

## Aggregating Elicited Probabilities

This goal of this project is to assess the value of using methods of probability elicitation that do not place constraints on participants' ability to abstain from judgment.

**Modeling Area:** Risk Management and Applied Decision Analysis

**Case Studies Supported:** NA

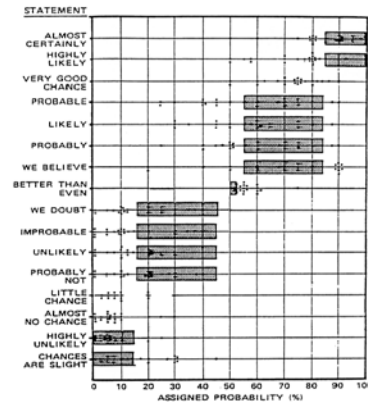
**Principal Investigators:** Henry H. Willis and Joel Predd

**Institution:** RAND Corporation

**Other Investigators:** Detlof von Winterfeldt and Steve Hora

### Brief Description:

The threat of terrorism is widely considered to be the most uncertain factor contributing to terrorism risk. Sparse historical data, vague intelligence about the intentions and capabilities of terrorism, and the expectation that terrorists adapt to a dynamic security environment combine to produce great uncertainty about when, where and how terrorists are likely to attack. Recently, DHS has been applying methods of probability elicitation to record judgments from the intelligence community about terrorism threat for specific scenario. Examples of this include the CREATE supported efforts for the Biological Terrorism Risk Assessment (BTRA) and the Risk Assessment Process for Investment Decisions (RAPID). The methods being used are well validated albeit time and resource consuming. In addition, simple linear combinations of expert judgments can result in incoherent aggregate estimates unless probabilities are elicited from non-overlapping sets of experts and respondents do not abstain from providing any of the judgments being elicited. Forcing all experts to respond to each question may introduce bias and error since people are asked to make judgments outside of their area of knowledge. While there exist ways to aggregate incomplete elicitation in lieu of simple linear combinations, they become computationally intractable when more than a moderate number of variables are involved. Joel Predd and colleagues have developed a computationally efficient means of estimating aggregate probabilities while allowing participants to abstain. This raises a question of what the value might be for allowing participants to abstain in terms of both elicitation ease and probability validity.



**Depiction of Sherman Kent's (1964) proposal for matching words and uncertainties.**

### Objectives:

This study will evaluate methods of probability elicitation that do not allow experts to abstain to approaches for estimating probabilities based on elicited results that allow for abstention. The evaluations will be first conducted using empirical surveys and elicitations of standard probability questions for which the true probabilities can be discovered. If possible, questions will be constructed to leverage existing literature on probability elicitation and minimize the collection of new data. Depending on results of this controlled evaluation, the work will be extended to assess applicability to terrorism threat elicitation. Evaluations will consider standard metrics of bias, error, calibration, and coherence as well as the time required and self-reported measures of the participants' perceptions of the ease and satisfaction with the elicitation process.

**Interfaces to other Center Projects:**

This work will maintain a close interface with expert elicitation studies conducted by Dr. Steve Hora. As this study is conducted and analysis is completed, the PIs will also work to coordinate results with ongoing elicitation efforts conducted in support of weapons of mass destruction risk analyses at DHS S&T as well as at DHS-Risk Management and Analysis in support of RAPID.

**Interfaces to non-Center Projects:**

This work will interact with researchers at partner institutions affiliated with other DHS centers; specifically Sanjeev R. Kulkarni and H. Vincent Poor of Princeton University who are affiliated with the DIMACS/DyDAN Centers at Rutgers University.

**Major Products and Customers:**

The principal product from the first year of this research will be a study that describes the experimental results comparing elicitation approaches. Depending on these results, the second year of the study will identify applications of the approach to terrorism threat elicitation and evaluate the performance of the approach in this specific context. The results of this work will be of interest to organizations and policymakers responsible for securing assessing terrorism threat to support risk and decision analysis at DHS. These include, but are not limited to, DHS-I&A, DHS-INS, DHS-CBP, DHS-TSA, and DHS-ORMA.

**Technical Approach: (Describe the technical approach to achieve the research objectives.)**

Evaluations of elicitation methods will be grounded in the theory and methods of decision analysis.

**Major Milestones and Dates:**

1. Complete experimental design – January 2009
2. Complete data collection – June 2009
3. Present draft paper and briefings to DHS and CREATE for review – September 2009
4. Identify application to terrorist threat assessment – November 2009
5. Complete experimental design for threat application – January 2010
6. Present draft paper and briefings to DHS and CREATE for review – July 2010