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Title: Implementation of the PR&PP Methodology: The Role of Formal Expert Elicitations

Author(s): Joseph F. Pilat

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Implementation of the PR&PP Methodology: The Role of Formal Expert

Elicitations

The application of the methodology developed by the GenIV International Forum's (GIF's) Proliferation Resistance and Physical Protection (PR&PP) Working Group is an expert elicitation. *Although the framework of the methodology is structured and systematic, it does not by itself constitute or require a formal elicitation. However, formal elicitation can be utilized in the PR&PP context to provide a systematic, credible and transparent qualitative analysis and develop input for quantitative analyses.* This section provides an overview of expert elicitation, a discussion of the role formal expert elicitation can play in the PR&PP methodology, an outline of the formal expert elicitation process and a brief practical guide to conducting formal expert elicitation.

Expert Elicitation: An Overview

Expert elicitation is a process utilizing knowledgeable people in cases, for example, when an assessment is needed but physically based data is absent or open to interpretation.

More specifically, it can be used to:

- predict future events;
- provide estimates on new, rare, complex or poorly understood phenomena;
- integrate or interpret existing information; or
- determine what is currently known, how well it is known or what is worth learning in a field.

Expert elicitation can be informal or formal. The informal application of expert judgment is frequently used. Although it can produce good results, it often provides demonstrably biased or otherwise flawed answers to problems. This along with the absence of transparency can result in a loss of confidence when experts speak on issues.

More formal expert elicitation is a structured process that makes use of people knowledgeable in certain areas to make assessments. The reason for advocating formal use is that the quality and accuracy of expert judgment comes from the completeness of the expert's understanding of the phenomena and the process used to elicit and analyze the data. The use of a more formal process to obtain, understand and analyze expert judgment has led to an improved acceptance of expert judgment because of the rigor and transparency of the results.

In practice, formal processes based on the judgment of experts are commonly used in many fields. Around the globe, governments, industry and academia use expert elicitation for:

- development of nuclear accident risk assessments;
- product improvement and new product reliability in the automobile industry;
- development of food inspection procedures;
- maintenance of dams;
- determination of uncertainties in climate change detection and attribution;
- choice of environmental remediation methodologies; and

- other uses.

Formal Expert Elicitation and PR&PP

In the GenIV International Forum context, the potential value of this approach is clear for systems where designs are not fully developed, other issues from fuels to related fuel cycles are not yet determined and safeguards and other PR&PP measures are not yet decided. As noted, the application of the PR&PP methodology is an expert elicitation, although the framework of the methodology does not by itself constitute or require a formal elicitation. *Formal elicitation could be utilized in the PR&PP context to provide a systematic, credible and transparent qualitative analysis and develop input for quantitative analyses.* Doing so would increase the transparency and credibility of the process and results. The use of a formal process for support elicitations (e.g., to gather and assess critical information inputs and to perform sensitivity analysis) would also enhance the product. More specifically, the methodology and support elicitations can:

- assess initial inputs and identify knowledge gaps;
- identify, prioritize and down-select pathways;
- assess performance of safeguards and physical protection systems across pathways (including estimates of detection probabilities for undeclared activities) and for specific types of facilities;
- assess intrinsic features and extrinsic measures to enhance PR&PP, including the comparative impacts of facility design changes, and optimize these features and measures;
- perform sensitivity assessments for specific features or measures;

- assess evaluation metrics; and
- identify and characterize uncertainties and error bars.

In these and other ways, application of the methodology using a formal elicitation process can enhance its value for internal planning purposes for nuclear engineers, safeguards experts, etc.

The Formal Elicitation Process

To achieve such objectives, procedures for formal elicitations should be employed throughout the process and in any support elicitations that may be utilized to enhance the technical credibility and consistency of this process, and to enhance its transparency. The formal elicitation process involves several steps, which are outlined below with key questions and issues.

- Identification and selection of issues
 - What is the problem that decision makers face?
 - What is the scope of the problem?
 - What issues are involved in understanding and resolving the problem?
 - What information do decision makers seek?
- Identification, selection and training of experts
 - What knowledge and experience is necessary?
 - Is there a requirement for geopolitical balance in the selection of experts?
 - If so, on what basis and using what parameters?
 - Is there a requirement for political balance for some states?

- If so, on what basis and using what parameters?
- Development of specific questions and assumptions
 - How can one avoid eliciting “opinions” rather than expert judgments that reflect a systematic, structured analysis?
 - How can one avoid various biases?
 - How do complex and difficult questions break down into detailed technical questions?
- Elicitation of expert judgment
 - What is the value of initial inputs?
 - Are there identifiable gaps in knowledge?
 - Can they be closed?
 - What is required to close them?
 - What level of effort is required?
 - What resources are available?
 - Have biases been avoided?
 - How is uncertainty elicited?
- Analysis, aggregation and resolution of conflicts between experts
 - To what extent can assessments of measures be aggregated?
 - Is consensus possible?
 - Is it necessary?
- Documentation and communication of results
 - What is the best way to present the findings?
 - How is credibility assured?

- How is transparency demonstrated?

Conducting Formal Expert Elicitations

If formal expert elicitations are to become the standard for implementation of the PR&PP methodology, the elicitation has to be undertaken with a level of resources and time that is acceptable and sustainable. It will not be likely for most GIF needs to be able to utilize elicitations that might involve hundreds of experts, take years and cost millions of dollars. It is critical to have a practicable code of conduct for smaller, more responsive and less expensive—yet formal—elicitations.

The implementation of the process outlined above involves the following actions, or steps. Completing all of these required steps in the process is critical to ensure its credibility.

The process begins with an internal effort to clarify the problem and associated issues to be addressed, frame general questions and select a manageable number of experts (four-six) based on knowledge, experience and prominence. The experts should have the necessary subject matter expertise. A mix of nuclear engineers, reactor/fuel cycle specialists, safeguards and security experts and nonproliferation specialists is appropriate for PR&PP expert elicitations. If possible, they should have the authority to be credible to decision makers who may not fully understand the process. In addition to their subject matter expertise, the group of experts consulted should reflect the geopolitical diversity

of GIF. For US decision makers at least, it is important as well to have diverse political views among the experts to help assure their results cannot be dismissed as partisan.

In addition to the experts, there is a need for a facilitator of the elicitation and possibly additional experts who are brought into the process as consultants or advisors as required to assist the facilitator or to address issues that may arise on which the original group of experts require assistance.

The experts, facilitator and other members of the team are brought together to assess and develop the results of the initial scoping exercise to determine specific questions, workable assumptions, information limits and needs, etc., and to receive training. .

Training is essential and the experts need to be knowledgeable on the PR&PP assessment methodology as well on the expert elicitation process itself.

For each elicitation, on the basis of the scoping exercise begun by the experts, the facilitator and others internally develop an elicitation package that consists of:

- a cover letter with instructions;
- papers on the PR&PP methodology and the expert elicitation process;
- papers on the substantive issues to be addressed, including threat definitions, facilities/fuel cycles considered, proliferation scenarios (involving diversion from a declared facility, misuse of a declared facility, use of a clandestine facility and abrogation), the identification and description of pathways (which identify and describe specific targets, possible diversion points, the strategy and actions

required of the proliferator including concealment efforts and the PR or PP measures that may be applied);

- a questionnaire with specific guidelines for the experts; and
- assumptions to be considered in answering the questions.

The experts are sent the full package and asked to complete the questionnaire, make clear their assumptions (including agreement or disagreement with assumptions put forward in the package, additional assumptions, etc.) and consider issues such as the correctness and completeness of key information provided, the dependence/independence of variables that come into play, relevant performance criteria including time, etc. The point on assumptions is particularly important. The experts need specifically to be asked to assess the working assumptions of the elicitation in their responses.

The experts undertake independent pathway analyses using the PR&PP methodology. As noted above, the proliferation scenarios will have been identified and described and specific, representative pathways will have been constructed and included in the package. The experts will review this material, suggest adjustments as necessary and then for each pathway assess the values for the measures along that pathway along with uncertainties.

In this context, specific issues and related questions either put forward in the package or added by the experts have to reflect the PR&PP methodology and to be so constructed as to enable concrete, unbiased responses.

For these pathway analyses, the issues that will need to be addressed include the following:

- Is the list of indicators on a pathway (including clandestine segments) complete?
 - What is the likelihood that the assumed indicator, or observable signature of an action down a proliferation pathway, will appear in the various sets of available data (with attention to concealment attempts)?
 - What is the likelihood that the indicator as such will be recognized?
 - What is the persistence of the indicator? Will the indicator, by its nature, remain available for detection or will it disappear?
- Is there a way to increase the number and/or intensity of the indicators, or to decrease their ambiguity? Is this feasible and cost effective?
- What actions will be taken by the IAEA or possibly others?
- What actions are to be used to follow up on the initial actions?
- Is the performance of suggested actions independent of one another?
- Which indicators could be defeated by effective concealment, deception and denial practices?
 - If a measure is not completely defeated, what is its residual effectiveness?
 - With concealment practices in effect, what is the effectiveness of detection before material production (i.e., within conversion time) and one year after material production?
- What is the likelihood that the follow-up activities themselves will effectively resolve the issue? What is the impact on detection capabilities over time?

The experts are given time to respond in writing to the questions and to raise other issues as noted above, including the validity of the initial assumptions.

Once received, the experts' responses are analyzed and aggregated, and a draft report of the elicitation is prepared and sent to the experts by the facilitator in consultations, as required, with the experts or, if necessary, outside consultants. This draft report should include threat definitions, facilities/fuel cycles considered, proliferation scenarios, the identification and description of pathways and the pathway analyses. In addition, the report should include an initial set of findings that were evident in the experts' analyses (e.g., comparison of PR and PP for facilities or fuel cycle systems under consideration, insights on design features that enhance PR or PP, safeguards challenges, etc.). The draft report of the elicitation should indicate specific areas of agreement and disagreement among the experts. As needed, it should also raise any required follow-on questions, request the experts to explain (in greater detail, in most cases) or clarify their rationales for certain elicited values or uncertainties, put forward sensitivity analyses that may have been suggested by the analyses and elicit their views on the initial findings and insights.

The experts are then given time to respond to this draft report. On the basis of these responses, a second draft is produced that delineates the status of agreement and disagreement among the experts, poses as needed, further follow-on questions, etc.

The experts then meet in at the close of each elicitation to discuss the second draft, resolve remaining issues and conflicts and, if possible, produce a consensus report.

Conclusions

In the GIF context, the potential value expert elicitations is clear for analyzing the proliferation resistance and physical protection of systems where designs are not fully developed, other issues from fuels to related fuel cycles are not yet determined and safeguards and other measures are not yet decided. The application of the methodology developed by the GIF's PR&PP Working Group is an expert elicitation. Although the framework of the methodology is structured and systematic, it does not by itself constitute or require a formal elicitation. However, formal elicitation can be utilized in the PR&PP context to provide a systematic, credible and transparent qualitative analysis and develop input for quantitative analyses. In this fashion, application of the methodology using a formal elicitation process can enhance its value for internal planning purposes for nuclear engineers, safeguards experts, etc.