

Stanford Symposium: A Discussion on the Tolerability of Critical Infrastructure Risks

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On May 21 a symposium entitled “A Discussion on the Tolerability of Critical Infrastructure Risks” was held at Stanford University. The symposium was organized in conjunction with a graduate course on risk management for critical infrastructure that is offered each year in the Department of Civil & Environmental Engineering at Stanford University. The symposium was a first of its kind to address a topic that receives limited attention in the classroom or in the engineering profession. The genesis of holding a symposium evolved from a number of influences. For one, it offered the opportunity for students to meet, interact with and hear from professionals who are dealing at a practical level with difficult risk management topics. Such opportunities are unique and invaluable. Secondly, the subject of risk tolerability is complex and multi-dimensional and as a consequence is difficult to resolve from a societal as well as a technical perspective. With these motivations, the concept of a symposium created an opportunity to bring together a group of speakers to collectively address the subject of tolerable risk. The feedback from the students (those in the class as well as others who attended), the speakers, and others who attended was extremely positive. The plan is to make this a regular event each year, exploring different topics in critical infrastructure risk management. The format for the symposium will be expanded, allowing the opportunity for more interaction between the participants and the speakers.

Attendees at the symposium included students in the risk management course as well as other students, faculty, engineering professionals (consultants and regulators) from around the country.

The subject of the symposium and the cast of speakers had a decidedly dam and hydropower theme. With the movement in the dams industry to risk-informed dam safety management, the subject of tolerable risk is of considerable interest and discussion in the profession. In the hydropower business in particular, the Federal Energy Regulatory Commission (FERC) is in the final stages of developing and rolling out its risk-informed decision making process as part of its dam safety program.

To address the subject of tolerability of risks for critical infrastructure, a panel of speakers was invited to participate that represent a spectrum of stakeholders and perspectives with an interest in the subject. These included a federal regulator and dam owner, both with a background in risk analysis and dam safety, a psychologist with a unique background in risk analysis and risk perception, and an attorney/judge to speak to the legal dimension of critical infrastructure management and tolerable risk. The speakers and their backgrounds are:

Professor Paul Slovic - Is president of Decision Research and a professor of psychology at the University of Oregon. He studies human judgment, decision making, and risk perception, and has published extensively on these topics. He is past president of the Society for Risk Analysis and recipient of its Distinguished Contribution Award. His most recent work examines “psychic

numbing” and the failure to respond to mass human tragedies. His recent books include *The Perception of Risk* (Earthscan, 2000), *The Social Amplification of Risk* (Cambridge University Press; 2003), *The Construction of Preference* (Cambridge University Press, 2006) and *The Feeling of Risk* (Earthscan, 2010).

Dr. Desmond Hartford – Is the Principal Engineering Scientist at BC Hydro and a member of USSD. He is recognized internationally for his formative work in risk assessment and risk management of individual dams and portfolios of dams. His responsibilities at BC Hydro span the development and guidance of the implementation of risk management policy, risk informed decision processes, and risk-informed management systems for all dimensions of the company’s Hydropower and Dams risk profile. He is also the co-author of the book, *Risk and Uncertainty in Dam Safety*.

Honorable Kathleen M. Banke - Justice Banke sits on the California Court of Appeals, First Appellate District, Division One. She was appointed to the bench in June 2009. Before being appointed to the bench, Justice Banke was a partner at Reed Smith LLP, where she specialized in appellate practice for more than 20 years. In private practice she represented clients in the United States Supreme Court, the United States Court of Appeals for the D.C. Circuit and the Ninth Circuit, the California Supreme Court, and all districts of the California Court of Appeal. Justice Banke has written numerous articles on civil appellate and writ practice. She is the chief consulting editor of and contributing author to the significantly revised and expanded California Civil Writ Practice, a consulting editor and contributing author to the revised California Civil Appellate Practice (3d ed. Cal. CEB), and contributing author to Employment Litigation, and Federal Civil Trials and Evidence.

Mr. Patrick Regan - Mr. Regan is a Principle Engineer at the Federal Energy Regulatory (FERC) responsible for developing the guidelines and procedures to incorporate risk-informed decision making (RIDM) into the agency’s dam safety program and is a USSD member. Prior to his current assignment Pat was the Regional Engineer for the FERC’s Portland, Oregon regional office which is responsible for dams in the northwestern part of the United States. In addition Pat was head of PG&E’s dam safety program and he has served as a consultant working in the hydropower industry. One of his current assignments includes the issue of tolerability of risks for hydropower projects and its incorporation into the FERC’s RIDM program.

The first symposium speaker was Dr. Des Hartford of BC Hydro which is the owner and operator of some of the largest dams in North America. Dr. Hartford noted at the outset of his talk that the hydropower industry is an inherently hazardous business and as such is a ‘risk creator’. He posited that as the owner and risk creator, BC Hydro should be providing to the regulator “reliable knowledge in a way that they can make informed decisions about how we propose to control the risk they create and to what level.” With this introduction, he went on to review BC Hydro’s evolution in the risk analysis/risk management arena which started in the early 1990s. He noted some of the difficulties in performing quantitative assessments and discussed BC Hydro’s evolution to develop a “completely different” approach to dam safety that is based on a different safety management philosophy. This philosophy will be based on the concept of “risk-informed” decisions as developed in the United Kingdom and as described in a

U.S. National Research Council report “Understanding Risk: Informing Decisions in a Democratic Society.”

Des concluded his presentation with BC Hydro’s current philosophical approach for dam safety management that he defined in terms of a seven tiered process in which BC Hydro looks to meet or exceed all:

1. General Legal Duties
2. General Duties of Dam Ownership
3. Legal Duties associated with Dam Operation and Safety
4. Regulatory requirements with respect to Dam Operation and Safety
5. Conform to established engineering principles for safety of engineered systems
6. Established dam safety standards/criteria and norms, and if the safety issue remains unresolved,
7. Perform quantitative risk assessment

The next speaker was Patrick Regan of the FERC. As a regulator, Pat stated the duty of the FERC is “to be the voice of society in assuring that the people who live below dams are not exposed to intolerable levels of risk.” As the principle engineer responsible for the incorporation of risk-informed decision making into the FERC’s dam safety program, Pat must grapple directly with the tolerability of risk issue. In his initial remarks Pat reviewed the history of dam failures and his evaluation of failure data. He showed the age distribution of dam failures that illustrates the point that years of satisfactory performance is not necessarily an indicator of future satisfactory performance since many of the dams that have failed have been 50 years of age and older. With this backdrop Pat discussed some of the questions the FERC is addressing as they strive to serve their role as the “voice of society”. These questions, which for the most part are non-technical (i.e., not related to technical matters of performing a risk analysis for a dam), but rather center around issues of society’s risk tolerance, the variation in risk perceptions (see Figure 1) our ability to measure and assess risks, and society’s willingness to make trade-offs between the benefits provided by critical infrastructure and the risks to communities.

Professor Paul Slovic made a rich and diverse presentation on the complexity and psychology of risk that touched on many of the issues Pat Regan raised in regards to the FERC’s search to be the “voice of society” as it strives to understand and ultimately define tolerable risk levels for hydropower projects. To be that voice requires an understanding of what society’s perceptions of risk are and how they influence the acceptance of risk. Professor Slovic’s presentation, which is based on more than 40 years of study in this area, addressed four main questions:

1. How do people think about risk?
2. What factors determine the perception of risk and the acceptance of risk?
3. What are some of the social and economic implications of risk perceptions?
4. How do we value human lives in the face of risk?

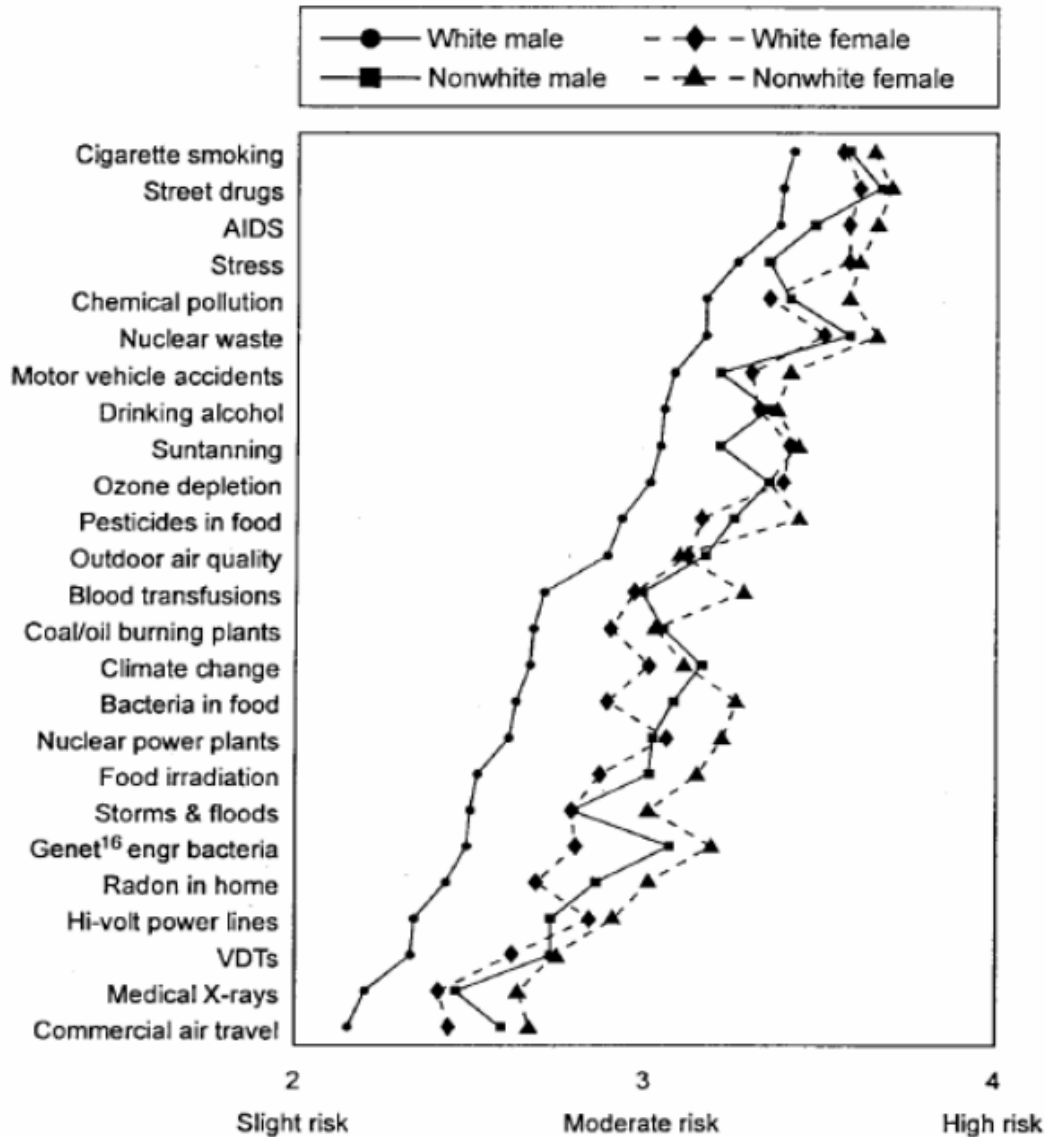


Figure 1 Illustration of the variation in risk perception of different activities based on gender and race referred to in Pat Regan’s presentation.

As a starting point, Professor Slovic noted that “Risk does not exist ‘out there,’ independent of our minds and cultures, waiting to be measured.” Rather, the concept of risk was invented to help us understand and cope with dangers and uncertainties of life. He noted that from the public’s perspective, risk is multi-dimensional and quite complex. For instance, it incorporates considerations of uncertainty, dread (deaths from automobile accidents versus death from cancer), catastrophic potential, controllability, equity (who benefits versus who is exposed to the risk), risk to future generations, etc.

In this context, he posited that defining risk is an exercise of power! Whoever controls the definition of risk, controls the rational solution to the problem at hand. For instance, defining risk one way, may lead to one option rising to the top as the most cost-effective or the safest or the best. If however, it is defined in another way, perhaps incorporating qualitative characteristics

and other contextual factors, a different ordering of actions or solutions may be reached (see Figure 2).

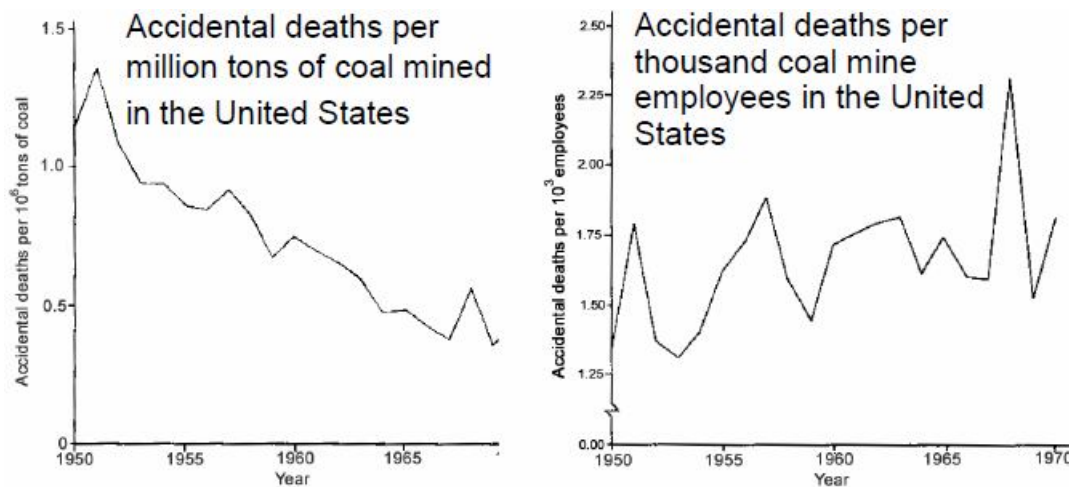


Figure 2 An illustration from Professor Slovic's presentation related to the question of risk characterization. The plots show different characterizations regarding the safety of coal mining - Is coal mining getting safer? It depends on which measure you choose.

In closing, Dr. Slovic spoke of the concept of the "Risk Game". Whereas games have rules of play, opponents, criteria for winning or losing, and so on, none of these attributes is essential to the concept of a game, nor is any of them characteristic of all games. Similarly, if we view risk in a sociopolitical sense (the arena in which public policy decisions are ultimately made), risk may be characterized in terms of various attributes such as voluntariness, probability, equity, etc., but none of these attributes is essential. Just as there is no universal set of rules for games, there is no universal set of characteristics for describing risk. The characterization must depend on which "risk game" is being played. In this context, Professor Slovic concluded the rules of the risk game must be socially negotiated within the context of specific decision problems.

The final speaker was Justice Banke who discussed a number of the legal and liability issues associated with events involving infrastructure failure. While professional engineers are uniquely aware of the professional liability associated with providing engineering services, a number of recent events in the gas transmission industry such as the 2010 transmission line explosion in San Bruno, California (among others), have added a unique dimension to the legal responsibility and liabilities of infrastructure owners and operators; criminal liability. Justice Banke pointed out that on April 1, 2014 PG&E Pacific Gas and Electric Co. was indicted on 12 federal criminal counts related to the San Bruno explosion that caused extensive damage to a San Bruno neighborhood and killed eight people. The allegations state that PG&E did not conduct required inspections that could have prevented the disaster and violated the federal Pipeline Safety Act which mandates that operators maintain accurate records about their gas pipes, identify risks to lines and inspect or test when pipe pressures exceed the legal maximum (San Francisco Chronicle, April 1, 2014). In another case in Washington state, a manager, supervisor and a control room operator were indicted and convicted of charges ranging from failure to provide

adequate training to release of gasoline into a water way as a result of a pipeline rupture. Sentences levied in this case included jail terms and fines.

Justice Banke noted once these cases reach the legal system and in particular a jury trial, the final risk/benefit analysis reflects the *community's* sense of justice.

The speaker presentations can be downloaded at: <http://npdp.stanford.edu/CEESymposium>

The symposium was co-sponsored by the National Performance of Dams Program (<http://npdp.stanford.edu>) and the John A. Blume Earthquake Engineering Center (<http://blume.stanford.edu>).