Elicitation Technique Selection: How Do Experts Do It?

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Abstract

Requirements elicitation techniques are methods used by analysts to determine the needs of customers and users, so that systems can be built with a high probability of satisfying those needs. Analysts with extensive experience seem to be more successful than less experienced analysts in uncovering the user needs. Less experienced analysts often select a technique based on one of two reasons: (a) it is the only one they know, or (b) they think that a technique that worked well last time must surely be appropriate this time. This paper presents the results of in-depth interviews with some of the world's most experienced analysts. These results demonstrate how they select elicitation techniques based on a variety of situational assessments.

1. Introduction

The success or failure of a system development effort depends heavily on the quality of the requirements [1]. The quality of the requirements is greatly influenced by techniques employed during requirements elicitation [2] because elicitation is all about learning the needs of users, and communicating those needs to system builders. How we select an appropriate elicitation technique out of the plethora of available techniques greatly affects the success or failure of requirements elicitation [2]. We believe that requirements analysts who have extensive experience (and are considered to be *masters* of elicitation by most) seem to have the ability to select appropriate elicitation techniques on a regular basis. Since most practicing analysts have less experience and are more journeyman than master, it is no surprise that over half the products created by the software industry fail to satisfy users' needs [3]. If we could improve the average analyst's ability to select elicitation techniques, we will most likely improve our record of successful products. Our industry should find ways of transferring these experts' knowledge of elicitation technique selection to the less experienced. This paper's mission is to begin that process by assembling and reporting in one place the elicitation technique selection processes employed by some of the experts.

Before beginning that process, however, it is important to recognize that unsatisfactory performance by practicing analysts could be caused by a variety of conditions. The poor performance could be (1) unrelated to elicitation techniques, (2) caused by lack of effective elicitation techniques [4], or (3) by availability but poor use of effective elicitation techniques. If the latter is true, and effective elicitation techniques do exist, then our product failures may be attributable to some problem relating to the skills of the practicing analysts. For example, perhaps technology transfer has not been taking place with the fault lying with researchers, or the techniques' inherent complexity, or insufficient time, or the analysts' lack of interest in new techniques [5]. Or perhaps, analysts do know of the existence of elicitation techniques but do not know how to apply them, or they know how to apply the techniques, but fail to understand *when* to apply them. In all likelihood, it is a combination of these conditions that cause projects to fail. This paper applies to conditions where analysts do not know how or when to apply elicitation techniques. In particular, given that appropriate elicitation techniques are available, given that we believe that the best analysts are likely to be innovators or early adopters [6], and given that we believe that more experienced analysts are more successful, what is it that these analysts are doing that can be captured and conveyed to less experienced analysts to improve their performance? By assembling the combined wisdom of the most experienced analysts in one place, we aim to improve requirements elicitation practice, and thus raise the likelihood that future products will meet user needs.

2. Related Research

Many articles [7, 8, 9] and books [10, 11, 12, 13, 14] describe *a* way to perform requirements elicitation. This is logical since so many practitioners are looking for a simple recipe for success – the *silver bullet* [15] that will solve all their elicitation problems. However, consensus exists that one elicitation technique cannot work for all situations [4, 16, 17, 18, 19, 20]. Therefore, almost all general requirements books [11, 16, 17, 21, 22, 23, 24, 25] and some articles [26, 27, 28] describe multiple requirements elicitation techniques.

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Some writings, e.g., [16, 17, 21, 23, 24, 25, 29, 30], provide limited insight into *when* an elicitation technique might or might not be applicable. Maiden and Rugg [18] have performed the most extensive research concerning the relationship between conditions and elicitation techniques, but the number of elicitation techniques analyzed was quite limited, and no attempt was made to assemble the collective wisdom of the most experienced analysts. As far as we know, no research has been done to date concerning how experts select elicitation techniques. And no author has tried to compare and contrast the advice from experts using common terminology.

3. The State of Requirements Elicitation

Requirements elicitation is the means by which analysts determine the problems and needs of customers, so that system development personnel can construct a system that actually resolves those problems and addresses customers' needs. Elicitation is an iterative process [31]. At any moment, conditions cause the analyst to perform a step using a specific elicitation technique. The use of that technique changes the conditions, and thus at the very next moment, the analyst may want to do something else using a different elicitation technique. The result of elicitation is a list of candidate requirements, or some kind of model of the solution system, or both.

Requirements elicitation is conducted today in a variety of contexts. For example, organizations that create software for mass market sale, perform elicitation while doing market research [32]. Meanwhile, the responsibility of elicitation in organizations that either create custom software, or customize a base of software for sale to a single client, tends to falls on an interdisciplinary team representing the customer and developer. Finally, in IT organizations that build custom software (or procure off-the-shelf systems and produce glueware) for use within the same company, analysts serve as a bridge between the company's IT and operating divisions. In all cases, the responsibility of the individual doing elicitation is the same: to fully understand the needs of users and translate them into terminology understood by IT.

As can be seen, elicitation is performed in a wide variety of situations, which span many dimensions representing various combinations of participants, problem domains, solution domains, and organizational contexts. It is also performed in a wide variety of ways, e.g., interviewing [33], collaborative workshops [34], prototyping [7, 35], modeling [10, 21, 22, 36], and observation [30]. It is this relationship between the detailed characteristics of such situations and elicitation technique selection that we are concerned with.

The requirements elicitation field has benefited from the presence of many expert consultants, who have had extensive experience in many projects, and who make themselves available to organizations endeavoring on a new or continuing systems effort. These individuals bring with them both successful and unsuccessful experience on many projects, and either help perform elicitation, or advise analysts on how they should perform elicitation.

If involvement by individuals like those described above does improve a project's likelihood of success (a conjecture that we and their customers firmly believe but that has not necessarily been proven to be true), then it would behoove us all to better understand how such people approach elicitation.

4. Overall Research Program

Given the limited research and theory regarding elicitation technique selection, we have chosen a qualitative research approach [37] using three primary qualitative information-gathering methods (participation in the setting, document analysis, and in-depth interviews) [38] to provide the data needed to discover situational technique selection theory [37, 39]. Figure 1 shows the 7 research phases necessary to achieve our final research goal. First we analyzed articles and books to create lists of potential situational characteristics and available elicitation techniques. The next phase is underway: to gather expert opinions about how these (and perhaps other) situational characteristics affect the selection of these (and perhaps other) elicitation techniques. We are gathering these opinions using three methods:

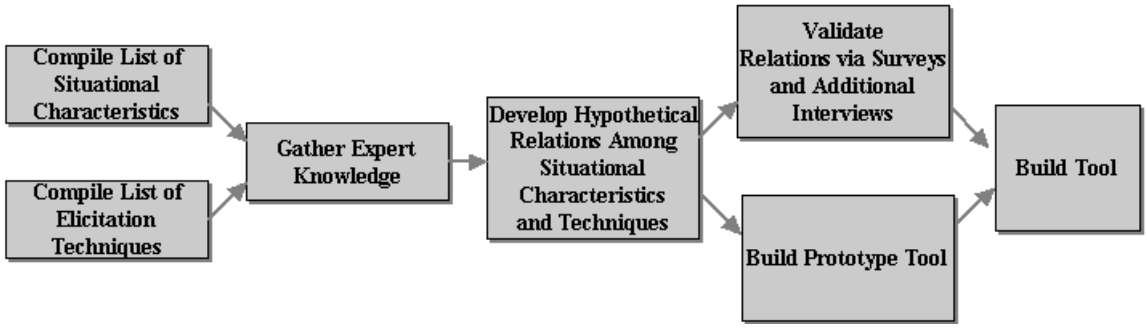

Figure 1. Overall Research Program

1. *Participation in the Setting*. In some cases, our own experience, based on a combined total of 40 years leading and participating in requirements elicitation in industry, has shown repeatedly that certain situations demand the use of certain techniques. For example, when we as analysts have little experience in a domain, we tend to start be seeking knowledge from a subject matter expert. In other cases, the knowledge borders on common sense, e.g., if there are multiple customers who may not know of each other's existence, then do not gather them together in a collaborative workshop.
2. *Document Analysis*. We have found preliminary information about how situations affect the selection of elicitation techniques in writings by Davis [21], Hudlinka [26], Kotonya and Sommerville [16], Laueson [23], Leffingwell and Widrig [24], Macauley [17], Maiden and Rugg [18], and Wiegers [25].
3. *Interviews with Experts*. In-depth interviewing is ideally suited for gaining understanding of people's behavior, its context, and the meaning they make of that behavior [40, 41]. Johnson [42] states that it is likely the best approach "where the knowledge sought is often taken for granted and not readily articulated by most" [p. 105] as it is in this case where experts often rely on tacit [43] knowledge to select elicitation techniques. These interviews are the subject of this paper.

Based on the information gathered from these sources, we plan to refine the lists of situational characteristics and elicitation techniques, and develop tentative relationships among the situational characteristics and the techniques. We then plan to validate these relationships through further interviews and surveys, and finally capture the results in a tool, which can be used by less-experienced analysts who wish to behave more like experts.

5. Research Method

This paper reports the results of interviews with nine of expert analysts[1]: Grady Booch, Larry Constantine, Tom DeMarco, Don Gause, Tim Lister, Lucy Lockwood, Suzanne Robertson, Karl Wiegers, and Ed Yourdon[2]. (In this paper, we will not associate specific opinions with any individual[3].) These individuals were selected using our a priori research design [41], which required elicitation experts, and purposeful sampling [40] to provide the broadest possible coverage of elicitation techniques, domains, and situations. They represent a subset of the list of thirty experts we assembled using the following criteria: (a) at least five year's experience performing analysis or elicitation in industry as a consultant or employee, and (b) author of a major book or many articles on requirements. Combined, the nine individuals have had over 225 years experience analyzing requirements on more than 500 projects. Six experts provided more detailed information for approximately 200 of their projects. These projects spanned many domains: 16% were embedded systems, 61% were business information systems, 10% were government systems, and 13% were systems software. Of these projects, 36% were intended for external sale and 60% were intended for internal use (4% unknown). Finally, 87% were mostly custom development and 8% were primarily commercial off-the-shelf (5% unknown). All considered themselves to be primarily "doers" as opposed to "thinkers" or "researchers." All have had extensive elicitation experience in multiple countries.

		Interview Location		
		At Subject's Office or Home	At Interviewers' Office or Home	At Another Location
Number of Participants	Two Interviewers with One Subject	2	3	1
	One Interviewer with One Subject	0	0	1
	Two Interviewers with Two Subjects	2	0	0

Figure 2. Interview Locales and Participants

The interview goal was to understand how each expert performs elicitation. Interviews were held from August through November 2002. Figure 2 summarizes the various interview settings. In all cases, the authors took extensive notes, and as many recommend [40, 42], all interviews were audio-recorded. Each expert completed a brief pre-interview questionnaire summarizing their elicitation experience, the types of projects on which they had worked and the elicitation techniques they were familiar with and had used. Recommended by Seidman [40], these 'focused life histories' enabled us to compare our interviewees to our desired sample. The expert's responses also served as the basis for follow-up questions. A flexible interview protocol was developed to guide the interviews, facilitate time management, and ensure all key issues were addressed [41]. Each interview started with:

1. A short period of informal social discussion.
2. A brief introduction to our research goals, definitions, research approach, and interview style.
3. An open-ended query to the interviewee along the line of "so, can you tell us how to perform elicitation?"

[1] Most practitioners and researchers consider these individuals to be experts. However, almost every one of the nine refused to acknowledge that they were indeed *experts.* They agreed they had much experience, but felt that they were also learning every day how to perform elicitation effectively. To be honest, we might have distrusted anybody who claimed to really be an expert, and didn't need to learn any more!

[2] In the future, we intend to expand this list of experts to include a greater mix of occupational and regional representation.

[3] As part of this, we have used the pronoun "he" for all references to the analysts. We do not mean to imply the genders of the individuals.

What ensued differed significantly from interview to interview. In response to our open-ended question, some of the experts told us "stories" of how they performed elicitation in a variety of situations. Others told us *the* way they always performed elicitation. And still others responded with a description of the conditions they consider when deciding upon an optimal approach.

- When the interviewee told us stories, we carefully listened for aspects of the stories that might trigger particular elicitation paths. When we suspected this, we asked the interviewee for verification by either asking directly, "Was it *this* situation that inspired you to do that?" or the contrapositive, "If *this* situation were not true, would you still have chosen to do that?"
- When the interviewee told us *the* way he always performs elicitation, we would take careful notes. Then we'd pose variations to the interviewee's assumptions, and invariably their response would be something like "Of course if *that* were true, I wouldn't do elicitation the same way." We thus discovered that although some experts think of themselves as practitioners of just *one* means of performing elicitation, they really have a *default* means of doing elicitation, and anomalous conditions result in alternative approaches.
- When interviewees told us conditions under which they would take one route or another, we listened carefully. In our opinion, these individuals were the most self-aware and process-aware of the group.

To insure that we received some normalized data, we also posed the same "situations" to all the interviewees, and asked them to describe how they would approach the situation. These situations will be described in section 6.2.

We independently analyzed the interview results. An open coding method [37, 39] was used; every elicitation technique and situation mentioned by the experts was highlighted, not just those included in the initial lists created in steps 1 and 2 of our research. We then compared our respective analyses to validate our observations and summarize the lessons learned from the expert interviews. These results are reported next.

6. Lessons Learned

We report on the results of the interviews with the nine experts, categorized as follows:

- *When to Use Techniques*. These are the insights from the experts concerning conditions under which *they* would select a technique. The ideas are summarized by technique. This is the primary focus of the research.
- *Normalized Situations.* As previously mentioned, we asked each of the experts to analyze a subset of the same four situations. Section 6.2 presents the experts' approaches in each case.
- *Other Useful Information.* We also learned other related information, which we report in section 6.3.

6.1 When to use techniques

This section summarizes guidance explicitly stated by the experts on when to use elicitation techniques. Whenever counts are provided (e.g., five of nine), the reader should assume the other experts did not mention that technique, not that they necessarily disagree with the others.

Collaborative Sessions[4]. Three of the experts stressed the effectiveness of gathering multiple stakeholders in a single room to conduct a collaborative session. One stated that it should always be done; and that not even geographic distribution of the stakeholders should be a deterrent – just use today's technology to conduct the group session in a distributed manner. Another said that such sessions should be held when there is general belief that "missed opportunities" exist; however he also acknowledged that this is likely to be all or most of the time. He also stated how essential such meetings are when a large, diverse, and autonomous set of stakeholders exists. A third emphasized the power of creativity exercises in collaborative sessions to aid envisioning innovative future systems, breaking the constraints of current system knowledge that would dominate interviews or observations. In general, it appears that collaborative sessions are seen by most to be a standard or default approach to eliciting requirements.

Interviewing. One expert interviews to gather initial background information when working on new projects in new domains. Another uses it whenever heavy politics are present, to ensure that the group session does not self-destruct. Yet another uses it to isolate and show conflicts among stakeholders whenever he has 2-3 days available to meet the stakeholders. When senior management has a dream, but the employees consider him crazy, one fixes the problem by interviewing subject matter experts and visionaries. Another said that interviews with subject matter experts are essential when the users and customers are inaccessible. In general, it appears that interviews are widely used, but primarily to surface new information, or to uncover conflicts or politics.

Team-Building is a second-order elicitation technique in that it does not directly surface requirements. Instead, it is any of a wide variety of synthetic group experiences that help build communication and mutual trust among the stakeholders so that later first-order elicitation techniques become more effective. Four emphasized the need to address the building of teams. Three of these called specifically for team-building exercises prior to conducting any elicitation involving stakeholders whenever the team has not worked together in the past or there is good reason to believe that strong differences of

[4] Many terms are used to represent this concept, or to represent examples of this concept, including joint application development (JAD), brainstorming, group sessions, and so on.

opinions exist. One recommended under the same conditions that face-to-face meetings be conducted in lieu of using technology to support a distributed meeting. There seems to be consensus that effective elicitation requires teamwork, and when not present, team-building exercises are important.

Ethnography. Five out of the nine experts highlighted ethnographic techniques as extremely effective. In particular, three implied that observation of users should always be done when they are available and there is an existing system. Another thought observation is a great way to gather requirements when users are too busy to be involved in interviews, group sessions, or questionnaires. One uses observation to assess political and power relationships when working in new organizations. All in all, many of the analysts seemed to acknowledge that stakeholders should be observed when feasible.

Issues List. Two of the experts emphasized the need to maintain a list of outstanding issues on the side (so that the issues are not forgotten and can be re-surfaced later). Regardless of what technique is being used, new issues are simply appended to the list as they arise. This enables the team to stay focused and not follow the tangent induced by the new issue. One of these recommended that every meeting end with the assignment of open issues to team members. Although only two mentioned issues lists per se, we suspect that most of the analysts actually employ them. We will need more data to verify this.

Models. Eight of the experts mentioned the critical role played by models, such as data flow diagrams (DFD) [10], statecharts [44], or UML [45], in elicitation. Of these, five had favorite models; for example, one always uses time-ordered sequences of events to capture a typical interaction between the system and the systems or people it interfaces with[5], one always uses data flow diagrams, two *usually* used data flow diagrams, and one constructs user role models and task models. All three of the DFD users expressed specific caveats concerning the use of DFDs. One emphasized the need to create the DFD on a white board as the result of collaboration, and felt pretty strongly that the purpose for any model is to help the thought process, not serve as final customer documentation. The other two emphasized the need to build DFDs bottom up based on events as defined by essential systems analysis [46]. Of these last two, one tends to model the current business rules (i.e., the "current model" as defined by classical structured analysis [10]), while the other tends to model the new or proposed system. Three emphasized the need to employ multiple models as a means to better understand customers' problems. Three of the analysts were able to state conditions under which they would use certain approaches. In particular, one said that all models should be built collaboratively when customers or users can be assembled. Another said that he builds a data model, probably ER diagrams [47], for database-intensive applications or systems to be implemented using object-oriented approaches. And the third said he uses data dictionaries whenever there are multiple, diverse, and autonomous stakeholders. Finally, one of the analysts cautioned to use only those models that the stakeholders find palatable. In summary, analysts seem to rely on models in almost every situation. Although historically, modeling was used as *the* elicitation technique, more and more analysts are now seeing modeling as a means to (a) facilitate communication, (b) uncover missing information, (c) organize information gathered from other elicitation techniques, and (d) uncover inconsistencies.

Questionnaires. Surprisingly, very few of the experts mentioned questionnaires or surveys. One limited his use to problems that were fairly concrete. Another focused on market research surveys as an aid in understanding external customer needs.

Data Gathering from Existing Systems. When requirements are being gathered for a new system to replace an existing one, one suggested that "click counts" be collected. Another warned to *not* over-analyze the existing system for fear that the new system will become too constrained. Another suggested performing an "archeological dig." And a fourth recommended meeting with current end users and to do a value analysis. None of the experts appeared to use this as a primary method.

Requirements Categorization. Three of those interviewed used the Volere template [48] as a guide to ensure that all categories of requirements are gathered. Some experts stated opinions concerning other dimensions of requirements categorization. For example, one categorizes requirements as essential, expected and gee-whiz. Another sees management as a threat to success and thus wants to tag requirements that he calls "management fantasies." One feels it is essential to purge the incoming statements of all stakeholder wants, resulting in a list only of needs. Another tries to eliminate symptoms, instead striving for underlying root causes. Two others like to make the system boundary explicit early in elicitation so that all parties know what is within scope and what is not.

Conflict Awareness and Resolution. When conflicts arise within a particular class of stakeholder, one of the experts defers the resolution to a single spokesperson for the class, rather than directly addressing the conflicts himself. Two suggested that before any elicitation is performed, make sure that you understand the power structure, the politics, and the political camps. Perhaps the most insightful, yet radical, idea was spoken by one of the experts who said that if you think you have a project

[5] Many terms are used to represent this concept, or to represent examples of this concept, including use cases, scenarios, stories, stimulus-response sequences, storyboards, and so on.

without conflict, you obviously don't understand the problem; he also points out that the more stakeholders involved, the more conflict will occur.

Prototyping. Only two of the analysts interviewed mentioned prototyping as an elicitation technique. In particular, one suggested that you should not do rapid prototyping unless you really believe it will be rapid. The other suggested prototyping only when there is mutual trust. We had expected more broad reliance on prototyping. Perhaps this is the result of the small sample.

Role Playing. When key stakeholders are inaccessible, one of the analysts recommended the use of surrogates, where non-stakeholders play the role of stakeholders.

Formal Methods. Only one of the analysts mentioned formal methods, and his comment was to never use them during requirements even for safety-critical systems. His reason is that they distance stakeholders from the process. He did however acknowledge their effectiveness in later stages of system development.

Extreme Programming. Extreme Programming [49] calls for little up-front explicit elicitation, and replaces it with an omni-present customer, co-located with the development team, who can answer questions that arise during development. Only one analyst interviewed recommended this approach, and he suggested that it be used when the domain is undergoing enormous and constant flux.

6.2 Normalized responses

In this section we will convey the approaches taken by the experts when presented with four specific situations. These four cases were selected based on the following criteria: (a) should be stated in a relatively vague manner, just like real problems, (b) should be about a problem not a solution, (c) should be such that the solution would likely involve a large software component, but would not necessarily be exclusively software, (d) should have no obvious solutions (when solutions are obvious, the choice of elicitation approach likely makes no difference), (e) should represent a variety of domains, and (f) should be outside the usual domains of most of the experts (otherwise, the expert could simply select whatever technique they "normally" use, without giving it more thought). Obviously, these four cases represent a small sample of the infinite number of possible cases that analysts face, but they sufficiently explore the richness and variety of the approaches taken by the analysts.

In order to hide the identities of the experts, each case's responses were randomized. For the same reason, we have neutralized the terminology, using our common vernacular rather than specific terms used by the experts.

When the experts were presented with the following situations, each made different assumptions about some of the conditions. Furthermore, some described just their first step, while others described two or more steps.

Case 1 Statement: "I am CEO of a large transportation conglomerate. Our constituent companies are in every aspect of transportation including aircraft, trucking, ocean shipping, automobiles and train service. We recently learned that there is a large demand for a new capability – transportation of people from New York to Tokyo in under 30 minutes. You are an expert on analyzing problems. Can you help me better understand how our company can address this need?"

Case 1 Expert Approaches: Six experts analyzed this case. All focused in on the seemingly unrealistic 30-minute goal. Three explicitly addressed the generality of the goal, seeking specific goals and constraints, identifying criteria for success, or defining the business case. The fourth focused on the goal from a reverse perspective, seeking "pain points." The last two implicitly challenged the goal by turning to the market and transportation experts to explore/identify possible solutions and, for the last, analyzing the sensitivity to value. Details of the experts' approaches follow.

A. I would immediately wear my "skeptical hat" and try to learn the constraints and goals. Why 30 minutes? Is 4 hours acceptable? When is it needed? Next year or is 25 years OK? What other similar projects are underway? I guess I'd attempt to create a context diagram (the highest level of a DFD), but I wouldn't have much faith that it would work; after all, what are my "edges?" I suspect I would be on a long journey just to ascertain the project's goals.

B. First I would define the criteria for success; otherwise I will not know if I succeeded. Then I would do brainstorming with all the stakeholders on the question of "Why are we doing this?" Assuming we can justify continuing, I would create a context diagram to make sure we know the system boundaries. Next, I would define all the external constraints such as schedule, budget, and laws of physics. Then I'd solicit proposals from key individuals to learn all the various general approaches to solving this problem.

C. I'd start be asking some general questions like "Why do it?", "What is the customer value?", and "What are the *business* requirements?" Assuming that I received adequate answers, I would work closely with the "project visionary," preferably the executive with the checkbook. To understand the constraints, I would interview subject matter experts. Next, I'd identify all classes of stakeholders. If representatives from each class are willing to participate, I'd conduct a group session; otherwise, I'd do more interviewing.

D. I would start by interviewing a variety of stakeholders. I'd ask them about their "pain points" (i.e., what keeps them awake at night). I would then try to understand the political climate and find the centers of power. I'd collect these centers of power in one group session and elicit scenarios. We would simultaneously work on the

product architecture. I would also maintain a "risk list" of the biggest pending problems. As we proceed, we all would watch for architectural patterns, especially those that fill a gap between users and the system.

E. I would start by bringing in experts in each type of transportation system. I'd have a group session with all of them to explore possibilities.

F. Since technology needs to be found to do this, I would first find existing sources. Then, I'd focus on identifying the underlying requirements and performing a value analysis to assess the sensitivity to value.

Case 2 Statement: "I am mayor of a large city. I do not want us to be the victim of the next terrorist act. You are an expert on analyzing problems and defining solutions. How would you help me meet this challenge?"

Case 2 Expert Approaches: Four experts analyzed this case. A fifth turned down this 'job' as outside his area of expertise. The open-ended nature of this case led to several different starting points. One expert focused on refining the problem to contain the area of investigation, while two sought a clearer definition of the problem through identification of customers or stakeholders. Two recognized the critical role of the terrorist in this case, and recommended role-playing or war gaming to try to include the terrorists' perspectives. Details of the experts' approaches follow.

A. This is a very political problem. I'd start by trying to pin down the mayor by asking, "Why are you doing this?" "What are your goals?" From this, I could sketch out investigative boundaries. If the mayor vacillates, I would find out who else is involved and talk with them. My primary goal in the early phases is to contain the problem. If we don't have a well-defined problem, we'll just waste a lot of money.

B. I would first need to understand who the customer is (e.g., federal agencies, United Nations, the city) and what resources are available. I would also want to understand why the stakeholders believe such a system is needed and how quickly. This situation is more abstract than most problems I deal with regularly.

C. I would start by identifying all the stakeholders. The most essential stakeholder is the terrorist. Since direct participation by terrorists is not a good idea, I'd form a group of people paid to think like terrorists to work with representatives from the police, fire department, financial centers, etc., to brainstorm likely attacks.

D. I would create a war game in which individuals playing terrorists and defenders compete. This will get people out of linear-thinking mode and replace it with emotion. This will help us better uncover system dynamics, learn subtle feedback delays, and assess the degree of potential loss. I would do all of this because both the problem and the solutions are so ill-defined. In such a case, I could not do what comes natural for me, i.e., define the actors and events.

Case 3 Statement: "I am an architect of innovative buildings. I have just completed the detailed design of an office building to be built on the side of a mountain. The floors follow the contour of the steep building site, so that each floor only partially overlaps the floor below it. The only thing left to design is the elevator system to move people between floors. How would you help me define the requirements for this elevator?"

Case 3 Expert Approaches: Four experts described their approaches to this problem. The first objected to the assumption that the right solution, i.e., an elevator, was even known. The other 3 analysts focused on modeling the situation using scenarios, workflow diagrams, or features. In all three cases, they were clearly trying to understand how the occupants use the building.

A. I think it is too early to assume it will be an elevator. We must understand priorities, safety, schedule, resources, and parameters. I would keep the discussion at the more abstract level so we could arrive at an optimal solution, maybe not an elevator at all.

B. I'd start by identifying all the elevator usage scenarios, i.e., find out how people will use the building.

C. Analysts would study the current physical model (the building's design). Then I would try to learn about the tenants and create a workflow or traffic flow diagram to understand how people move between floors. I would not use my standard approach of constructing a DFD. I would talk with geologists and the building owner to get a list of viable solutions. I might suggest rearranging tenants to make the problem easier. What I am trying to do is understand the constraints, and what I can and cannot alter in the building's design.

D. This is a nice concrete problem. So, I'd start by learning about who would use the elevator. I would bring them together in a group session to discuss desired features, and then desired attributes. I also need to know more details (e.g., the grade angle/variability; if there is any recreational value for the system; whether it would be used only by people, for freight, or by cars; what building codes apply). I would then insist that the customer sign our document of understanding.

Case 4 Statement: "I am the registrar for a major university. Every semester, students complain because the student information system has denied the request to enroll in classes they had wanted to enroll in. However, we also seem to have many empty seats in the classrooms. Clearly, our student information system needs to be rebuilt. Can you help me?"

Case 4 Expert Approaches: Three experts analyzed this situation. The first two questioned whether the 'system' was really the problem at all. The third selected ethnographic techniques to learn the problems users were experiencing with the system. Interestingly, this was the expert who stated "I doubt we really know that the elevator is the solution" in the previous case.

A. The first thing I want to discover is whether the problem really is the information system. There are many other possible reasons for the empty seats.
B. I would look at historic patterns of data. Just what is the problem? Perhaps it is just a scheduling issue. We need to be aware that the solution may not lie in technology at all. For example, perhaps the university is using bad times, bad teachers, or bad rooms.
C. I'd interview and observe current users, perhaps videotape them, and collect "click statistics" to see what functions are performed most often. The analyst would also try to use the system looking for usability problems. Once these are located, I'd decide to either redesign the system or try to just fix it.

6.3 Other useful information

In this section, we report on other useful information gathered from the experts, including additional situational characteristics that they would consider when selecting an elicitation technique, and other general advice.

Situational Characteristics. Some of the experts offered specific conditions under which they would use certain techniques. For example,

- One expert recommended war-gaming when we have time and any of the following is true: the situation is emotional, there exists a risk of large loss, the problem is ill defined, or we don't know the actors or events.
- When there is little confidence that the developers understand the user needs, one expert suggested iterating toward a solution. When there is lack of trust in the developers, the expert suggested buying or licensing the solution rather than building it.
- The analyst's background, skills, and preferences may be a factor, but should never take priority over the needs of stakeholders.

General Advice. Some experts offered general advice:

- Several experts highlighted the need to identify users and other stakeholders first, and then to find a spokesperson for each. Others reflected sometimes contradictory views about the analyst's relationship to stakeholders stating: Analysts should always ask, not tell; Don't trust marketing personnel, always learn requirements yourself; Always work closely with people who have the checkbook; and Users are more important than the paying customers. Another emphasized that the analyst must demand that stakeholders define terms to ensure that different stakeholders are not using the same term for different purposes. Finally, one expert stated that you must remove toxic players from the process.
- Experts also discussed their recommended sequence of information discovery. One recommended that analysts find out users, features, and then attributes of the system, while two others recommended stakeholders, constraints, assumptions, and then scope of the system. Another emphasized that you should always understand and document the business case and quantify it financially prior to eliciting requirements.
- Finally, from a format/presentation perspective, one expert declared: Don't attempt to document requirements as a long list of shalls.

7. Discussion

Overall, the expert interviews resulted in an extremely rich source of information about requirements elicitation and technique selection. The structure and flow of the interviews also provided information, since they were a form of elicitation as well. For example, when asked how they performed elicitation, many of the experts told stories about their elicitation projects. This demonstrates the power of stories (i.e., scenarios, use cases) in elicitation. However, it is also interesting to note, that the stories the experts chose to tell us described their standard, default elicitation approach. While this may have been a result of our specific question, it may also be an indicator that individuals tend to choose common stories and must be prompted for exceptions. In our interviews, experts showed the most diversity when presented with the normalizing situations (see section 6.2). Finally, while the focus of our research is on technique selection, the experts were just as likely to describe the information they were seeking as the specific technique they would use. From this we can conclude that elicitation technique selection is not only a function of situational characteristics, but is also a function of what information (requirements) is still needed [31].

The research reported herein has some limitations:

- These interviews of nine experts may not (a) be representative of all expert analysts, (b) capture all their expertise or (c) provide sufficient coverage of all situations and techniques. We have not reached "theoretical saturation" [39] where we have learned all we need, so are planning additional interviews.
- Although we are both very experienced interviewers, our style of interviewing and previous experience may have biased the responses given by the subjects. We have tried to limit this bias through use of the interview protocol [41], delaying hypotheses formulation until after the interviews [37, 39], and following research-based interviewing guidelines [40].
- Like less experienced analysts, expert analysts may simply select the technique they are most comfortable with (one actually admitted this to us), and do not either consciously or subconsciously *select* a technique from the large set of available techniques. However, given the variety of approaches described by each of the experts, our conclusion is that while they may have a default approach, they do adapt that approach to the

situation if necessary. This became evident during the normalizing cases where we took many of the analysts out of the domains they were most familiar with.

- A difference may exist between what these experts *say* they do, and what they actually *do*. The best way to check this is to observe the experts doing elicitation rather than just asking them what they would do.

The study reported in this article represents early results of a larger research effort. Plans are underway to extend these interviews to many more experts in the field. Because of the preeminence of the nine analysts interviewed, we felt it important to report their unique and insightful comments. Other research that can be performed based on this paper includes:

- Integrate the results of these interviews with the results extracted from the other two sources of information as described in Section 4, i.e., our own experiences and the results of our document analyses.
- More fully understand the full range of situational characteristics that could affect technique selection. This work has begun [51].
- Create a more complete faceted classification of elicitation techniques. This work has also begun [51].
- Pivot the results reported in this paper, i.e., rather than discuss the conditions necessary to drive an elicitation technique, we need to discuss the technique alternatives that make sense under sets of conditions.
- Creation of a tool that uses the knowledge of the experts to map situational characteristics into the set of appropriate elicitation techniques.

8. Summary & Conclusions

Even though we have interviewed only a small sample of experts, some general trends are appearing. When analyzing the trends, new theories of elicitation technique selection, grounded in the data [37, 39], began to emerge:

- For each elicitation technique, there exists a specific, unique, small set of predicates concerning situational characteristics that drive experts to seriously consider that technique. We call these "Major Drivers." For driving a car, an example is a green light. For collaborative sessions, the major drivers are multiple stakeholders, disparate needs, and a demand to reach consensus before proceeding.
- For each elicitation technique, there exists a set of additional predicates which if true cause experts to alter their primary choice. We call these "Anomalies." For driving a car, this includes an ambulance in the intersection. For collaborative sessions, the anomalies include stakeholders who cannot know of each other's existence, geographical distribution of stakeholders or no suitable venue (and no distributed meeting technology available), and not enough time to adequately prepare for the session.
- For each elicitation technique, there exists a set of basic analyst skills that must be present or the technique will not be effective. We call these skills "Prerequisite Skills." For driving a car, these include the ability to press the accelerator and brake pedals. For collaborative sessions, they include communication, leadership, and the ability to facilitate meetings.
- For each elicitation technique, there exists a set of additional skills that are not universally needed, but that come into play during the technique's execution without pre-knowledge. We call these skills "Success Enhancers." For driving a car, this includes defensive driving. For collaborative sessions, these include modeling, conflict resolution, and creativity skills.

In addition, we believe that we can tentatively reach these conclusions about the use of modeling in conjunction with elicitation techniques:

- Creation of models (perhaps multiple models) seems to aid analysts in fully comprehending a situation and in communicating with stakeholders. Almost all the experts use them.
- For the experts (but probably not for most analysts), selecting a modeling notation that they are most comfortable with appears to be a good choice, but that notation must be palatable to the users.
- Many experts assess early the immediate gaps in knowledge among the stakeholders, and deliberately direct the elicitation in the direction of achieving these intermediate goals. Examples might include particular non-behavioral requirements, user interface, and database contents. This often drives the expert analyst toward specific modeling notations to supplement the elicitation technique.

To summarize, while the state of our research has not allowed us to reach definitive conclusions on all situations and techniques, this paper is an important contribution to understanding the techniques that experts use during elicitation and the situational factors they consider when choosing those techniques. Future research will allow us extend these conclusions to a wider range of experts, techniques and situations, provide specific guidance to practicing analysts, and ultimately improve the state of the practice in requirements elicitation.

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