MEETING SUMMARY

A person makes thousands of decisions every day and those decisions are complicated by *risk*—the possibility of loss or injury—and *uncertainty*—the indefinite likelihood of future events. At this meeting of the Government-University-Industry Research Roundtable (GUIRR), the decision makers in attendance discussed when, why, and how to consider risks and uncertainties. Particular focus was given to high-risk, low-probability events and what methodologies may be warranted for decision making around such events. Leaders from the three GUIRR sectors described the difficult decisions they face and offered guidance by sharing the tools they employ to address and overcome those challenges.

The June 19 keynote speaker, **Dr. Subra Suresh**, Director of the National Science Foundation (NSF), spoke on “Decision Making Under Risk and Uncertainty: A Federal Science Agency Perspective.” The NSF’s FY2012 budget was $7.3 billion, which it directs toward basic research in the sciences. As head of this federal agency, Dr. Suresh is faced with difficult decisions such as how to respond to budget cuts and what activities take precedence. For example, the NSF prioritized preserving funding for graduate fellowships, even in the face of a reduced budget, as part of its long-term view on what is needed to push science forward.

Dr. Suresh underscored that the decisions made by NSF can have long timelines before the full results are known. For instance, mathematical modeling work supported by the NSF in the 1970 led to advances more than a decade later. The wider economic implications are likewise difficult to anticipate, such as NSF support in nanotechnology research leading to development of 180 nanotechnology companies.

In implementing its mission to support basic research, the NSF faces several challenges. First, given the nature of the U.S. federal budgeting process, the NSF finds itself unable to make long-term funding commitments to research projects like colleagues in Europe where many countries have multi-year budgeting processes. Second, the NSF wants to focus on the long term but people have short attention spans. Third, there is a cost to inaction and Dr. Suresh expressed concern that if investments in infrastructure are not made now, then in 10 to 30 years the United States will not have the kind of science the nation will need to advance.

Some specific risks to advancing science that Dr. Suresh noted included: (1) key discoveries “collecting dust” or “inconvenient findings” being actively ignored; (2) the danger that women will not choose to work in science and technology; (3) globalized science not being guided by shared principles; (4) interdisciplinary research no longer fueling our fundamental science engine; and (5) short-term and parochial interests overtaking evidence-based, long-horizon scientific findings. He underscored America’s need to continue making significant, thought-driven investments in science and technology if the United States does not want to be outpaced by other countries who are investing significant portions of their R&D in research.

Dr. Suresh closed by noting that many urgent risks in the biosphere are global and are ripe for international collaboration and cooperation. In addition, new tools are constantly emerging such as using portable devices for “citizen science,” so investing in a wide range of technologies will help address uncertainties about what will be the needs and technologies of the future. He stated that we have an opportunity and an obligation to make sure science around the world benefits from our rich experience while we vigorously pursue our own initiatives and collaborative efforts.

The opening speaker on June 20, **Dr. Baruch Fischhoff**, Howard Heinz University Professor in the departments of Social and Decision Sciences and Engineering and Public Policy at Carnegie Mellon University, set the stage with his presentation “Understanding Risk and Uncertainty: Making Decisions for Complex Problems.” In studying decision making under uncertainty, researchers look at (1) how people should make decisions (normative analysis), (2) how people do make decisions (descriptive analysis), and (3) how to help people make better decisions (prescriptive interventions). Decision science has identified many principles underlying judgment and choice. For example: people are good at tracking what they see, but are not so good at undoing the effects of biased information. People consider the return on their investment in making decisions and hence may stop trying if they do not expect to make progress. People may not know what they want, especially when facing novel questions. Under stress, people tend to revert to previous actions with which they have the greatest familiarity and comfort. Because there are so many such principles, simplistic approaches to predicting and aiding decision making are unlikely to succeed. Rather, decision-specific research and design is needed in order to help people make better choices and recognize their limits.

Dr. Fischhoff reviewed several specific cases, applying decision science to understanding and aiding the decisions of patients, customers, and policy makers. A task facing many professionals is communicating their knowledge of risks to others. As an example of how an organization can mobilize its resources in order to protect itself and those who depend upon it, Dr. Fischhoff described the U.S. Food and Drug Administration’s strategic plan for risk communication, which it has applied to providing useful, timely information for managing such diverse emerging events as new food contamination and unexpected drug side effects. He encouraged the creation of decision science resource centers to provide scientific support for designing, implementing, and empirically evaluating solutions.

The next session featured three speakers discussing various aspects of managing catastrophes. **Dr. Kathleen Tierney**, Professor of Sociology and Director of the Natural Hazards Research and Applications Information Center, University of Colorado at Boulder, spoke on “Disaster Decision Making: Smart People, Smart Institutions?” Her research has shown that disaster decision making at the micro level—by individuals and groups—is positive and productive. She shared examples of people self-organizing effective disaster responses during natural and human-induced crises. Decision making during disasters by organizations and institutions, however, has yielded more mixed results. While organizations can make sound decisions in the face of emergencies, they can also fall prey to pathological decision making manifested as command and control thinking or “elite panic.” Under command and control thinking, organizations may put too much emphasis on hierarchies and procedures without sufficient deference to “on-the-ground” information and improvised action.

Elite panic reflects a situation where fear of public disorder and lawlessness may lead to violence or other inappropriate responses. Given that the best decisions in disaster situations are often made by individuals on the scene acting through improvisation, Dr. Tierney closed by posing the question, “How can we design institutions that are capable of adapting to the decision-making demands disasters create?”

Next **Dr. Henry Willis**, Associate Director of the RAND Homeland Security and Defense Center and Professor at the Pardee RAND Graduate School for the RAND Corporation, presented his remarks on “Managing Risk from Catastrophic Terrorism and Disasters.”

He described how managing catastrophic risks requires addressing three challenges:

1) Decisions are affected by biases and heuristics;
2) Catastrophes often result from complex phenomena; and
3) Risk management requires balancing competing objectives.

Dr. Willis described how traditional scenario analysis is inadequate for addressing these challenges and that adaptive planning is needed. Such planning should engage the public to counter biases, consider a range of alternatives, and allow for gathering information about values and priorities in order to balance interests and goals. To illustrate this, Dr. Willis shared a specific example of RAND's work with the National Oceanic and Atmospheric Administration to model flood risks in New Orleans. With multiple scenarios and management measures built into it, the model is intended to identify strategies that are flexible, adaptive, and robust.

Col. Douglas Stropes, Deputy Director for Humanitarian Assistance, Disaster Relief and Global Health with the U.S. Air Force, closed the session with his presentation on the "Department of Defense Approach to Foreign Disaster Relief and Preparedness." The Department of Defense (DoD) supports foreign governments to develop resilience before a disaster strikes and helps in the recovery following a disaster. The decision for DoD to provide disaster relief is made by considering the following:

1) How strong is host-nation support for DoD assistance?
2) What is the size of the "footprint" and impacts upon other DoD missions?
3) How do key U.S. government and other stakeholders view the potential involvement of DoD?
4) Are there concerns about what message DoD involvement may communicate within the nation receiving assistance and elsewhere?

DoD only responds to about 10 percent of disasters worldwide, meaning 7 to 10 disasters per year on average. DoD is traditionally tasked to respond when the host country is overwhelmed, the host country requests assistance, or when the department represents a unique capability not available commercially or from the host government. The U.S. Agency for International Development is the designated lead federal agency for disaster response, so DoD often looks to that agency to articulate the assistance required for a specific disaster.

The discussion then shifted to estimation of the value of risks to human life and how that factors into decision making. **Dr. W. Kip Viscusi**, University Distinguished Professor of Law, Economics, and Management and Co-Director, Ph.D. Program in Law and Economics at Vanderbilt University, outlined this subject in his remarks on "Valuing Risks to Life: Ethical Issues and Policy Challenges." There is no agreed upon monetary value for a human life, but his estimate of the median value in the United States is about $9 million (in 2011 dollars). Taking into account such aspects as age, income, and citizenship are controversial ways that the value of life could be adjusted in different policy analyses. In his own work, Dr. Viscusi has found that the Value of Statistical Life (VSL) tracks lifetime income and consumption and that using VSL by age can be useful if done correctly. He cautioned that identified lives are not statistical lives, so decisions about saving individual lives are not intended to be made by comparing rescue costs to VSL. The utility of VSL is in monetizing benefits to factor into quantitative policy analyses.

Insurance is a primary mechanism used to address risks and uncertainties and was the focus of the next meeting session. **Mr. Edward Pasterick**, Senior Policy Advisor, Mitigation Division/Risk Insurance for the Federal Emergency Management Agency (FEMA), led off the session with his presentation entitled "Public Policy and the Denial of Risk." FEMA oversees the National Flood Insurance Program (NFIP), public/private insurance aimed at reducing the federal cost of flood recovery by shifting some of the financial burden to the beneficiaries of assistance after a flood. If communities commit to establishing ordinances for better construction in flood-prone areas, then they are eligible for the NFIP. FEMA chose this route, rather than prohibit all construction within high-risk flood zones, in recognition of the socio-economics of communities built around waterways. The insurance program is not designed strictly to indemnify people but instead to incentivize best practices for minimizing flood damage.

Dr. Mark Pauly, Bendheim Professor, Professor of Health Care Management and Professor of Business and Public Policy at the University of Pennsylvania, spoke next on "Insurance and Behavioral Economics: Improving Decisions in the Most Misunderstood Industry." He described insurance as a highly efficient and effective device for cushioning the consequences of large losses with a small premium. However, insurance markets are tested when dealing with low probability-high cost events because (1) consumers have very limited personal experience with such events and (2) correlated losses pose challenges for insurers.

Dr. Pauly suggested that in dealing with extreme events, the best approach for evaluating insurance needs for both consumers and insurers is to assess risks, utilize accurate information, and make tradeoffs. Oftentimes, however, people operate automatically and quickly with imperfect information, leading to suboptimal decisions. To structure insurance in a way that promotes optimality, Dr. Pauly outlined the following principles for insurance:

Information Principles	Contract Design Principles
1) Make accurate risk assessments available 2) Identify and address interdependencies 3) Detect and adjust strategies for behavioral biases and heuristics due to System 1 (quick response) behavior	1) Design premiums to reflect risk 2) Define equity across buyers and sellers and apply it consistently

The session closed with remarks from **Mr. Gideon Pell**, Senior Vice President and Chief Risk Officer for New York Life Insurance Company, about "Enterprise Risk Management in a Highly Uncertain World." He stated that we are living in an age of unprecedented uncertainty, especially with regards to finance and regulations, and therefore insurers are looking at how to prepare for and mitigate adverse situations that could arise. Mr. Pell shared an Enterprise Risk Management Framework of linked activities that insurers use to actively manage risk (see figure top right).

Risk culture and governance is at the center because it is a key element of any risk management program. Mr. Pell underscored the importance of making sure senior management and the board set the tone for what risks the organization is and is not willing to take and what the consequences will be if those standards are breached. In addition to organization-wide risk thresholds, many companies also look at risks in each business line and at global threats and trends. Periodic discussions by management of emerging risks and how they could influence business models are another good practice. Insurance companies are doing advanced modeling of a variety of scenarios, sometimes looking as far as 50 years out, but also recognizing that some events are so extreme that modeling can fall short.

Enterprise Risk Management Framework

Source: Gideon Pell, New York Life Insurance Company

Finally, Mr. Pell suggested that risk should not be looked at only in isolation but also aggregated to communicate the risk profile to management in order to make decisions that address multiple and correlated risks.

The luncheon keynote speaker was **Mr. Cass Sunstein**, Administrator of the Office of Information and Regulatory Affairs (OIRA), Office of Management and Budget, who delivered his remarks on "Regulation in an Uncertain World." He described how a key feature of the U.S. regulatory system is the ability to assess what rules will do before the fact and to test them carefully after the fact. Using a "regulatory look-back" approach initiated by President Obama, OIRA does retrospective analysis of rules to catalogue their effects, to streamline them, or even to eliminate rules as needed. The goal is to use ex-post analysis (after-the-fact analysis) to inform and improve ex-ante analysis. The Obama Administration also put in place new requirements for promoting public participation and requiring quantification. The goal of public participation is to take advantage of the dispersed knowledge of the American public and using state-of-the-art tools is a means of dealing with uncertainty by promoting accurate measurement that ensures regulation is empirically justified in advance by assessing both costs and benefits.

In January 2011, President Obama also called for a government-wide review of all significant rules currently "on-the-books," known as retrospective analysis or "lookback." As a result of this analysis, 500 reform proposals have been made and 100 are already finalized or proposed to the American public. At least $5 billion in savings are anticipated from only a fraction of these reforms over the next five years. OIRA finds that using retrospective analysis can be used to improve prospective analysis, with a sea-change movement toward developing rules in a way that provides for ongoing evaluation of effects.

OIRA operates under formal guidance on how to deal with uncertainty. First, there is recognition that in some circumstances the level of scientific uncertainty is so large that the only thing that can be done is to present alternative scenarios without assessing quantitatively the relative likelihood of each. Second, for major rules costing $1 billion or more, there has to be a formal quantitative analysis taking into account numerical sensitivity analysis to show how the results vary with changes in assumptions, choices of input data, and variations in analytical approaches and with formal probabilistic analysis of the uncertainties.

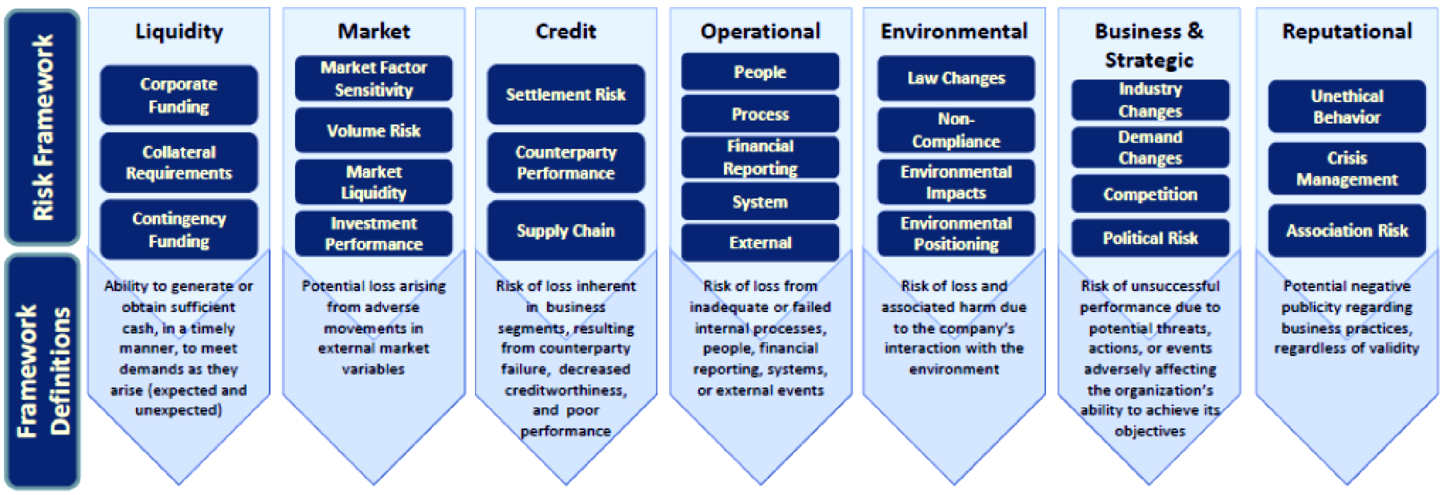
Taking a quantitative approach is not without its shortcomings. First, sometimes it can be difficult to get at the magnitude of relevant effects. Second, in some cases, effects can be quantified but not monetized, e.g. improvements to ecosystems. Third, it is recognized that some rules may have beneficial or adverse distributional effects on certain populations, e.g., low-income groups, but it may not be possible to measure to what degree the effects will vary. Finally, rules might provide for protection of human dignity, e.g., wheelchair access to bathrooms, or have adverse effects on human dignity, e.g., airport body search scans as an invasion of privacy, which is difficult to quantify.

In cases where quantification is challenging, OIRA promotes being as transparent as possible and asking for input on how to improve the rulemaking process. When quantification is not possible, there is now greater reliance on "break-even analysis," where agencies specify how high the unquantifiable costs would have to be in order for the benefits to justify the costs. Retrospective analysis then becomes even more important as a means of evaluating after the fact whether estimated benefits were accurate and narrowing the range for future benefit-cost estimation.

Mr. Sunstein closed by suggesting that over the past 30 years, there have been significant advances with respect to the analysis of regulatory options that have saved money and lives. Predictions are not entirely reliable since we live in an uncertain world, but he expects advances to continue into the coming decades.

The day's final session provided insights on how industry leaders consider risks. The first speaker, **Dr. Brenda Boultwood**, former Chief Risk Officer for Constellation Energy (now Exelon Corporation), explored "Growth Requires Risk Taking: Do We Thrive, Survive or Fail?" Like earlier speakers, Dr. Boultwood addressed the increasing complexity of the business environment, particularly in terms of new financial instruments, changing environmental, financial and health care regulations, and the growing size of major players.

The introduction of new regulations, according to Dr. Boultwood, can increase uncertainty about whether risks are being well managed. It can also be easy for companies to overlook new risks when they push into different markets. Businesses have a significant reliance on models but Dr. Boultwood cautioned that the outputs of models are only as good as the inputs.



Source: Brenda Boultwood

Differentiating between risk and uncertainty, Dr. Boultwood said risky events can happen in the future but they are events with which there is prior experience, understanding, and probability of the event occurring. Corporate risk managers can look at a way to hedge risks and minimize losses. Uncertainty pertains to events where there is little or no experience and the probability cannot really be articulated, with firms displaying a tendency to draw back in uncertain times. The above diagram illustrating various business risks for a typical energy company was presented, with more quantifiable risks on the left side and non-quantifiable risks to the right.

Dr. Boultwood stated that risk is fluid, so if risks are not being taken in one area, companies will take risks elsewhere in order to meet investor return expectations. She suggested that a national dialogue may be needed on what investors expect, what companies have to do and the acceptable level of government guarantees to meet those economic growth expectations. Reducing risk in a system will lower company growth, expected investor returns, and national output.

Next the audience heard from **Mr. Mark Deadwyler**, Vice President, Technology Finance and Alliance for Monsanto, on “Product Development Through the Balance of Innovation and Risk.” Mr. Deadwyler described how Monsanto strives to balance innovation prospects with risk, noting that risk tends to go up with the size of the commitment. Monsanto is particularly focused on the anticipated future demand for food. The company anticipates that grain demand will double by 2030, but the supply of arable land is finite. Monsanto is supporting research aimed at increasing yields while also reducing inputs needed.

Mr. Deadwyler noted that because rural areas develop more slowly, Monsanto encounters significant risks pioneering in such environments. The company emphasizes communication between researchers and farmers in the field in order to identify and address risks early in the development process. Further, Monsanto decided to make significant investments to develop a network of universities and research institutions, which enables greater sharing of innovations and thereby speeds progress towards addressing major agricultural challenges.

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DISCLAIMER: This meeting summary has been prepared by Katie Kalinowski as a factual summary of what occurred at the meeting. The committee's role was limited to planning the meeting. The statements made are those of the author or individual meeting participants and do not necessarily represent the views of all meeting participants, the planning committee, GUIRR, or the National Academies.

The summary was reviewed in draft form by John Kastanas, California Institute of Technology, to ensure that it meets institutional standards for quality and objectivity. The review comments and draft manuscript remain confidential to protect the integrity of the process.

ABOUT GUIRR

GUIRR's formal mission, revised in 1995, is "to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. This forum will be designed to facilitate candid dialogue among participants, to foster self-implementing activities, and, where appropriate, to carry awareness of consequences to the wider public."

For more information about GUIRR visit our web site at http://www.nas.edu/guirr
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