People will ask questions regarding trust in institutions that, considering past track records, are going to be somewhat difficult to deal with.

The process of how all of that gets dealt with--and that's not merely a mediated process, but certainly, the media will have a role in that process--therefore, I think, becomes critical in any sort of work to try to determine what sort of impacts might or might not be mitigatable.

DR. BREWER: Boy, that was a wonderful summary.

Paul?

DR. SLOVIC: First, just to set the record straight, the term, I think, comes from Roger Kasperson and his colleagues, who used it to describe a phenomenon that had come out of the earlier risk perception literature, whereby not all events have equal impacts on society, and so, for example, with regard to airplane accidents, when the largest commercial aviation accident on record is a collision of two 747s on the runway at Tenna Reef, Canary Islands, about 700 people died, and yet it was, you know, rather quickly forgotten. I mean, it was big news for a little while, and then it passed on and had relatively little broad or social consequences.

When an engine fell off a DC-10 climbing out of Chicago in the early stages, well, sometime in the early eighties, that was much bigger news, because people saw in that a different message, and what I think is partly underlying social amplification, social amplification attempts to ask why is it that some events that take very few lives, or have very low risk from a technical standpoint,

have a large social impact?

And one of the concepts that was put forth to try to explain that is the notion that events or accidents are signals of, say, a change in risk, or maybe no change, so if the event portends that the world is suddenly different than it was for you before the event, that we now know something new or things have changed, this is an ominous signal which often triggers very strong social and economic political consequences, so that the engine falling off the DC-10 was a signal of possible metal fatigue that could be running through the whole fleet of DC-10s and portend further crashes, or accidents and crashes unless something, you know, strongly was done, and it had a big response.

We started to study media response in light of this, and we actually had people judge their view as to what the media should cover, what kind of accidents and events the media should cover. We also studied their perception of signal value of accidents and different sorts of things. We found a very strong correlation between the strength of the signal of an accident, and the desire for media coverage, and, in particular, things nuclear were in the high signal area, because it was also linked to aspects of perception, like the perception that the hazard domain is catastrophic, that it has a dread element to it, that it's not fully understood.

So when something goes wrong in a system like that, and nuclear power and nuclear waste are categorized as that kind of hazard, then you get a much stronger system and a desire for strong media coverage, and I think that supports Lee's contention that, you know, when things go wrong, or even, you know, are seen as leading in that direction, you're going to get high media coverage.

It's the same thing now with the Ebola virus coming out. I mean, you know, there haven't been a lot of deaths yet from that, and by accounts of what other things are happening in other parts of the world that are killing people, the hundred deaths in Africa from Ebola are not big news, but it is a strong signal that something's different here.

Just a couple of other comments. The notion of social amplification is broader than just the media. It also takes into account the role of, say, the emerging power and sophistication of special interest groups in our society who use the media more and more to their advantage, and in getting us to focus on risks that they think we ought to be worrying about, and that's another way that a small event, in a technical way, can end up having a big impact.

DR. BREWER: Which really goes to Warner's point from about ten minutes ago, the idea of a few passionate people who are sophisticated about the use of the media having

disproportionate kinds of consequence or impact.

Hank, do you want to pick up on this?

DR. JENKINS-SMITH: Yeah. A couple of aspects of this. First, I mean, back to the media question, that was an enjoyable summary, but there's another side to this that I think is critical, and that is that we are all receivers of the signals that the media sends, and we're not entirely passive in that process.

You pointed out, in part, that there are different constituencies, essentially, for the different media sources. We do choose those for different reasons, in part, because they provide us with different things, but when we've studied the way people consume information that comes about environmental hazards, and looked at what sources they employ, and what credibility they impute to the different sources, and, overall, media reporters, particularly for newspapers and television, are accorded an extremely low level of trust, rivaled by Congress, in this society.

And it varies by the different sources that are involved. I mean, people put in--and we do have filters. It's not as if we simply take at face value all of the information that comes to us, so it's not just that there's a variegation in that market. I think that different kinds of individuals are treating those sources of information in quite different ways.

And, you know, the result is that in some sense we immunize ourselves to expected deviations from veracity amongst those news sources if we don't trust them. We can even look at the directions in which we think that bias will occur. We've measured if, you know, do you think that in an event like this, that reporters would overstate or understate the risk and, by and large, with environmental technologically associated hazards, people expect reporters to overstate the risk. They do so because they sell newspapers, and people understand that, and--or sell Nielsen points.

The issue here is that then there is some variegation in taking these kinds of things, and we've actually gone out and tried to measure what happens to people's perception of risk over time around a specific event, and this is repeat panel surveys. We go back to the same people before and after some major event to see whether or not there's been a major amplification of the level of risk.

One study that we did was in Idaho and Oregon. Some of you may be familiar that there was a major campaign by the Department of Energy to ship Cesium capsules from northern Colorado up through Wyoming, Idaho, and into the Hanford facility where these Cesium capsules were being stored. They were being shipped because one leaked down in

Georgia, and Cesium is nasty stuff. I mean, it's basically used to kill the bugs and, in this case, in medical equipment after the stuff had been packaged, and it's hot. I mean, it makes the containers in which the stuff is physically hot, so if it rains on them and they're stationary, they steam.

And there was lots of potential in this case for all kinds of interesting signals about these trucks, enormous publicity for the first shipment; helicopters following it, filming it, protesters all over the place. In fact, in one of the early shipments that took place, there was a bomb threat called in to a truck stop where one of the--where the truck was stopped. It's not clear that it was--the two were related; nevertheless, there was a lot of activity associated with this.

In addition, shortly after the inception of the program, there was a staged accident, called "TransAccs 94" I believe. This was early last fall, in which the freeway was closed not far out of Boise, Idaho, and they had a truck out there and they sort of staged it, basically trying to see whether the local emergency responders could, in fact, handle an event like this that took place.

We measured, prior to this event, the way that a lot of people in Oregon and Idaho understood the risks associated with this event, and then we went back in about six--was it four months, I guess, afterwards, to see whether

or not there was a change, and there was not. To the extent that there was a change, a statistically discernible change, it was a decrease in the level of perceived risk, modest, and only amongst people who had obtained a fair amount of information.

What's interesting, though, is that in contrast to the direction that people's perceived measures of risk went, most of the ones who told us that they had, in fact, heard about this in the news media said that the nature of the information that they obtained would have caused them to increase, would have made them more worried about the program. So, despite the fact that those people who got information from the news media told us that the information would lead them to be more worried, in aggregate, the effect was--or the change, pre-post, was to a diminished level of perceived risk.

Now, I'm not sure what to make of this. There were no major controversies. I mean, there wasn't an accident. None of the Cesium got loose, or anything along those lines, so in that sense, it's not a real strong test, but, nevertheless, there was a lot of information, a lot of initial controversy that died down fairly rapidly, and a diminishment in the level of perceived risk associated with it.

We have a harder test underway right now with

respect to the return of the foreign spent nuclear fuel to South Carolina from European research reactors, and we did a pre-measure on that one and we'll have a--we have a post-measure underway right now.

DR. BREWER: And what's your prior?

DR. JENKINS-SMITH: My prior is that--I guess my--I have a distributional prior, and I think the mode is that it won't change, but we'll see. We'll see.

DR. BREWER: I'm going to ask a question where the answer is sometimes yes or no, I promise, before this two days is over.

Lee?

DR. WILKINS: Just let me add a couple of things. The work that you're doing, especially about finding people doing things like acquiring facts, based on reading news stories, this follows--I hate to say this--at least a 50-year tradition in mass communication research. I don't know what we do, but we don't teach people facts. I mean, that's very clear.

The second thing, I need to put in a plug, at least for my own profession, as battered as it is right now. Most of the studies that have actually looked at media coverage of hazards and disasters and risk seem to indicate that far from sensationalizing the risks, that media coverage tends to minimize it. There have been some outstanding exceptions to

that, but if you look over this scale of, you know, many sorts of health-related risks, hazard risks, you know, all that sort of stuff, media coverage tends to deflate rather than inflate.

Sometimes people who look at this sort of thing--and, as you said, there are lots of groups of folks out there who are real savvy about how journalists work and how the media work. One of them is special interest groups, which Paul's already referred. Another one's the government.

My all-time favorite Chernobyl footage--I did a little bit of content analysis of the first month of Chernobyl coverage--was of that well-respected nuclear physicist, George Schultz, who managed to make all three networks the first 24 hours after Chernobyl, saying that he was positive that 2,000 people had died.

Now, from a journalistic standpoint, it's real hard to know what to do with that, because he's a government official, he supposedly has access to information. True, he's not trained in nuclear physics, but we didn't exactly expect him to lie, so some of this which we attribute to the media--and, indeed, it aired on all three networks, so, obviously, it was mediated--in fact, you can track it back a couple of levels.

You know, that doesn't excuse mistakes, misstatements, ignorance, all the things of which journalists

truly often are quite, you know culpable on, but it is to say that journalism in some ways, particularly news, tends to be reactive rather than proactive, and because it can be such a reactive profession, you can tend to be at the mercy of your sources, and most journalists who are any good at their job realize that, and know that, but it's still a difficult predicament to get out of.

DR. BREWER: Yeah, Gib?

DR. BASSETT: I'm not sure whether the social amplification of risk will occur, and when it will occur, and so on, but like Warner might like to do, I like to think about decision analysis, and then raise a question about the social amplification of risk, and I'm at a decision node where the social amplification of risk going on one way doesn't exist, not real--we don't worry about it. On the second node, social amplification of risk is important.

The media, other leadership groups are going to blow up the event to large proportions, but then it seems that the consequence of storing waste at 70 or 100 places versus storing it at one place become so clear in terms of deciding what public policy should be, that it just becomes clear that you've got to get it in one place, because the consequences of an accident at one of 70 places are going to be felt at 70 places, which are near large population centers, and so I've never kind of understood how the social

amplification of risk wasn't being used as the strongest conceivable argument that people could make in favor of a strategy for single site storage.

You want to keep your portfolio diversified, when you can kind of keep things uncorrelated. Social amplification of risk says that these things are going to be correlated events. We only have to look to Three Mile Island. There was one event which had far-reaching social amplification of risk consequences that I might even say were not bad consequences, but it seems that the risks that we're running now, if social amplification of risk is right, you know--we don't even--we haven't committed to that, but if it's right, then it just seems like the policy prescription is just so crystal clear that I can't understand--I can understand why there's other issues here, but it just seems clear that social amplification of risk pushes one way, unless we can point to certain kinds of features about single site storage versus disbursed site storage, which would cause social amplification to be big in the one case, and not in the other case, but that's not been the way that I've understood this argument.

Paul's heard this before, so he may have, you know--

DR. BREWER: It's Elaine, and then Warner. Elaine?

DR. VAUGHAN: Gil, I said this to you last time we met

at a conference. You sound like an economist again, so you always do this, but--you are an economist, but, Gil, I think that that would work if we were talking about the most efficient decisions versus the most equitable. Perhaps social amplification can occur because if an accident does happen in Nevada, why should Nevadans be subject to this, in looking at the distribution of risk throughout society, when the benefits of storing waste in one site benefits, let's say, all of society, and yet, the risks are being incurred by those in close proximity to this site.

So if you look from an efficiency standpoint--and this seems to be a conflict, a paradigm conflict that's coming up in a lot of policy domains, where you get the efficiency view versus equity, and sometimes they don't always match, and so, I would argue that, in some cases, if equity is a dimension that's being weighted, people might see this one site solution as being very unfair; that why should people in this state incur the risk when you're accepting waste from a lot of other sites, and those people are never incurring the risk and all of the benefits.

DR. BASSETT: I completely agree with that, I do. I'm just kind of--but then we can talk about that.

DR. VAUGHAN: Right, I'm sure we can, Gil.

DR. BREWER: But not now.

DR. BASSETT: Right.

DR. BREWER: Warner?

DR. NORTH: Well, I think this illustrates that a very important research area is why do we get amplification in some situations, and we don't get it in other situations which seem to be very, very similar.

Now, maybe the issue is equity. Maybe the issue is some semantics that trigger different ways of having people think about it; that a storage site is somehow okay and a dump is not, even though it's the same material being managed in a very similar fashion, simply, in one case, the label is such as to trigger an amplification, and, in the other case, that doesn't happen.

Now, my sense is that we know far too little from the many examples we have of these kinds of things happening in our society as to how do you recognize it while it's still developing, and there is some opportunity to change policy and try to improve the situation, as opposed to we have a huge mess on our hands. The number that comes into my mind these days is from the weapons complex, $230 billion to clean it up. Many people think that number may be low. That's my definition of a huge mess.

DR. BREWER: Let's see, Paul, and then Jim, and then Howard.

Paul?

DR. SLOVIC: I have a couple of comments. First, on

Warner's point, which I agree with, we need to understand the social amplification better. We do understand it to a certain extent, and one of the things that seems to trigger these broader impacts is the sense that you can--that management has failed, okay, the control system has not done its job, and that there's some blameworthiness or incompetence in the management system. If an event takes place that sends that signal, then you get a real strong response.

Another factor is the type of victim; innocent people, children. I think the impact on NASA of the Challenger accident was probably amplified by the fact that there was a schoolteacher on board, an innocent person in that sense.

With regard to Gib's point about social amplification being used to argue against single site storage, I think that's not quite the case. I mean, maybe some people have used that as an argument, but I think those of us who have researched it were interested, basically, in the phenomenon of supposedly small events from a technical standpoint, multiplying out and having major impacts on the agency in charge, on the industry involved, on the economics as well as the direct damages, and I think we would agree that it has the potential to happen from accidents on site, as well as at a repository, so we just would argue that it

needs to be up front and part of the analysis, which it hasn't been part of the analysis, so, you know, put it in the analysis and see how it comes out.

Then there are issues, of course, of single site versus multiple, and in addition to equity, there's issues of transportation, which can have problems, which could lead to social amplification as well, so it's, you know, complicated in that respect as well.

DR. BREWER: Thanks, Paul. Jim?

DR. OPALUCH: My point was just the same one that Paul made about that there has been a fair amount of study of dimensions of risk that lead to more amplification, like whether the risks are voluntary or involuntary, and there's a whole list of things.

DR. BREWER: Howard?

DR. SCHUMAN: The example of Tylenol that Lee gave seems to me to raise an important variable that we haven't considered in looking at the relation of attitudes to behavior. It's the immediate effect, a later effect, and so forth. I mean, there may be a drastic negative effect, but then if your example--and I think I saw this in the Brazilian example that was in a paper we were given, where there was a very substantial effect, but, apparently, also a pretty complete recovery.

So, in any case, the time dimension is very

important. Unfortunately, most of the attitude behavior studies that I know of are single point in time studies, so there's not a lot of light from those.

DR. BREWER: Jim?

DR. OPALUCH: And I think that those are the ones that are easiest to measure. I think the longer term, chronic kinds of things are difficult to observe, difficult to measure, difficult to link to something. Can you really determine that loss in population in this area was due to this facility, you know, over a 30-year time span, or was it something, you know, that would have happened anyway?

DR. BREWER: This is a good transition to the next panel, basically, but we have a couple things to do beforehand.

I'd like to ask another one of the curmudgeonly questions. Based on what we've heard, in terms of perceptions, attitudes, and then behavior--and an excellent discussion, by the way--what would you tell the Department of Energy to do? Ten minutes. I mean, what is the take on all of this? What are they supposed to do with respect to Yucca Mountain? Good, constructive suggestions. I mean, what does it all add up to?

Steve, and then Warner.

DR. KRAUS: It's pretty obvious, but I'd say don't have any accidents. You know, we've used the phrase, you know,

systematic desensitization, which kind of brings up the image of a phobia, and I think that's kind of an interesting analogy, because, in some ways, the public's attitudes towards this issue does have some analogous aspects to a phobia.

I mean, if you take a child who has a phobia of dogs, and, you know, how you treat that, the approach is usually systematic desensitization. You know, you put the child in a room with a dog, and if you do that often enough, and the dog doesn't bite the child, the child typically gets over it, but if the dog does bit the child, then what happens is now, all of a sudden, you know, the child's fears are based on direct experience and thinks about it more, and all those kinds of attitude behavior things that we talked about, and, you know, in this example, you know, if there are accidents that will, you know, kind of reinforce the negative attitudes that are already there. You know, having accidents is news, whereas a plant running smoothly is not.

That's that I think makes this so difficult to predict what the economic impacts would be. I think it really comes down to how smoothly would things function.

DR. BREWER: Warner?

DR. NORTH: I'll pick up from that. If you've got an accident, the Tylenol people seem to have done it well. That is the judgment we've heard, and I'd concur with it. Now,

where are the places where people have dealt with a very difficult risk situation and seem to have done it reasonably well, as judged after the fact?

All this brings to mind some comments I heard back in the seventies from an individual who was just leaving the staff of the Joint Committee on Atomic Energy, and I encountered this individual--I think it was a plane flight--and we had a long talk, and the individual was quite despondent about the future of nuclear power, well before Chernobyl and Three Mile Island, and the judgment was as follows:

This issue could have been taken out into the various chambers of commerce, Rotary Club, Lions Club, et cetera, and really discussed that there were substantial risks, that nuclear power was a dangerous technology that needed to be dealt with very carefully, but had potentially large benefits. Instead, as this individual related it, we tried to do this in Washington, and we tried to do it with a very small number of highly influential people in the Congress, and it's not working, and it's really going to blow up.

And I've reflected on that conversation many times, that that individual, I think, understood what was wrong with the system. In my judgment, we've taken some steps toward getting it fixed, but we're a long, long way from being in a

situation where you can explain nuclear waste and the physics involved at the level of a Rotary Club, and have it anything less than a revelation to most of those people that that's what you're talking about, because very few people understand the science involved. Most of them, I think, have convinced themselves that it's too hard for them to be able to understand it, and it's a matter of which expert do you trust.

I might add, I gave a speech to a Rotary Club, half an hour last week, and I thought it worked pretty well. I had lots of people tell me, "Gee, I really learned a lot of things about this issue that I never understood before," so it strikes me that there's an awful lot that the Department of Energy could be doing that they're not now doing.

DR. BREWER: Paul, and then Hank. Paul?

DR. SLOVIC: Well, I would say that the first thing they should do is take the issues we've been discussing here seriously. The trust task force that Admiral Wadkins commissioned led to quite an interesting report and valuable report that Todd LaPort and Dan Metlay were instrumental in, and I would ask, well, what have they done with that report? I mean, that was a distillation of, what, eighteen months or more of hard effort by many people to provide advice on many of these, you know, on basically the issue that we're discussing here today. It's been a year or two since that's

been out. You know, what's been the impact of that? And if there has been no impact, why not?

Another direction would be to enlist the help of the scientific establishment, such as the National Science Foundation, in addressing these issues, because, I mean, while they could support research themselves, DOE, they may not be the best agency to launch a research program on this. For one thing, there may be some credibility problems. There should be some sort of neutral, you know, peer review agency that takes the lead on this, and if they recognize that these issues are a problem for the implementation of a high-level nuclear waste program, which I think many of us feel that they are, then they ought to be, you know, leading the charge to try to get some help, enlist some help in that regard.

DR. BREWER: Any other suggestions? Hank?

DR. JENKINS-SMITH: Yeah, I guess I'm a little bit more cautious to make inference to what DOE should do right now, but I can think of one thing that DOE should not do, back to the issue of accidents and not having them, is we shouldn't tell people that there will be no accidents, because they don't believe it.

The fact is, is that when we have, in repeated measures of likelihood of accidents, both in transportation and in the existence of facilities, we get very large

fractions of our respondents who tell us, "Oh, yeah, there will be an accident," and we ask, "Well, what do you mean? What kind, and what's the origin?" They typically tell us it's going to be human-caused error. People do it, you know, and people aren't experts in nuclear physics, or other things, but most people spend a lot of time watching themselves, their own behavior, and other people's behavior, and they see people making mistakes all the time, and they're pretty confident in their assessment that people make mistakes, people get tired, people, you know, just make errors in judgment.

And to the extent that we have federal agencies out there telling people, "There will be no accidents. We can, you know, zero per cent chance of this," you destroy credibility so fast it's astounding. What you need is a robust system that can handle accidents. I mean--and the fact is, if you think of most of the sort of trusted things that go on in society, I mean, we have many industries that operate with reasonable levels of acceptance, and people know accidents are happening, but they know that they happen, we recover, we pick things up, we fix them, we go on.

And now, when we try to claim that there will be no accidents in these kinds of areas, or we're going to reduce them to some astronomically small level, what we're doing is essentially sending a signal that says, "Boy, if an accident

happened, it would be so catastrophic that we can't even think about it." Maybe robust systems is a better way to think about it than zero accidents.

DR. BREWER: Interesting point. Gib, and then Elaine.

DR. BASSETT: If there is a magic bullet solution, I don't know what it is. The TRB, in its most recent report, had a chapter devoted to a look at low-level waste, and the difficulties that--and I take that to be real instructive, because low-level waste has met with almost every one of the problems in the arenas that we've talked about today as high-level waste, but it's different, and so, I mean, it's not ruled so much by DOE, although it may have those kinds of connotations.

I know of instances where the people who have tried to site the facilities have gone the extra mile to try and involve the public at the Rotary, and do all this stuff, and yet, on the low-level waste front, as we speak, you know, nothing has happened, and I kind of--whenever somebody proposes something that is a magic bullet kind of solution, I kind of always ask, well, have they tried that in low-level waste, and if they've tried it at low-level waste, then the question is, well, you know, that's not going to do it, that's not going to do it.

And so, I don't know what it is, but the low-level waste situation that the TRB looked at, I thought, was

extremely instructive in terms of trying to find some way in this landscape towards not solutions, but just to make the problem a little bit more tractable.

DR. BREWER: Thank you, Gib. Lee?

DR. WILKINS: To put a little bit of a finer point on something that Warner said that I think is really important, is you need to worry a whole lot about process. There are communities--Seattle/Tacoma is one that comes to mind--that basically, over a period of a couple of years, essentially arrived at a community decision about how much arsenic they were willing to have a plant dump in the air, and what the consequences of that were.

Now, arsenic is--arsenic will not make you glow in the dark, okay, but it will make you real sick, and I think it really does--a whole lot of this does get back to the issue of how long are you willing to let the process run, what are reasonable outcomes for process, and, fundamentally, back to the issue of can the process and the people in charge of the process be trusted, and, at that level, DOE has a history of problems that are not all of the agency's own making, but you all get to live with them.

DR. BASSETT: There is low-level waste. Where the trust issue, you know, where DOE hasn't contaminated the waters, and yet, low-level waste, there's no solutions on that front, either.

DR. WILKINS: I agree.

DR. BREWER: Interesting sort of collection of responses to the hard question of what would you tell DOE. We've got a couple more minutes if you've got a couple quick ones, and then we're going to go listen to the public for a bit.

Elaine?

DR. VAUGHAN: Just a comment that I think the DOE shouldn't assume at this point that it understands the basis of conflicts, just from some of the comments from this panel. When I go to other meetings, I still hear some of the same rhetoric from 15-20 years ago, ignoring 20 years of research in risk management, risk perceptions, and social conflict, so I think maybe the first step is to really do a good assessment of what the problem is, what is the basis of conflict.

We've been throwing out a lot of dimensions, but is it equity? Is it issues of people don't trust the technical numbers? Is it an issue--I don't think people have to understand on some very detailed level the technology of nuclear waste storage, but, in the absence of that, you have to have trust, and so maybe that's the issue.

And so, I think that for the DOE, I would suggest a very reasonable assessment of what the problem is, and then to look at different scenarios, different possibilities of when amplification might occur, what kinds of events or

circumstances might lead to that, and I would say develop something like a sensitivity analysis, given the different scenarios, based on some of the research done from panelists here.

DR. BREWER: Yeah, good, constructive suggestion.

Doug?

DR. EASTERLING: I guess when you first asked that question, I was thinking more in terms of what can DOE do to reduce the impact of an accident, but it sounds like the conversation is more what can DOE do to reduce controversy around the siting, and I think I agree with Gib, that you've --the Congress has basically painted DOE into a corner. I don't think there's much that they can do at this point, barring a re-examination of the basic mission that they're confronted with. I think the public has so little confidence that building a repository either in Yucca Mountain or anywhere at this point is a good idea, that I don't think any agency, regardless of the level of trust, could go forward.

Just one set of findings, based, partly, on Hank's work. We went back and tried to look at the relationship of trust in DOE and acceptance of a repository and perceived risk of a repository, and there's a whole range of correlations, but trust generally seems to be less of an important determinant than things like overall faith in the technology. DOE's coming in almost after the fact, and I

wonder how much they actually can do.

DR. BREWER: One more comment, if you have one. Warner?

DR. NORTH: I'm going to reiterate the recommendation in the report to Congress from the TRB awhile back, not too long ago, about the schedule-driven program. I think if you are perceived as having a schedule-driven program, you have a terrific problem in generating trust in that.

DR. BREWER: Okay, thank you.

What we're going to do now, five members of the public have indicated they'd like to talk to us, and they can say what they want. They can address questions to you individually, collectively, or whatever. I'm going to ask that the comments be kept to five minutes, so that we can--speaking of being schedule-driven--so that we can maintain our schedule.

And while all this is going on, I want everyone to be thinking about kind of the next step in the logical progression of the conversation today, which is if you've got behaviors--we've gotten to that point; yeah, we have behaviors--can they have impact, and what is the nature of the impact, and this is particularly in the area of social and economic standard kind of things that can be thought about in the realm of social and economic.

What we're trying to do here is to bring the connection from special effects to standard effects, to use

the jargon of the trade.

Basically, what I'd like to do is to stand here and keep time, so that we do give everyone fair treatment in terms of the amount of time that's available, and also direct traffic in case there are questions.

James Short and John Petterson. You have indicated you'd like to do a duet. Mr. Short?

MR. SHORT: Not exactly a duet. I'm going to introduce John Petterson.

DR. BREWER: Fine.

MR. SHORT: I am Jim Short. I'm a sociologist from Washington State University, and I chair a National Peer Review Committee for research in this area of concern for Clark County.

I had a little presentation to make, and I have so much scribbled all over it here that I don't know where to begin. The comments have been very helpful, I think, and stimulated a lot of thought.

I must recall an incident that occurred on the first meeting that our peer review committee held at this hotel in 1991. The meeting was held up because the accident that couldn't happen did happen in Henderson, a suburb of Las Vegas. A very severe chlorine leak occurred, and we were assured that that was one that couldn't happen, so Hank Jenkins-Smith is absolutely correct. Don't tell people that

accidents won't happen or can't happen.

I want to suggest that risk perceptions and related behaviors can't be separated from the values that people use to guide their understanding of the world and their lives. This, in part, it seems to me, accounts for the persistence of findings regarding the social distribution of risk perceptions regarding nuclear matters.

Among those values, I suggest, are three that are particularly important. One, the value placed on one's children and succeeding generations; secondly, the value placed on trustworthiness and fairness in interpersonal relationships and in evaluations and judgments concerning organizations and institutions; and, thirdly, the value placed on one's ability to influence public decision making and control over one's life.

All of these values are implicated in the current debate over high-level and low-level nuclear waste disposal. People fear nuclear waste not just because of the tragedies that have been associated with Chernobyl, Hiroshima, et cetera, but also because of uncertainties associated with the disposal, particularly as those uncertainties extend into the futures of their children and succeeding generations.

Secondly, the relationship between risk perception and social and economic impacts can only be understood within particular contexts, and that, it seems to me, is what has

been largely missing from your discussion, although it's been eluded to elliptically several times. The State of Nevada and affected units of local government currently are the most relevant contexts.

This will change drastically, I predict, as soon as the shipment of nuclear waste becomes more imminent, and transportation corridors are greatly recognized, and then the constituencies of high-level nuclear waste disposal will expand dramatically. Then, I suspect Nevada may get a good deal more support than they've gotten so far from within the Congress.

Thirdly, I want to--I don't know whether I'm first, second, or third, but the focus, I suggest, on the individual, relationship between individual attitudes, perceptions, and behavior is, in some sense, misplaced. What has been missing in each of--in much of the discussions so far are the organizations and institutions by means of which issues become defined, policies formed and implemented, and reactions to those policies as well.

We know a good deal about social movements, and how risk becomes amplified, not just in terms of an individual nexus of attitudes and behavior, but in terms of the sorts of interpersonal relationships people have, sort of organizations they belong to, the sorts of movements, social movements that they become affiliated with.

Now, research conducted in Nevada by the state, and among several of the affected units of local government is beginning now to tell us how and why risk perceptions are likely to be played out in behavior within these contexts, and I think the panel must come to that sooner or later. The most immediate need, it seems to me, is to strengthen these research efforts, particularly as they relate to current and pending legislative and DOE activities, which are upon us all the time.

Now, this is just an introduction to John Petterson, who has been doing a lot of that research for the Clark County. Paul and others have been associated with the state effort, but I hope maybe these remarks will help to introduce John's presentation.

DR. BREWER: Thank you, Mr. Short. The next speaker is John Petterson, and John, if you'd take a moment, just at the beginning, to introduce yourself?

MR. PETTERSON: My name is John Petterson, and I'm the principal investigator on the Clark County socioeconomic impact assessment of the high-level nuclear waste repository at Yucca Mountain. That started in 1990. Previous to that, I was the PI on the impact of the Exxon Valdez oil spill for the State of Alaska, and prior to that, I was the PI on the socioeconomic study of the Hanford site for its short two-year life span, so I've got about ten years on this

particular issue.

And what I've done is prepared two papers: one, at the direction of Dennis Bechtel, who's the head of the program, a verbal response--I'm not going to try to convey ten years in five minute, but I'm going to try to give you the document and hope that somebody reads it. So, these are the verbal comments.

The second set of documents is--I guess it's Dan. I don't know who prepared those questions. Who did prepare those questions?

DR. BREWER: We did it in conjunction with Hank and Paul and Dan and lots of other people thinking about it.

MR. PETTERSON: Those were fantastic questions. These are precisely the questions that we've had to deal with in actually doing this work for the last ten years: What are the methodological issues? What are the, either the moral issues, the equity issues, all of those questions. We've tried to address each one of those point-by-point, and if you want to spread that around, I'd be happy to defend them and to be the straw man, because we're out there doing it, and we'd like to know.

We'd like to know about the risk communication. We'd like to know about the methodological issues. We'd like to know about the philosophical issues. All of these things, we'd like feedback, if they're just marginalia, or criticism,

or laughter, whatever.

Okay. I'm going to go through just a couple of things. The Goiania event provides kind of counterpoint. It's the extreme case. I haven't seen the worst case. Chernobyl was a real event. Goiania was a real event, also. It was one cubic inch, one ounce of cesium, so, in a sense, it was real and people died, but no more than in a traffic accident in southern California.

The effects of that on the economy of the state, social, political ramifications on the nuclear waste program for Brazil, how that affected their program, it's a classic example of this amplification issue, of one ounce spilled, and the essentially catastrophic events that resulted from that. It's a classic example of the media, by themselves, magnifying this all over the state intentionally, in some cases, creating stories that never had any basis in fact, so I think it's an interesting analog.

I won't go into it except to say that of the 110,000 people that lined up for monitoring after the event, 5,000 were sent to the hospital with symptoms. It's a classic example. Not a single one was contaminated.

The end of this paper actually goes into a description of what we're doing in our study design of the verbal comments, so anything you could give us back in feedback of what we're doing, essentially, we're in the third

phase of the study that involves surveys to assess, just as several people have noted, establishing what the--our program is designed to monitor changes over time, not just changes in attitudes towards nuclear waste, but the relationship between those attitudes to nuclear waste and other prevailing attitudes, based on an initial survey, open-ended survey that said, what are the problems?

The bottom line is if you ask the question in Clark County: What are you concerns? Fewer than one per cent will respond with nuclear waste. That's a fact. Okay, well, if you change the question and say: Among these 20 issues that we've now identified as the most profound in Clark County, how do you rank them over five years? The answer is totally different. It's a profoundly important issue. Why? Why does it change just by taking--because, in fact, it's not a current risk, okay? It is a future risk. It's not a risk posed to the current population. We're asking them a fictitious question. Okay. We go into this in some detail.

We have a chronicling program that is trying to track this contextual issue, the key question, the social and political context is key. It determines, it determines people's response. We have a behavioral study aspect, which I'd really like some response on, which says we want to look --how do you get at behavior? That's the key question here.

We're saying you can't get at behavior by saying, what would you do, and just assume that the intentions, stated intentions are going to be what they do, but you can go out and interview people in depth, and ask them what they have done, establish a history, a context of their behavioral responses, an inventory of those responses, and then ask them the specific questions in regard to crime, in regard to water, in terms of the context, and how that changes over time, and we're also saying this point in time issue is precisely correct. You cannot come out and do a study and say we know something.

If you do two studies at two points in time, and talk about changes in all of the variables, and how they relate to each other; if crime goes up, nuclear waste goes down as an issue. Well, that's what you need to track over time, and in response to an event to understand how that event affects the entire complex of issues, positive and negative, inside that particular context.

I'm out of five minutes, aren't I?

DR. BREWER: Yes, you are.

MR. PETTERSON: Well, that's surprising. Okay. I'll put some of these in the back.

DR. BREWER: Now, John, let me just be clear. You are inviting members of the panel to respond to this study; is that what you're doing?

MR. PETTERSON: I'm begging them.

DR. BREWER: Okay. So, there's the invitation, panelists.

MR. PETTERSON: Yeah. As critical as you can be, abusive, send the abuse to me directly, of course, not to the contracting officer.

DR. BREWER: Thank you very much.

Our next scheduled public speaker is Tom McGowan. Mr. McGowan, would you identify yourself, please?

MR. McGOWAN: My name is Tom McGowan. In order to make your quota, I am a member of the local public. I, too, brought some notes, about six or seven tablets, and that's concise, but I'll just digress from that and do as you have done, which is step on the rocks, and it'll be a little episodic, but I think I can squeeze it in within five minutes.

First of all, I appreciate the fact that you're here. You may find that surprising. The reason I appreciate it is you have done more in the last three hours to elucidate the very starkly self-evident fact that you really don't know, number one, whether your science is applicable to the public perception of risk. I want to indicate, also, the title of your meeting is risk perception, which implies, in my understanding, that there is a risk to be perceived. Unfortunately, you have not identified or delineated any such

risk to date. Perhaps you will at some point in time. I don't know. I have now two items to make known, put under the heading of good news and bad news.

The good news is you can show DOE (snaps fingers) just like that, how to convince this public to accept this material. Quite simple. The other part of the good news is it is scientifically and technologically impossible to guarantee safe and secure the underground emplacement of nuclear fissile material and high-level waste, not only in the State of Nevada, but nationally, and worldwide, anywhere in the terrestrial domain.

The bad news is you apparently don't know that, or, if you do, you may not care, so my job, today and henceforth, is to reiterate and convince you both of those truths. The secret to public acceptance is public acceptance by you. You are not the public. I am the public, and colleagues like me are the public. We are the Congress and the President of the United States. It may come as a complete surprise, even to the Congress and the President, but that's who we are.

This is not waste that belongs to some future generation. It is our mess. We have the responsibility, ethical, moral, beyond science, technology, and legalistics into that realm of humanity, reasoning humanity. We must take care of this mess, and we can, and we shall.

And so, the other part of the good news is we need

to eliminate it. The bad news is we've known how to do that for more than 40 years, but special interests have made it a little difficult. We're about to change that. We're about to transmogrify the entire national and world public opinion with regard to nuclear issues, nuclear policy.

We're going to transform it from a catastrophic risk, inherent insanity, to a golden age of abundance of safe, clean, and inexpensive energy for the entire world, including, but not limited to the sovereign State of Nevada. Quite simple. If you're interested, you may join. If you're not, simply get out of the way, because it's going ahead, with or without you, while you continue your studies.

I want to tell you that I'm particular impressed with some of the statements made by some of the people on the panel, for different reasons. Incidentally, proliferation, meaning decentralization, is the proper response, not over-centralization. If you want to discuss it in some other forum, we can do that at length.

Media is just another public, like Joe's Body Shop. Media doesn't know that yet, but that's what media is. Media is not an agency of government. It was not authorized by anybody, except by media. They're a private, limited special interest, commercial project. They don't deliver news at all, they deliver sound bites. They're sensationalists. You need not worry about media. Worry

about the public. That's who you're dealing with, and the secret to public acceptance of risk is--do you mind if I smoke?

DR. BREWER: Yes, we do mind.

MR. McGOWAN: You do. Thank you very much. On the public record, you have just identified the public acceptable level of risk, which is none, zero, nil. God bless you, my son, and that will go for toxic radioactivity as well as for secondhand smoke. I hope we all agree. Is there a consensus? Don't even raise your hand.

And so, it's quite simple. The truth is, nobody is smarter than all of us combined. We have learned a great lesson over the last several years, particularly today. Unless we get together, united as a people, we cannot conceivably address and resolve this issue. If we do, tomorrow morning, bright and early, we take the first step down from the -- tree. Who will be first? Coward, take my coward's hand, and let's move forward.

You can go home any time; preferably, one way. On fast track airlines, piloted by the adroit stunt aerobatic pilot, Dr. Daniel Mengele Dreyfus, I believe it is, who has a very unique way. He will do part of the inspection of safety for the aircraft prior to takeoff, part of it during the flight, and part of it after arrival at the destination, if you get there. The tickets are free. All aboard. You begin

to get the idea.

Yucca Mountain is inconceivable. Underground storage is unconscionable. Your reasoning being first, scientists, way down the line after that, and as far as Bowman and Venneri, who I know personally and respect very well, their work is commendable. It is also quite late.

There was a supreme author, and a higher authority who made it possible for this naturally-ordered universe and its variable dynamic flux in geophysical state, ongoing and continuum of the geologic time scale to be autocatalytic, critical, upon occasion. There really was an occlude; not only one, there were 17 locations, and it lasted for one million years. There undoubtedly were occludes before that, much larger, much more Draconian, probably at the Big Bang, if there was one, and if you are able to look at the entire spectrum, and then come back into this microcosm, this micro nanosecond of time that you are about to make decisions to affect all ensuing and current generations of mankind and universe in continuum, and still go home and face yourself and your loved ones, you are not human, but beneath contempt.

Welcome to Nevada, the gambling capital of the world. The problem is, your casino is not licensed.

DR. BREWER: Thank you very much, Mr. McGowan. As always, an interesting discussion.

Our next individual is Atef Elzeftawy. I have

probably done great injustice to your name. Why don't you, for the record, repeat it yourself and please tell us who you are.

DR. ELZEFTAWY: That's all right. That has happened during the last, what, 32 years since I've been here in the United States.

DR. BREWER: Fine.

DR. ELZEFTAWY: You may call me Bob. That's okay.

DR. BREWER: Thanks, Bob.

DR. ELZEFTAWY: That's Atef Elzeftawy. I wasn't intending, really, to take a couple minutes here to say anything, but just one minute, I guess, about my background.

I originally was born and raised in Alexandria, Egypt, that's why this funny name, if you want to call it that way, and I got my first doctorate degree in soil science and geology from the University of Alexandria, and then I was fortunate to come to the United States and become an American citizen, and earn the second doctorate degree from the University of Florida in hydrology and environmental engineering.

And as I sit down and listen to you, I can't help but except to remember my physics professor in the University of Florida. I took a course with him in physics, grad school physics, and after the course I took with Don Deere, who used to be the chairman of that Nuclear Transportation Research

Board, and he told us a real story. I don't know where is the source of it, but he said in 1800, there was a biologist in England, an excellent biologist, I wish I could find the source, but I'm quoting him. I think he passed away, the fellow.

And he said the biologist was trying to study the effect of the number of legs on this little caterpillar as it moves in its jump, so he got a caterpillar, and put it on the bench, and then he plucked two legs, and then he hit the bench and said, "Jump," so the caterpillar jumped. And he did the following two legs, and he hit the bench and said, "Jump," and the caterpillar jumped. And he kept going on doing this until the last two legs, and he pulled them out, and he hit the bench and said, "Jump." The caterpillar didn't jump.

His conclusion was, as a scientist, as all of you are, including me, that when the caterpillar loses its legs, it also loses its hearing.

So, needless to say, with my background during the last 30 years, with all the papers I've published, and all the reports I've published, technically speaking, I'm proud of them, and I'm proud of all your work, and I've been in this particular nuclear waste program since Chester Sees (phonetic) of the University of Illinois got me involved into that back in 1974, when I went there as assistant professor

to work with the university and Illinois State Geological Survey.

To make it short, I moved out here, did a couple things in the unsaturated zone and Desert Research Institute. I went to the NRC, and I did a couple things with them, and I came back here, did a couple things with the state, and then during the last five years, I left completely the program.

I was fortunate to go to--talking about perception of risk--to go to Madison, Wisconsin, and I spent there about three years working on the toxic and chemical waste, on CIRCLA site or RCRA site, and, by law, you have to interact with the public, and perception of risk, and so on.

I had a seminar presented to the people--I didn't expect 300 people to come--about the status of the nuclear waste program as an "expert," and it was interesting to me to find out that most of the attitudes of the people who were there, who attended the seminar, was, well, if we have a problem with toxic waste, I think the best way is to send it to Nevada, because Nevada has very little water, Nevada has very little people, it's all desert over there, so we might as well just take it there.

And I think that was a shocker to me, regardless of their background in terms of knowledge. Most of these people have bachelor's degrees and they work in the toxic and the

chemical waste, and they know the ramification of all that, but it was interesting to see their hands in terms of asking them questions. What do you think? How about putting it here in the State of Wisconsin? No, no, no, no. The State of Nevada doesn't produce any nuclear--it's not really nuclear waste, it's just a by-product, call it that way, and it's not really waste, but...

So, I got involved into the perception of risks, and so on, and I appreciate all the panel members here to come. That was sort of enlightening to me to really see what the perception of risk, but, you know what? I'm going to give you another example for the perception of risk.

One second. Diane Sawyer went to the Middle East sometime during the Gulf War, or right after, and she said in one of those things that, "Boy, they have blue eyes and blond hair in the Middle East." Well, young lady, my brother has red hair and green eyes, and my younger brother has red hair and green eyes, so, you see, the perception of us, knowing that the people over there in the Middle East, they really don't have a whole lot of blue eyes and green eyes and all that determines our attitude.

So I really like the question that the chairman addressed today, what should you say to the DOE, knowing the DOE and the knowing the program all along. I think somehow, somewhere, we cannot avoid the past, the past of the DOE in

terms of the work, in terms of Yucca Mountain and other programs, always going to stay with us, but I think I agree with the panelist member who said, "Well, try to do your best, and try to avoid mistakes. Be open to the public," and that's really what I'm saying, be open to the public. Keep your things open. Earn their trust. The more people who come here to Las Vegas, Nevada, which is supposedly the Sin City of the country, as I came here 15 years ago, you know, that was when I lived in Illinois. If you go to Las Vegas, that's the Sin City; gambling and prostitution, and that's a perception, see?

So, I think what we need to move on and help with the DOE is to understand that earning the trust of the public is very important, and that's all I want to say.

DR. BREWER: Good.

DR. ELZEFTAWY: Thank you for your time; appreciate it.

DR. BREWER: Thank you very much.

We have one more speaker, Judy. As always, for the record, please identify yourself.

MS. TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force.

I had some absolutely brilliant comments to leave you with, and I was just going to spew those out and let you take them home and savor them, and now I can't do that, because with one of the discussions that went on here,

there's got to be something cleared up, and either you're going to have to make me understand this, or it's got to go away, and it's this argument about 70 versus one site. That's the rationale that we've been given here in Nevada for doing our patriotic and national duty, that suddenly you're going to have a minimization of risk, because you're going to go from 70, or as the nuclear industry says, 109 sites, to one site.

And, well, NEI has been out there running these big ads in major newspapers, and this is just one of them, but it talks about this solution, the one place solution, and in terms that you've been using, what they're trying to do with this 109 to one site is a social de-amplification of this problem, and they're convincing their constituents that the risk of waste near them is gone if they get Yucca Mountain.

Now, nobody's going to convince me that if the trucks roll away from one or more of those reactors carrying fuel, that there isn't going to be more spent fuel produced and put into that pool, and I'm not here to argue nuclear power, I'm here to say that you can't use this argument about going from 109 or 70, whatever the number of sites is, to one site. It just ain't going to happen. You're going to have 110 sites, because that waste is going to be replaced.

The last people on earth who would decide to shut that plant if the waste leaves is NEI, and the very close

second is the Department of Energy, who is still funding new reactors, and so forth, and, as I say, I'm not here to discuss that. I'm just here to say this is a very wrong argument, and you cannot convince Nevadans, and shouldn't be able to convince anybody else that there's any truth to the fact that you would have the nation's nuclear waste in one spot. You would have one additional spot, and, in addition to that, you would have all those trains and trucks, which are sort of mobile sites, during this 30-year campaign that it would take to get it here.

But I have absolutely no understanding of where this one site solution comes from, and if I have a question for you, aside from trying to ask you to make me understand that, it's I would like to know what your definition is of the solution. You've been talking about coming up with the solution, and I guess I'd want to know what that is, what are we going for here, and what would you see as having accomplished the solution, and we can talk about it later, because I guess you're not ready to do that, but I just want to get rid of that 70 to one, or 109 to one argument that we use.

DR. BREWER: Good, Judy. Thank you very much.

I'd like to point out that the comment, and sort of the argument was in the course of discussing a whole range of other things. It is not the official sort of position of the

Board. As I said at the beginning of the day, the Board is here to ventilate the issue, not to take sides one way or the other, and I think it's worth my saying that.

If you would like to talk to Mr. Bassett, I'm sure he would be delighted to talk to you.

All right. Thank you very much. There will be another opportunity tomorrow for public comment; same rules apply. Please sign up with Donna or Linda in the back of the room. The agenda gives you the time. I can't remember right off the top of my head what it is.

This is a long day. We're trying to make the most of our panel and make the most of the time. We next have a moment, about a half an hour, twenty minutes, something of that sort--probably more. We're going until six, aren't we, Dan?

DR. METLAY: We'll begin this next session today, and finish it tomorrow.

DR. BREWER: Yes, this is the point. We are, in the interest of time and efficiency and all of that, because we are schedule-driven--let me get back to that--we will begin the discussion now of what likely impacts might be. We are now getting to make the connection between special effects and standard effects in the jargon of socioeconomic and risk assessment.

I'd like to begin the conversation by inviting one

or the other of those who have self-identified as economists, to perhaps reflect--the admission's been made that you are economists--and the economic, the potential economic consequences here are certainly something on everyone's mind.

There are also issues related to the creation of standard effect baselines, in terms of the economy and social consequences. It's another one of the issues we want to talk about.

Now, I will flip the coin. Gib, do you want to go first, or, Jim, do you want to go first? Gib wants to go first.

DR. BASSETT: Do I?

DR. BREWER: Yes, you do.

DR. BASSETT: Special effects and standard effects is a distinction that I think was created by the people doing research for Nevada; standard effects referring to the kind of immediate impacts from building the repository on schools, roads, sewers, and multiplier types of effects. Special effects have to do with the kinds of impacts that come from increased perceptions of risk due to Nevada being potentially stigmatized as a nuclear place. I'm not the person to make, to present that argument, but that's my understanding of it.

The only thing I might want to just say in my role as an economist here, with that hat on, is that economists aren't interested, particularly, in attitudes, or even

actually in behavior. They are interested in behavior. They're interested, ultimately, in economic impacts, however they might occur, and if people are not going to visit Nevada as a result of its stigmatization, if people are going to lose property values because of some sort of perceptual issue, economists kind of take those as not--as real impacts. We don't trace back through how those things kind of came into being. If people respond, and prices move, and migration occurs, and economic revenues are affected, then that's sufficient for us to say that there's economic impacts there.

I don't know, Jim's been in this contingent valuation and valuing environmental goods area much more than me, and he might just correct me in, you know, the areas where I'm wrong, and maybe expand on it.

DR. OPALUCH: I haven't really studied the nuclear waste issue in great detail, so it would be difficult for me to talk about specific impacts. The stuff that I'm familiar with is things I've read from other people on the panel, as well as elsewhere.

The one thing I would like to add to what Gib said is, economists also go beyond purely financial impacts to consider other kinds of impacts that people would rather avoid. I mean, if it's a negative impact on people, whether it's through the market or not through the market, it still

is a concern.

I think in the natural resource area, the term non-use value is one that economists have put a lot of thought into, and it's a highly controversial issue, particularly when it comes to trying to measure that thing, trying to measure non-use values, but non-use values arise when you value something that you may never use, you know. The wilderness of Alaska, people may never go up there, but still have value for it. That still is considered an economic value, even though it's not expressed in market decisions, market behavior.

I guess the main issue, having read through the stuff that we were given, it seems like the relatively easy impacts to measure are impacts from point events. If there were a spill, or if there were a crash on the highway, how do people respond? You can go out there and you can try and measure that thing.

I think the harder thing to measure is the long-term chronic effects that could potentially happen because people get a different perception of what Las Vegas is all about, or something like that, if this somehow were to tarnish that image over a long period of time, such that people may, you know, they changed their behavior and stopped coming here, or whatever, I think those things are much more difficult to measure.

DR. BREWER: Let me sort of re-focus the question just a bit, because I didn't do a good job at the beginning. Maybe we should start simple, like we did earlier today, by just saying: Well, what are the kinds of impacts that we ought to be looking for? What are the things that we should be worrying about? It came up just a bit in your comment. What's important? That's another way of describing the question. So what? I mean, what matters?

DR. OPALUCH: Well, I guess if I were given that question, I wouldn't answer it. I would go out and ask the people in the area: What matters to you? What are you concerned about? And, you know, I think that's where you start. I think all this work needs to start from listening, rather than speaking, to hear what people say, what their concerns are.

DR. BREWER: Warner, did you want to comment?

DR. NORTH: I'll tell a story about my experience this last year on the study of risk on the weapons complex. One thing that our study was not chartered to do was to look at risks associated with transportation from the weapons facility sites to a place of disposal. We were severely criticized by that, about that, and especially by the Native American tribes around the Idaho National Engineering Lab.

In one conversation, they said, "Imagine the situation. There is a truck carrying a waste cask, and the

truck is involved with an accident, and there is now a container in the ditch on the side of the road, and the truck itself is heavily damaged, not necessarily a rupture of the cask, and this is on our land. The news media find out about it, the network helicopters are there within a half an hour or so, well before the public safety people get there, and now, on national television, we have visual footage of this waste container in the ditch on our land, with nothing being done about it, and we're worried that this will have a major effect on tourism to our reservation, and a lot of income that we've come to depend on, and we really think you people ought to look at it, because, for us, this is a real economic threat."

DR. BREWER: Okay. Where do we go with this, folks? Paul, please.

DR. SLOVIC: Warner's identified one of the types of impact that have been of concern.

DR. BREWER: Thank you. Thank you very much.

DR. SLOVIC: But it's one of only a number of such impacts, especially, you know, when a region is dependent on tourism for its economy, of course, then that's the salient impact, but other issues as well, and not necessarily economic, but are psychological; that is, you know, satisfaction with the place that you live, you know, kind of your image of your community, your region, your state.

Many people don't have the option of moving away, you know, as they see more and more things impinge upon it that affects what they see as their quality of life, or the quality of the environment. They may get anxious. There may be increased political, social and political tensions within the community. Fights break out between different factions, and you're going to lose the sense of harmony and unity in a community that's important for making good things happen in a community.

John Petterson's study of Goiania, again, is instructive in terms of the potential impacts. He sort of alluded to them, but all the things that happened to residents of this state in terms of the way they were treated by other people, and, in addition, if you produce goods, such as were produced in Goiania, or, you know, agricultural products, or clothing or other products become stigmatized, and there's an economic loss there.

So, there's a variety of both psychological and political and economic considerations, impacts that could conceivably occur due to events associated with risky technologies and, you know, the issue and the challenge is what is the probability of these events, and how do we weigh these in decision making, along with all the other considerations we have to weigh?

DR. BREWER: Hank, did you want to comment?

DR. JENKINS-SMITH: Yeah. Paul has sort of opened this up fairly broadly in terms of the array of impacts that might be involved. The one that has been the focus of most of the research that's been done, I think, has been--at least amongst those of us around here who have been working on these projects, is the economic impact that might come from people who obtain a negative image of the State of Nevada, or of southern Nevada, in particular, because of the existence of the nuclear repository.

And the basic theoretical structure--Paul, correct me if I'm wrong here--people acquire images of the place because of the advent of opening of Yucca Mountain, or any sort of events that may be associated with that. These images, because they are associated with nuclear things, will tend to be somewhat negative, dreadful kinds of images. Those images being given a negative value will change people's preferences for Nevada, either as a place to relocate, set up a business, move, or, particularly, to engage in tourism.

That will result, that change in preferences, then, would be translated into behaviors, reduced propensity to vacation in Nevada, or to relocate to Nevada or whatever, and that's sort of the chain of reasoning that's involved with the argument that siting Yucca Mountain here would lead to rather dramatic, potentially large negative economic impacts,

and that's the most direct of the models, in essence, that would argue for this.

Paul and I have been kind of going back and forth over what the model specification ought to look like in this. I believe that, in fact, different kinds of people are more or less likely to pick up certain kinds of signals, and the reason this has consequences is that people, in the studies that I've done, the people who like to gamble, people who are attracted to Nevada, in particular, tend to have different propensities to pick up images of things nuclear, or to give them negative valances than people elsewhere.

I think the best way to understand this is in terms of what attracts people to a place to begin with, all right? I mean, when I'm attracted to Florida, I might go there because I like beaches, out of doors, the environmental amenities that are associated with Florida. When I'm attracted to Nevada, I might be attracted here because of casinos and gambling and floor shows and things along those lines.

Now, people do have different sets of images attached to a place. That's one of the first points that Paul and the Nevada research folks made in trying to study imagery, but the fact is, is that these different sorts of things that attract us to a place are differentially vulnerable to a nuclear image. People who are attracted to a

place because of its environmental amenities are the ones who are most likely to respond highly negatively to the nuclear imagery.

For example, we did a test just recently looking at the differential effect on people's preferences to vacation in Nevada and in Florida if a nuclear waste repository were put into these two regions, and there were, of course, different initial levels of preference in both places, but once we introduced the nuclear facility, the preference for vacationing in Florida dropped substantially more than did the preference for vacationing in Nevada.

And the point isn't to say that it's a good thing to put it any place. The point is that when we look at different alternatives for siting a nuclear waste facility, the economic impacts are likely to be different, because the stigma model, I think, points out that different kinds of things attract people to different regions, and when we're thinking about siting a facility in one place versus another, we have to look at how imagery associated with that facility might get tangled up with things that attract people there, versus somewhere else, and that's the tough part of the question for us, and we're just beginning, I think, to understand what goes on there.

DR. BREWER: I am going to exercise the prerogative of the chair. I'm tired. I think we've had a very full and

productive day today. We've covered an enormous amount of territory. I think it would be useful to stop now, for the panel to be thinking hard about the connection between risk perception, behavior and impact. We're trying to keep the chain all connected here, and we'll start tomorrow morning at eight o'clock, and, really, the issue is, let's start simple. What are the impacts? Let's all kind of think hard about that, and then see if we can get back to risk, which is really what the whole enterprise is about today.

I want, while we're in the midst of it, we're still in the middle of another half a day of presentations. I'd like, right now, to thank everyone for a full and very, very thoughtful day's work in this particular format that we're using.

Thanks a lot. The meeting is adjourned until eight o'clock tomorrow morning.

(Whereupon, at 5:40 p.m., the meeting was adjourned, to reconvene at 8:00 a.m. on May 24, 1995.)