

**WHEN IS ANALYSIS SUFFICIENT?
A STUDY OF HOW PROFESSIONAL INTELLIGENCE ANALYSTS JUDGE RIGOR**

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ABSTRACT

The proliferation of data accessibility has exacerbated the risk of shallowness in information analysis, making it increasingly difficult to tell when analysis is sufficient for making decisions or changing plans, even as it becomes increasingly easy to find seemingly relevant data. In addressing the risk of shallow analysis, the concept of rigor emerges as an approach for coping with this fundamental uncertainty—motivating the need to better define and understand analytical rigor. The concept of rigor is explored in this thesis through a study that asks how professional analysts decide when there is sufficient rigor in an analytic process. Nine professional intelligence analysts participated in a scenario walkthrough in which they critiqued the analysis processes of two junior analysts—one representing a high-rigor analysis process and the other a low-rigor process. In the study, participants assumed the role of analyst supervisor, deciding if these analyses were of sufficient rigor to send to a decision maker—a fundamental judgment task characterized as the Supervisor's Dilemma. This study design validated and refined the Elicitation by Critiquing methodology, also developing the Liquified Natural Gas Scenario, based on security issues that challenge safety analyses, as a cognitive case for exploring themes in information analysis. This research identified three general findings on rigor in information analysis. First, it found that process insight influenced judgments of rigor. Second, it found that while similar cues were used in forming assessments of rigor, the way in which those cues were interpreted as indicating rigor tended to be more varied. Third, the results of the study suggest a revised definition of analytical rigor, reframing it as an emergent multi-attribute measure of sufficiency rather than as a measure of process deviation. This expanded understanding of rigor serves as an analytic broadening check to be leveraged against the risk of shallow analysis.

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INTRODUCTION

Connectivity... is pervasive. Access... abundant. And more people now have available at their proverbial fingertips more data, in more varied forms, than ever before. Paradoxically, no matter how much data availability technology affords us, it still requires a person to transform that data into information... to give it meaning (Woods, Patterson, & Roth, 2002).

Presumably, someone somewhere is doing just that at this very moment—turning data into information. These people are *information analysts*. A broad term, information analyst describes a wide array of people performing an even wider array of tasks. In fact, given the access that the proliferation of technology affords us, most all of us qualify as information analysts by this definition at one time or another.

And indeed, we all are. From the middle school student browsing the internet on a home computer, doing research for a book report; to the recent graduate thumbing through auto magazines at the local library, preparing for the purchase of a new car; to the busy parent contacting family, friends, and local travel agents, looking to identify an affordable, yet fun-for-all-ages destination at which to spend an upcoming family vacation—these people are unified in that they are engaged in a process of collecting data and aggregating it into something of value. This is the process of *information analysis*.

There is another important commonality that spans across these instances of analysis—and that is the risk of being too shallow. The risk of shallow analysis describes the possibility, inherent in all information analysis processes, that an analysis is of inadequate depth relative to the demands of the situation—the student, for example, who searches only for "Vikings" and subsequently hands in a World History report asserting that the Vikings were from Minnesota (and technically they are, but only if one is interested in the National Football League team, rather than the seafaring Scandinavians—which the student's teacher most probably is not). The risk, then, is of being insufficiently rigorous in analysis—a better understanding of analytic rigor, in turn, representing an approach to cope with this potential risk. As revealed by the Vikings example, the proliferation of data availability and connectivity has exacerbated the risk of shallowness, as analysis tools that were once confined to the domain of experts are now wielded by neophyte information analysts abound.

The expanded access to data has impacted more than the casual information analyst. This thesis examines a different set of analysts—those who perform information analysis not to pursue personal goals, but to support another person or group in the pursuit of their goals. These are the *professional* information analysts. In the professional analysis domain, the cognitive work of information analysis and its complement of decision making are often partitioned across individuals. Thus, the professional information analyst acts, at least in part, on behalf of another stakeholder—typified as the decision maker. By this definition,

significantly fewer of us qualify as information analysts, though some still do—the broker checking into the financial history of an investment opportunity on behalf of investors, the marketing researcher assembling an analysis of a competitor's new products for a corporate executive, and the military analyst preparing a report of enemy troop movements to brief to a commanding officer, to name but a few.

What makes professional information analysis interesting to study is also part of what makes it difficult—it is fundamentally a coordinated joint activity. Because multiple stakeholders share an interest in the process, there are requisite aspects of coordination and communication that are not necessarily required of other forms of analysis. It is from these necessary collaborative interactions that many novel challenges to the information analysis process emerge—challenges for which there are few, if any, easy solutions. These challenges can be addressed, however, through the recognition of the critical connection between the professional analysts who perform information analysis work and the decision makers who use information analysis products to support decision-making.

In addition to acting on behalf of another party, there are other aspects that separate these cases of professional information analysis from those general cases previously mentioned. In all instances of analysis, the risk of shallowness is fundamental—for both the middle school student and the marketing researcher, to be shallow is to chance a failure of the analysis process. However, when analysis is performed professionally, the stakes are almost always substantially higher.

In the former information analysis cases, unacceptably shallow analysis leads to very real but, relatively speaking, not very serious outcomes—the student has to rewrite the book report, the car buyer ends up with a lemon, and the family arrives at their hotel only to find that it looks nothing like it did in the travel agent's brochure. In contrast, to fail in professional information analysis is to risk significant adverse events—investors go bankrupt because of poor investment advice or, in the more consequential case, soldiers die because of inaccurate tactical intelligence reports. In professional analysis, the consequences resulting from insufficiently rigorous analysis are often both very real and very serious. Thus, the understanding of rigor emerges again as even more valuable in confronting the risk of shallowness, further motivating the need to better define and understand the concept.

Another, more subtle trait of professional information analysis is that, although seldom performed exclusively to fulfill a goal of the analyst, it is, however, done with a specific purpose. Most often, this class of information analysis is performed with the purpose of generating information to influence a decision or action in the world—the corporate executive, for example, may adjust the company's research and development priorities to keep pace with a rival firm's newly released technologies.

The corollary to this trait, also a distinct aspect of professional information analysis, is that analysts are necessarily collecting evidence from a data space that is shaped by other decision influencing agents. That is, given that an analyst is collecting information with the expressed purpose of influencing a decision maker, there are invariably other agents who have both the ability and the desire to influence an analyst's data sources, with the intent of influencing the decision maker by proxy. In its mildest form, a professional analyst must be cognizant of the potential for bias in data sources. Taken to an extreme, active deception

may be used by some agents to mask adversarial intentions and distort the data that is available for an information analyst to collect and synthesize.

As in other forms of research, professional information analysis also tends to be a hypothesis-driven activity. That is, analysts endeavor to collect and use data to generate and verify—or, perhaps more appropriately, falsify—hypotheses that explain the data. However, unlike in many other research domains, information analysts are often limited in their ability to control and vary the conditions under which their data are generated. Both organizational and practical factors typically contribute to limit the authority and ability of analysts to experimentally test hypotheses through the direct manipulation of the world of interest. Rather, they collect data that is most often generated through the dynamics of real-world interactions and strive to make sense of it—a fourth attribute of the process of professional information analysis.

And so the originally proposed definition of information analysis has been somewhat refined, as four characteristics were identified that differentiate professional information analysis—hereinafter referred to simply as information analysis—from other more general forms. These traits include the conditions that information analysis is (1) performed in support of goals that extend beyond those of the analyst, (2) occurring in a professional context where the consequences of shallow analysis are substantial, (3) done to influence a decision or action in a world where other agents are also trying to influence that same decision or action, and (4) completed with limited ability to directly manipulate the world of interest in building and testing hypotheses as possible explanations for data.

In this revised framing of information analysis, the risk of shallow analysis is even greater—in part because of the changing technological landscape of the professional analyst, but also in part because the cognitive work of information analysis is partitioned across analysts and decision makers. Consequently, in information analysis it is often difficult for both analysts and decision makers to detect shallow analysis. In addressing the risk of shallow analysis, the understanding of the concept of rigor emerges as an approach for coping with this fundamental uncertainty. Through a study of professional information analysts, this thesis examines the question of whether providing insight into an analysis, by revealing the rigor of the analytic process, is a promising approach for supporting success in information analysis. section

Section 1 presents the background of the concept of rigor, exploring how it is conventionally defined in information analysis. Additionally, the section briefly touches upon the history of the concept, as this research into rigor is motivated by a case of analysis-based decision making where critical decisions were made based on analysis products perceived as being rigorous, but that were in actuality produced by processes of very low rigor. In this case, the misperceptions contributed to a catastrophic, loss-of-life outcome. This influential case frames how the concept of rigor is commonly understood as being meaningful in analysis contexts.

Section 2 discusses the domain of intelligence analysis as a natural laboratory for the study of rigor in information analysis. While there are many domains that offer potential settings for researching rigor, this thesis presents findings from a study of rigor in intelligence analysis—a distinct, but arguably representative, instance of information analysis. This

section also identifies the two basic research questions that motivate the study, which focus on the influences of process insight and the cues used in inferring rigor. In the context of this thesis, process insight refers to making observable the analytic process behind an analysis product.

Section 3 describes a research study in which intelligence analysts participated in an exploration asking how professional analysts decide when there is sufficient rigor in an analytic process. Specifically, the study explored the role of process insight in influencing perceptions of rigor. In addition, it explored the cues that identify analytic rigor, or lack of rigor, investigating the challenges that inhibit the understanding of rigor in intelligence analysis. The study used an innovative approach, based on formal knowledge elicitation methodologies, to tap into the domain expertise of the professional intelligence analyst.

Nine professional analysts participated in a scenario walkthrough in which they critiqued the analysis processes—one representing high-rigor analysis and one a low-rigor analysis—of two junior analysts. These analysis processes were developed in the context of a researcher-created information analysis scenario, based on actual events, that incorporated aspects of energy, siting, safety, and security in the case. In the study, participants assumed the role of analyst supervisor facing the decision of whether or not to invest additional resources into the analytic processes of the junior analysts, by deciding if the analyses were too shallow or if they were of sufficient rigor to send forward to a decision maker—a decision characterized within this study as the Supervisor's Dilemma. The results of the research study are also reported in the section, presented in relation to the prompts embedded in the study that elicited feedback from participants about how the concept of rigor is embedded in the domain of intelligence analysis.

Section 4 discusses the contributions of this research effort, describing their implications in relation specifically to intelligence analysis specifically as well as to the broader context of information analysis. The study produced valuable contributions both in its methodology and in its results. In method, the study design both validated and refined the Elicitation by Critiquing approach in that it yielded participant insights that extended beyond surface-level practitioner observations of the nature of their work. Additionally, the study developed the Supervisor's Dilemma as a means for highlighting the interface between analysis and replanning decisions, developing the Liquefied Natural Gas (LNG) Scenario as a cognitive test bed for exploring the critical themes of information analysis.

The results of the study identified two general findings that serve to expand the understanding of rigor in information analysis. First, it was found that process insight influences judgments of rigor. Second, it was found that similar cues are used by analysts in forming assessments of rigor, although the way in which those cues are interpreted as indicating rigor tend to be more varied. The most surprising finding, however, was that only one of the nine participants viewed either scenario-based analysis as being of sufficient rigor to send forward. This finding challenged the conventional definition of rigor, leading to a proposed reconceptualization of a meaningful definition of rigor in information analysis. Finally, this section discusses the varied perspectives on rigor in the intelligence community, identifying future directions for the continued exploration of the concept of rigor in information analysis.

1. ON THE UNDERSTANDING OF RIGOR

In information analysis domains, rigor describes the quality of an analytic process. There is, however, some debate surrounding what it means to be rigorous in the analysis process. This section attempts to establish a meaningful, operational definition for analytic rigor within this context. Additionally, a brief history of the emergence and evolution of the concept of rigor is presented.

1.1 Defining Rigor

Formally defined, rigor is the quality of being strict and inflexible (Merriam-Webster's Collegiate Dictionary, 2003; McKean, 2005). When applied, rigor is often used to describe process. In information analysis, rigor—or analytical rigor—reflects an assessment of process quality, affording communication about the process, rather than the product, of analysis. One cooperative effort to identify a generic definition of analytical rigor describes it as the "application of precise and exacting standards... to better understand and draw conclusions... based on careful consideration or investigation" (Military Operations Research Society, 2006). In this view, to be rigorous in analysis requires only the meticulous adherence to standard process.

This colloquial perspective, however, mischaracterizes the understanding of rigor in information analysis. Despite the etymological implication that to be rigorous is to "be stiff" expert information analysis processes often are not rigid in their application of a standard process, but rather, flexible and adaptive to highly dynamic environments (Merriam-Webster's Collegiate Dictionary, 2003; McKean, 2005). In information analysis, judgement of rigor reflects a relationship in the appropriateness of fit between analytic processes and contextual requirements. Thus, as supported by the research presented in this thesis, rigor is more meaningfully viewed as an assessment of degree of sufficiency, rather than degree of adherence to an established analytic procedure.

This debate about what it means to be rigorous in analysis does not lessen the important role of understanding rigor. Rather, it shapes the perspective taken in exploring the understanding of rigor in information analysis.

1.2 A Brief History of Rigor

The research on rigor in information analysis began in engineering safety analysis, where significant and high-profile "failures" made salient the criticality of understanding analytic rigor. At NASA, following the Columbia accident, post-accident investigation reports revealed that managers were unaware they were making decisions based on analyses that

appeared thorough, but were in fact of very low rigor (Columbia Accident Investigation Board, 2003; Crippen, et al., 2005; Woods, 2005).

Prior to the foam strike event that ultimately fated the STS-107 mission, some NASA engineers and managers were concerned about the uncertain risk associated with the recognized problem of foam loss from the shuttle's External Tank. However, the understanding of this problem was not validated by rigorous engineering analyses, and past successes became the basis for justifying future flights. As described in the Columbia Accident Investigation Board (2003) report:

With each successful landing, it appears that NASA engineers and managers increasingly regarded the foam-shedding as inevitable, and as either unlikely to jeopardize safety or simply an acceptable risk...NASA and contractor personnel came to view foam strikes not as a safety of flight issue, but rather a simple maintenance, or "turnaround" issue...

What was originally considered a serious threat to the Orbiter came to be treated as... a reportable problem that was within the known experience base, was believed to be understood, and was not regarded as a safety-of-flight issue... [However,] assessments of foam-shedding and strikes were not thoroughly substantiated by engineering analysis.

Moreover, as reports addressing the foam loss events progressed through the organization, decision makers increasingly failed to realize—in light of increasing pressures to remain on schedule—that the processes behind these analyses, and thus the bases for their decisions, were insufficiently rigorous relative to the safety-critical questions being asked and the potential consequences of the decisions being made.

It is in this context that a definition of rigor as "the scrupulous adherence to established standards for the conduct of work" emerges (Crippen, et al., 2005). However, as noted earlier, this definition of rigor is also insufficient in much the same way that an error-as-deviation from standards definition of "human error" in safety analysis is inadequate: "defining error-as-deviation from a model of 'good' process... collides with the problem of multiple standards" (Woods & Cook, 2003). The "problem of multiple standards" describes the inherent difficulties in selecting which, among many viable candidates, is *the* standard process to which performance should be compared. In information analysis—intelligence analysis, especially—it is pragmatically even more challenging to define standard process.

The standards-based perspective on rigor is also insufficient in that it fails to consider the influence of time pressure on analytic rigor. As dictated by the speed-accuracy trade-off, the amount of time available to perform an analysis will have a direct impact on its quality (Wickens & Hollands, 2000). Thus, assessing the rigor of an analysis product requires some consideration of the constraints under which it was produced. This finding, in conjunction with the recognized importance of understanding the level of rigor demanded for a particular decision, reframes rigor more meaningfully as a measure of sufficiency, rather than as a measure of deviation.

Engineering safety analysis is not the only domain where understanding the role of judgments about the rigor of analyses is recognized as important. In the physical sciences, the significance of rigor is embodied in the canonical "scientific method" of

experimentation. As noted by Davies and Dodd (2002), "rigor is the authoritative evaluation of good research and the unspoken standard by which all research is measured." In the social sciences—although the definition of what constitutes rigor is a bit murkier—the appreciation of the importance of rigorous process remains.

It is also recognized, in various manifestations, that poor representation hides and obscures the process being represented. Thus, rigor represents a mechanism for revealing the observability of an analysis process (Woods, Patterson, & Roth, 2002). In the design literature, Tufte (2003) is especially critical of the influence of slide-based presentations on the understanding of analytical process. Microsoft PowerPoint in particular, he argues, encourages the acceptance of unacceptably low-rigor analyses. At the root of his criticism is this same observation—that the form of an analysis product can hide the process behind it. This finding is extended through the acknowledgment that all forms of analytic products, to some extent, obscure the processes that produced them—an insightful perspective that guides the exploration of rigor in information analysis.

2. RESEARCHING RIGOR IN INFORMATION ANALYSIS

This work serves to expand the understanding of rigor in information analysis by studying it in the domain of professional intelligence analysis. This section describes the context of intelligence analysis as a natural laboratory for studying the concept of rigor. Additionally, this section identifies the specific research questions that guided the exploration of rigor.

2.1 Intelligence Analysis as Information Analysis

In the introduction, information analysis—as a manifestation of abductive reasoning (Josephson & Josephson, 1994)—is defined loosely as a form of cognitive work that involves the collection and assessment of data with the goal of verifying or refuting hypotheses which explain that data (Elm, et. al., 2005). Information analysis is more than just explanation building and testing, however, as it is performed to support high-consequence decision-making in domains where the events to be explained or the projections of how events will develop may not be testable in the same way as one would in classic experiments. Intelligence analysis—in particular strategic, rather than tactical or operational intelligence—provides a representative natural laboratory for refining the understanding of rigor in information analysis.

Intelligence analysis, as a form of abduction (Schum, 1987), is a special case of information analysis. While it shares the previously noted features with most other information analysis, it is confounded by the added challenges of necessary secrecy and adversarial intent—as decision influencing agents operating within this context employ deception as the extreme form of decision influencing factor. Similar to the above definition of information analysis, Johnson (2005) defines intelligence analysis as "the application of individual and collective cognitive methods to weigh data and test hypotheses within a secret socio-cultural context." This characterization partially overlaps with the model proposed by Elm, et al. (2005), which frames intelligence analysis as an interaction of the three primary functions of Down Collect of relevant data, construction of interpretations of the data through Conflict and Corroboration, and building explanations for those interpretations through Hypothesis Exploration.

In the interest of clarity, it should be noted that there are three senses in which the term "intelligence analysis" or, more simply, "intelligence" is colloquially used (Kent, 1966). Most commonly, intelligence analysis describes the process of analysis. However, the term can also be used in reference to the product of an analysis process, for example, in reference to an intelligence briefing report. By this definition, an intelligence analysis processes produce intelligence analysis products. Less frequently, intelligence analysis describes the broader analysis process of the intelligence community—a cycle traditionally including collection, processing, analysis, dissemination, and planning (Doctrine for Intelligence Support to Joint

Operations, 2000; Johnson, 2005). In this framing, intelligence analysis is a component of the intelligence cycle.

In the context of this work, every effort is made to use the term "intelligence analysis" only the first sense—in reference to the actual process of analysis. Consequently, intelligence analysis products are referred to as intelligence reports or intelligence briefings. And, in keeping with convention, broader analysis-related interactions within the intelligence community are referred to as the intelligence cycle, rather than as intelligence analysis.

Intelligence analysis is a particularly interesting domain for studying rigor because, in view of the consequences of failure, recent high-profile events have prompted many to question the present state of the U.S. intelligence community (National Commission on Terrorist Attacks, 2004; Duelfer, 2004; Hammond, 2004; Johnson, 2005). In the ensuing debates, it has become apparent that changes in technology and in the international political landscape, among other influences, have transformed—and continue to transform—the role of the professional analyst (Medina, 2002; Ward, 2002). In response, there is a renewed effort to better understand the factors that impact the performance of intelligence analysts.

Table 1 shows a number of different perspectives in the intelligence literature aimed at characterizing the challenges and vulnerabilities that influence the performance of intelligence analysts. Note that, although the order in which the challenges are listed in each row is somewhat arbitrary, the order of the columns are not. On one end of the spectrum, researchers such as Krizan (1999) and Heuer (1999) focus on identifying the misperceptions and biases that degrade the performance of the individual analyst, while some, such as Johnson (2005), focus on understanding the situational and organizational factors that hinder the collective performance of professional analysts. Others have taken a more moderate position, recognizing that both types of factors play a role in determining analytic performance (Hutchins, Pirolli, & Card, 2006; Trent, Patterson, & Woods, in press).

Another perspective in addressing the challenges of intelligence analysis focuses not on the cognitive biases or situational attributes that impact behavior, but on the interactions among agents who support the intelligence analysis process—most notably, the interaction between analysts and decision makers. In the face of significant production pressures (Johnson, 2005) and rapidly proliferating data availability (Patterson, Roth, & Woods, 2001)—and resulting data overload deluging the professional analyst—it is increasingly easy for analysts to be trapped by shallow, low-rigor analysis. Given similar pressures, it is also increasingly difficult for decision makers to recognize when an analysis is not of sufficient rigor for a given decision. Thus, it is increasingly clear that analytical rigor is a relevant concept within the intelligence analysis community, contributing to its appropriateness as a valid context for exploring the broader theme of rigor in information analysis. In the context of this work, the exploration of the concept of rigor is guided by the specific research questions defined in the following section.

Krizan ^a	Heuer ^b	Trent, et al. ^c	Hutchins, et al. ^d	Johnson ^e
Prematurely Formed Views	The Vividness Criterion	Inappropriate Mental Set	High Cognitive Workload	Secrecy versus Efficacy Tradeoff
Willful Disregard of New Evidence	Absence of Evidence	Environmental Pressure	Potential for Error	Focus on Current Production
Lack of Empathy	Base-Rate Fallacy	Fixation	Time Pressure	Time Constraints
Ethnocentrism & Mirror-Imaging	Oversensitivity to Consistency	Recognition of Relevant Data	Coping with Uncertainty	Confirmation Bias, Norms, and Taboos
Ignorance	Anchoring	Trust	Data Overload	Analytic Identity
Rational-Actor Hypothesis or Denial of Rationality	Assessing Probability of a Scenario	Experience viewed as Expertise	Synthesizing Multiple Sources of Information	Production-based Rewards and Incentives
Proportionality Bias	Availability Rule	Learning	Insufficient Tools	Analytic Training
Defensive Avoidance & Wishful Thinking	Similarity of Cause and Effect	Tool Understanding	Organizational Context	Perception of "Tradecraft" Versus Scientific Methodology
Conservatism in Probability Estimation	Internal vs. External Causes of Behavior	Sustained Attention	Complex Human Judgments	
Presumption that Support for One Hypothesis Disconfirms Others	Persistence of Impressions Based on Discredited Evidence			
Best-Case Analysis or Worst-Case Analysis	Overestimating Our Own Importance			
Image and Self-Image	Illusory Correlation			
Overconfidence in Subjective Estimates	Expression of Uncertainty			
Inappropriate Analogies & Superficial Lessons from History	Bias Favoring Perception of Centralized Direction			
Evoked-Set Reasoning	Coping with Evidence of Uncertain Accuracy			
Excessive Secrecy				
Presumption of Unitary Action by Organizations & Organizational Parochialism	Bias in Favor of Causal Explanations			

Note. ^aAdapted from *Intelligence Essentials for Everyone* by L. Krizan, 1999. ^bAdapted from *Psychology of Intelligence Analysis*, by R. J. Heuer, 1999. ^cAdapted from "Challenges for Cognition in Intelligence Analysis," S. A. Trent, et al., in press, *Journal of Cognitive Engineering and Decision Making*. ^dAdapted from "What Makes Intelligence Analysis Difficult? A Cognitive Task Analysis of Intelligence Analysts," S. G. Hutchins, et al., 2006, in P. L. Piroli (Ed.) *Assisting People to Become Independent Learners in the Analysis of Intelligence*. ^eAdapted from *Analytic Culture in the US Intelligence Community: An Ethnographic Study*, by R. Johnson, 2005.

Table 1. Intelligence Analysis Challenges and Vulnerabilities

2.2 Research Question

The overarching purpose of the research presented in this thesis is to refine the understanding of rigor by exploring the role that the concept of rigor plays in information analysis. As noted previously, a better understanding of rigor can be leveraged against the ever-present risk of being too shallow in information analysis.

The primary research question addressed by this thesis is: *How does insight into the analysis process influence judgement of rigor?* Additionally, this thesis investigates the related, secondary research question: *What cues do analysts use in making assessments of rigor?*

These research questions are explored through a study of rigor in professional intelligence analysis, which provided the context for the study of rigor in information analysis more broadly. This research study, discussed in the next section, yielded valuable contributions both in method and in findings.

3. A STUDY OF THE PROFESSIONAL INTELLIGENCE ANALYST

To address the primary research questions, a study of the professional analyst was undertaken to explore how the concept of rigor resonated within the domain of intelligence analysis. Rather than resolving the question of precisely what does or does not qualify as rigorous analysis, this research studied how rigor is understood within the intelligence analysis domain. In developing the study method, the LNG Scenario defined the context while the Supervisor's Dilemma shaped the methodology. The first four sections of this section discuss the method of study and include a description of the participants, the development of the study LNG Scenario, the background of the Supervisor's Dilemma, and the scenario walkthrough procedure. The final two sections discuss the results of the study, describing how the data were analyzed and identifying the major findings that emerged from the research.

3.1 Participants

Nine professional intelligence analysts (P0–P8) participated in the study, consisting of eight primary participants and one pilot participant. The pilot participant (P0) was distinct from the primary participants (P1–P8) in that he represented a different intelligence organization than the other eight. Additionally, minor adjustments were made to the verbal protocol used in the study based on feedback from this participant. However, as no significant changes were made to the study—and all core components remaining constant across all participants—the results of the pilot study participant are not treated as distinct from those of the other participants.

The analysts selected for the study were volunteers who responded to an IRB-approved, e-mail recruitment request for participants made via a contact at a cooperating intelligence organization. All analysts who volunteered were accepted, although one potential study participant was turned away due to scheduling confusion which resulted in two analysts arriving for the same study session. This analyst was unable to be rescheduled. No compensation was provided for participation in this research.

For reasons of confidentiality, limited personal and demographic information was collected from study participants. Formally, only two types of information were requested: years of experience and familiarity with the scenario topic. The study included analysts with a broad range of professional experience (*Median* = 20 years, *Mean* = 21 years, *SD* = 10 years), from junior analyst with less than three years of experience to senior analyst with over forty years of experience. Note that one novice analyst was recruited to participate in the study in order to provide a mechanism for gauging the role of domain expertise in assessing rigor. Regarding familiarity with the scenario, formally defined in the next section, none of the participants indicated that they had any notable prior professional or personal experience

with the topic. As per the IRB-approved procedure, only verbal consent of participation was collected from participants in order to ensure protection of their identities.

Informally, some descriptive information about participants was revealed during the individual research sessions. Most notably, all of the professional analysts who participated in the study represented the strategic, in contrast with the tactical, intelligence community. However, the participants varied with respect to their intelligence backgrounds (e.g., economics, linguistics, aeronautical engineering, etc.) and current principle duties (e.g., senior analyst, linguist, analyst supervisor, etc.). The study participants also varied with respect to gender (6 male, 3 female).

3.2 LNG Scenario

The research study was based on a scenario that defined the context of the interactions between participants and researchers. Study participants, from the perspective of an analyst supervisor, critiqued the analysis processes of two junior analysts in the context of a defined scenario. This section of the thesis provides a description of that scenario, a summary of how the scenario was adapted for the study, and information about the selection of the scenario as well as about its design process.

In order to preclude a confusion of terms, throughout the section the hypothetical junior analysts, who are the focus of the scenario, will hereinafter be referred to as "analysts" or "junior analysts", while the real professional intelligence analysts who participated in the study will be referred to as "participants" or "participant analysts". With regard to the scenario, the participant analysts might also be referenced in their assumed role as "supervisor" of the junior analysts.

3.2.1 Description

The Liquefied Natural Gas (LNG) Scenario reflects the debate in the United States energy sector as to whether the importation of LNG is an appropriate approach for coping with increasing natural gas consumption, in light of the projected near-term depletion of the domestic natural gas supply. In the context of this debate, to significantly increase U.S. natural gas imports would necessitate the construction of numerous LNG terminals—which often serve as the primary, and most visible, focus of the controversies surrounding the importation of natural gas. While there are many details related to LNG importation that make it an interesting base scenario, there are four facets of the controversy—energy, siting, safety, and security—that interact to make it particularly valuable as a cognitive case. In fact, the scenario developed for this study serves as a case that is useful not only for exploring the understanding of rigor in information analysis, but also, potentially, for future explorations of other aspects of information analysis as well.

At the broadest level, the issue of LNG importation stems from disagreements about energy policy. As in many energy policy cases, central to the debate is the tradeoff between the continued short-term exploitation of a finite natural resource and the long-term need to develop viable energy alternatives. Related are the economic and geopolitical concerns of further increasing U.S. dependence on foreign energy suppliers, as in the somewhat analogous case of crude oil importation. Also factoring into this decision are the tradeoffs

between the economic imperatives driving increasing consumption and the potential adverse environmental impacts arising from the industrialization necessary to increase natural gas importation. Although this list of tradeoffs is by no means exhaustive, at a cognitive level the energy tradeoffs in the LNG Scenario are fundamentally about replanning. Here, replanning describes the need to regularly reassess and re-plan natural gas energy policy to respond to the changing consumption of a limited resource in a dynamic energy market.

The next critical facet of the LNG Scenario is the debate over terminal siting. Much like the issue of energy policy, tradeoffs are at the core of this issue—in this case, the those tradeoffs arising during determinations of where LNG receiving terminals should be located. As in the parallel cases of landfill and prison sitings, there is often local opposition to new construction, even when the more global benefits of development are valued. This occurrence—sometimes described as the "not in my back yard" (NIMBY) phenomenon—introduces the concept of factions into the LNG Scenario, as different stakeholders accrue differing levels of benefit relative to the assumed risk of a specific terminal siting. From a cognitive perspective, this aspect of the scenario represents a more basic type of planning decision. In contrast with energy policy planning, which is inherently recurrent—and thus represents replanning—LNG terminal siting is typically an all-or-none proposition, each instance of which represents a largely unique planning decision. Siting decisions, then, are manifested in the LNG Scenario in the weighing of tradeoffs relative to the local and global goals that conflict in planning the expanded infrastructure necessary for LNG importation.

The third aspect of the LNG importation controversy identified as being a critical component of the overall scenario is the issue of safety. Safety issues encompass many facets of the liquified natural gas importation process, though in the U.S. these concerns most often focus on the tankers that transport LNG and the receiving terminals that offload it from the tankers. In both cases, safety is a particularly relevant issue because there is little that is definitively known about the impacts of a large-scale release of LNG, as few safety analyses address this issue specifically. Moreover, in light of the limited research base, there is some concern that, as a volatile, compressed gas, the worse-case outcome of a widespread release could reach catastrophic proportions. Thus, while the benefits are fairly well defined, the nature of the risks remains largely unverified. As a cognitive aspect of the study, these safety issues can be thought of as risk versus benefit tradeoff analysis. In addition, as the LNG safety assessments that do exist are themselves information analysis products, the scenario also has an embedded component of nesting in that it is effectively an analysis-of-analysis.

The final dimension of the controversy—security concerns—is an especially interesting aspect of the LNG Scenario because it reflects a form of safety tradeoff that was, at one time, not viewed as being significantly different from other safety concerns. While traditional safety analysis primarily focused on accidental LNG releases—such as those attributable to "human error" or natural disasters—the recognized risk of terrorism led to the rethinking of previous safety analyses with a specific consideration of the threat of an intentional LNG release. Consequently, in light of the fact that this critical failure mode was not adequately considered in prior analyses, many of the conclusions and assumptions about the inherent safety of LNG importation were challenged, leading to revised assessments of risk and safety tradeoffs. The change in security concerns, then, served as a catalyst for reassessment. At the

cognitive level, this aspect of the LNG Scenario reflects an event-driven reanalysis of previously established perceptions of safety.

The four basic aspects of energy, siting, safety, and security define the importation of LNG as a multidimensional case for studying the concept of rigor in information analysis. From the cognitive perspective, the development of this scenario is particularly valuable in that it taps into both the analysis and planning aspects of information analysis—through LNG safety analysis and site planning issues, respectively. Additionally, the scenario captures a setting that is significantly influenced by the dynamics of a changing world through the functions of reanalysis and replanning—reflected by the event-driven security reanalysis and future-oriented energy policy planning. Taken together, these four cognitive components of the LNG Scenario—analysis and planning, reanalysis and replanning—serve as basic cognitive levers, built into the scenario, that can be manipulated to understand varied themes in information analysis.

3.2.2 Adaptation

In the scenario, two junior intelligence analysts—Analyst 1 and Analyst 2—were tasked by a decision maker to answer a question related to LNG as a factor in a U.S. energy policy decision. The specific task question driving the scenario was, "What are the primary obstacles to using Liquefied Natural Gas to address energy needs in the U.S.?" (Appendix A, Figure A.1). Each junior analyst performed an analysis and prepared a briefing report addressing this task question. The responses of Analyst 1 and Analyst 2 provided the processes—Analysis Process 1 [A(1)] and Analysis Process 2 [A(2)], respectively—that were critiqued in the study.

The request by the hypothetical decision maker in the scenario was framed as a quick reaction task, meaning that the junior analysts each spent a few hours over the course of a couple days producing a response to the task question. Each analyst spent a comparable amount of time responding to the task question. The backgrounds of the analysts were also similar, so as not to be a significant factor in the scenario. Throughout the study, participants assumed the role of the hypothetical supervisor of these junior analysts, responsible for deciding if their analysis briefing reports were of acceptable quality to forward to the decision maker who initiated the request—thus engaging the Supervisor's Dilemma.

3.2.3 Selection

The Liquefied Natural Gas Scenario was selected from among six potential scenario topics, listed in Table 2, that emerged from iterative brainstorming sessions between investigators and intelligence analysis practitioners. The primary determinants in choosing a scenario were, in approximate order of importance: authenticity, classification status of information, scope, and topical interest. While no formal scoring methodology was employed in comparing and contrasting the scenarios, they were weighed and considered in consultation with two professional analysts. The insights and perspectives offered by these analysts contributed to the selection of LNG as the final study scenario topic. The two analysts were from the strategic intelligence community and represented the same intelligence organization as the pilot study participant.

Domain	Topic	Focus
Energy	U.S. Importation of Liquid Natural Gas (LNG)	U.S. natural gas infrastructure.
World Health	Pandemic Flu Outbreak (e.g. Spread of Avian Flu)	Impact on U.S. and international transportation and travel.
International Finance	Collapse of the Euro	Likelihood of occurrence and impact on sustainability of the E.U.
Energy / International Relations	Russia / Ukraine Natural Gas Pricing Dispute	Future governmental involvement in Russian energy supplier (Gazprom) decisions and policies.
Energy	E.U. Transition to Hydrogen-Based Economy	Required changes for initial transition.
Technology	International Copyright Issues	Strain on U.S. / China relations resulting from internal pressures for enforcement.

Table 2. Potential Scenario Topics Considered

In scenario-based studies it is particularly important that the scenario be viewed as authentic by participants, as it influences the degree to which they view a study as meaningful and relevant. Consequently, it influences the extent to which they are willing to engage in a scenario—which relates directly to the quality of feedback they provide. In that light, it should be noted that the LNG Scenario was chosen not because of its authenticity as a strategic intelligence analysis task, but rather because of its authenticity as a representative information analysis task. Thus, it was intentional that the scenario chosen for the study that was not exactly like the work of the professional intelligence analysts who participated in the study.

A highly authentic, intelligence-specific task was not selected for two primary reasons. First, the scenario was chosen to avoid topics of direct relevance to any participant. Because the focus of the study was on process, rather than on whether the conclusions conveyed in the reports were right, the topic selected was intended to be outside the specific areas of expertise of the participants. This avoided the possibility that a participant might have a predisposition toward a scenario that would restrict their ability to provide unbiased feedback. As noted previously, the selection of the scenario topic was at least informally successful in this respect, as none of the participants indicated any significant experience with the topic of LNG.

Second, not selecting a heavily intelligence-focused scenario avoided introducing the problem of participants revealing classified information. Because of the inherently sensitive nature of the work of intelligence analysts, the scenario topic selected was intended to allow participants to speak openly. Selecting a authentic intelligence topic risked restricting the ability of participants to communicate their perspectives candidly throughout the study. Moreover, it risked being a distraction from the focus of the study, which was to explore the understanding of analytic processes, rather than products.

In choosing a scenario it was also important that all process inputs came from unclassified sources in order to address the issue of scope, the third selection criteria used. As there was

a limited amount of time available for each interview, relying only on open source data aided in developing a tractable scenario case. It was determined that the LNG Scenario was a topic of acceptable scale, given the pragmatic constraints of running the study.

The final consideration in selecting the scenario was its anticipated level of topical interest. It was determined that the importation of LNG is a relevant issue in many areas of the United States, in light of the current status of U.S. energy needs relative to other energy production and distribution alternatives (National Commission on Energy Policy, 2004; Energy Information Administration, 2005). As noted previously, it also provided an interesting case because of the unique risks and challenges associated with the integration of LNG within the current U.S. energy supply infrastructure, given the high level of concern surrounding homeland safety and security (Hightower, et al., 2004; Clarke, 2005; Aspen Environmental Group, 2005). Accordingly, it was estimated that the LNG Scenario was apt to be of topical interest to study participants.

Although no formal measures were taken to quantify how well the scenario met the selection criteria, again due to privacy concerns, informal feedback indicated that participants judged the scenario to be moderately representative of intelligence analysis. Comments on topic authenticity were mixed. As expected, no participant indicated that the scenario was exactly like their work as an analyst. Most indicated that they found the scenario to be representative of their work, though a few commented that they did not find the scenario to be highly generalizable. Most participants also found the scenario to be acceptable in its use of unclassified information and in its scope. However, the LNG Scenario prompted mixed reactions in terms of topical interest, with some participants expressing a general interest in the topic, while others expressed indifference.

3.2.4 Design

Once selected, the study scenario was developed and refined based on inputs from information analysis researchers, professional intelligence analysts, and a LNG industry domain expert. Because it was scenario-based, the two sets of products and processes used in the study were not taken directly from any specific analysis. Rather, they were representative analytic products and processes, based on a real world case, designed to amplify the cues analysts use to infer rigor—with one designed to reflect a high-rigor analysis process and the other a low-rigor process.

The analysis briefing reports for each junior analyst in the scenario were constructed through collaboration (Appendix A, Figures A.2–A.5). The briefing report for Analyst 1 was a unique analytical response developed in collaboration with an LNG industry domain expert who was a critical contributor to the *Battery Rock LNG* risk assessment report (Clarke, 2006). The briefing report for Analyst 2 was heavily based on an unclassified strategic forecast on the future of LNG in the U.S. (STRATFOR, 2005). Both reports were critiqued by a former intelligence analyst during pre-testing of the study methods, resulting in significant revisions to the analysis reports.

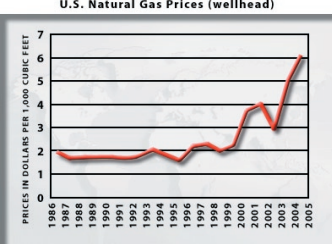
Difference	Description	Excerpt from A(1) Report	Excerpt from A(2) Report
Tone of Reports	The two briefings conveyed distinctly different tones to the reader. Most notably, the reports revealed a difference in perspective between author analysts. While Analyst 1 did not support the position that importing LNG is an appropriate response to the increasing U.S. energy need, Analyst 2 favored LNG as a viable solution. In addition, the reports differed in tone relative to writing style as well as in the subtle differences in briefing format and organization.	"Terrorist groups... have the intent and capability to attack urban LNG facilities... It is unlikely that deterrence or prevention measures would be adequate to defend against attacks" "Rising gasoline prices, oil price volatility, and the possibility of domestic oil shortages have increased U.S. demand for natural gas... Domestic natural gas reserves are no longer sufficient to satisfy the growing demand" "There are four primary obstacles..." "The goals publicly articulated by these groups include..." "[M]easures to reduce the risk or attacks on LNG facilities include..."	"[L]iquified natural gas... provides a way to both plug the gap and bring down prices from their recent highs... the politics, security concerns and economics of LNG and the United States' energy needs match" "[N]ot all is well in the world of natural gas in the United States... In times past, U.S. natural gas demand was entirely satisfied by domestic, and then Canadian, production. That time has ended... If a long-term solution is not adopted quickly, wide swathes of U.S. industry will simply cease functioning" "Luckily for the United States..." "Unfortunately for the United States..." "LNG is more than merely cost competitive. It is far cheaper than American... piped natural gas."
Obstacle Set	The two briefings differed in the obstacles that were cited in each report as those primary in prohibiting the more widespread acceptance of LNG. The reports had only partially overlapping obstacle sets.	"1) risk of fire and radiation release from intentional terrorist attacks... 2) risk of fire and radiation release from unintentional release... 3) resistance to the use of lowly populated environmental areas for industrial purposes, and 4) reduced property values to local areas"	"[T]he United States... lacks a unified energy policy capable of addressing long-term issues. That has allowed local — as opposed to national — environmental groups effectively to stall the development of LNG import facilities"
Inclusion of Figure	The A(2) report included a line graph related to LNG, while A(1) did not. Because the figure was included in the low-rigor analysis product, note that the graph was not directly relevant to the primary task question.	No figure.	 U.S. Natural Gas Prices (wellhead) PRICES IN DOLLAR PER 1,000 CUBIC FEET 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005

Table 3. Designed Differences Between Analysis Products (Briefing Reports)

Process Document	Description	Analysis Process 1	Analysis Process 2
Query Summary	While the total number of queries did not differ substantially between the two processes, the type of queries used in each process did. A (1) used more targeting queries and broader queries, while A(2) tended to use search queries that were focused on a main hypothesis.	4 query targets	3 query targets
Documents Read (in order of reading)	A(1) and A(2) had a nearly four-fold difference in number of documents read. The number of documents read reflected both on the overall rigor of the analytic process, but also on the experience and knowledgeability of the author analysts.	26 documents	7 documents
Where Documents Stored in Folders	The two processes differed on the extent to which documents were organized during the analysis process and also in the approach used to organize the document sets. The A(1) documents were better organized.	7 folders	4 folders
Key Documents (relied on heavily)	The nature of document identified as key differed between processes. In A(1), the key documents were classified as formal research reports whereas in A(2) tended to rely on a varied mix of less formal supporting documents.	4 key documents	3 key documents
Hypotheses — Considered Obstacles to LNG	A(1) reflected one in which more hypotheses were weighed and considered. Additionally the nature of the hypotheses that were investigated varied between the two processes.	5 hypotheses	3 hypotheses
Collaborations with Others During Process	A(1) showed a substantially greater the incorporation of alternative perspectives through collaboration. It included both more and better quality collaborations than A(2).	6 collaborations	1 collaboration
Research Note-Sheet	For A(1), study participants were able to view the collection of notes the analysts used in preparing the final briefing report. In contrast, the A(2) analyst did not use a process that included a note-sheet.	Note-sheet	Not used

Note. Each of the Process Documents listed in the first column of this table is included in an Appendix A.

Table 4. Designed Differences Between Analysis Processes (Process Documents)

In order to ensure that participants would have enough time to critically evaluate both of the reports, each briefing was limited two pages in length. Report 1, designed to be a high-rigor analysis product, was created by combining perspectives from a number of different LNG reports. Report 2, in contrast, was created by abridging the single perspective in the strategic forecast report to reflect a low-rigor analysis product. The briefing reports were then further refined to differ with respect to the facets of tone of reports, obstacle set, and inclusion of figure, as shown in Table 3.

Concurrent with the development of the briefing reports, the analysis processes that produced the reports were meticulously constructed (Appendix A, Figures A.7–A.40). As was the case for the briefing reports, the analysis process of Analyst 1 was designed to reflect a high rigor process, while the analysis process of Analyst 2 was designated as a low rigor process. In the case of A(1), this was done by refining aspects of the actual process used to create the report. In A(2), the process was constructed to describe the briefing product that was created in paring down the strategic forecast, with respect to the stated goal of representing it as a low-rigor process.

In the context of the study, analytic processes were reflected by a set of process documents. Process documents are a collection of descriptive documents that provide insight into an analysis process, with each document in the set revealing partial insight. As an aggregate, this document set affords the construction of a model of the analytic processes that produced an analysis report. Process documents were used in the study, rather than other methods of providing process insight, because they offered a compromise between providing raw data about process (e.g., the recording and replaying of an analysis process) and providing interpretations of process (e.g., a descriptive summary of a process), while not requiring participants to have a direct interaction with the producing analyst (e.g., a discussion with the author analyst about their analytic process).

Although there are many potential types of process documents that could be used to describe an analysis process, seven specific process documents were selected for inclusion in the study. Two sets of process documents, listed in Table 4, were developed to be used by participants in forming an understanding of the analysis processes. The seven specific document types were selected because they were deemed effective in capturing the ways in which the analysis processes in the scenario differed with respect to assessment of rigor. Additionally, some of the document types were selected for inclusion based on their potential to be collected electronically and automatically during the course of an analysis.

3.3 Supervisor's Dilemma

This research was driven in part by a critical judgment task referred to as the Supervisor's Dilemma. The Supervisor's Dilemma describes a generic situation wherein a supervisor must decide if the output product of an analyst is acceptably rigorous or if more resources must be invested in the analysis process before sending it forward. This judgment provides an interesting mechanism for exploring the understanding of rigor in analysis because, while in principle it is an abstraction of a common occurrence, it represents a critical decision that, in practice, is often made tacitly (Betts, 1978). Moreover, it captures the spirit of many related questions that a supervisor might ask about an analysis product—*Is the analysis ready to send*

forward? If not, what else needs to be known? Given what is not known, what is the best way to invest limited analytical resources to reduce this uncertainty and improve the analysis product?

The Supervisor's Dilemma, however, represents more than just a series of binary questions a supervisor could ask about an analysis. Rather, the dilemma highlights the criticality of the interactions that occur at the interface between the analysis and replanning components of information analysis. It represents a point in the intelligence cycle where a decision is made—whether by supervisors, decision makers, or the analysts themselves—as to whether or not an analysis product is ready to pass on to the next stage in the cycle. Simply, whether made implicitly or explicitly, the Supervisor's Dilemma addresses a basic question in information analysis—*When is analysis sufficient?* Thus, the Supervisor's Dilemma also serves to increase the generality of the study design beyond intelligence analysis alone, as the ubiquity of judging sufficient rigor is a task fundamental to all forms of information analysis.

Framing the Supervisor's Dilemma as a generic judgment task also circumvents some of the controversies in the intelligence community surrounding the role of the decision maker relative to the analysis process. Structuring this critical judgment as a dilemma of the supervisor frames the decision as one that is explicit, collaborative, and yet largely informal. The dilemma is not so personal that the decision is made implicitly by an analyst and yet not so formal that the analysis is used by a decision maker as, perhaps, the sole basis for a policy decision. Thus, the role of supervisor reflects a perspective somewhere between that of analyst and that of decision maker, providing an agreeable point on the continuum for eliciting feedback from study participants about how they judge rigor in the analysis process.

The Supervisor's Dilemma spanned across the phases of the study, as participants were asked to make an assessment of analysis report readiness both before and after gaining insight into the processes that produced the reports. In the study, the dilemma was framed, "As a senior analyst, you might be asked to decide if junior analysts' reports are ready to be passed on to a policy-maker" (Appendix A, Figure A.1). The dilemma facing the study participants, as proxy supervisors, was to decide if either, both, or neither of the scenario-based analysis briefings were ready to be forwarded on to the decision maker, by assessing the rigor of the processes that produced them. Thus, the Supervisor's Dilemma put participants into an information analysis role that highlights the criticality of the concept rigor.

3.4 Procedure

The design of this study was based on the Elicitation by Critique (EBC) methodology (Miller, Patterson, & Woods, 2006). In the EBC approach, participants share their expertise by critiquing the processes of other domain practitioners, rather than by directly verbalizing their individual experiences. EBC is also similar to the individual allo-confrontation method in that both approaches confront participants "with an activity they practice but which is performed by someone else" and prompt them to verbalize about that activity (Mollo & Falzon, 2004).

The findings of this study support the EBC method as a valuable approach for taping into the expertise of specialist practitioners, while simultaneously refining the method, as the

approach used in this study was modified from the original EBC methodology in three ways. First, participants critiqued not only the processes of other analysts, but also the briefing products that were produced by those processes. Second, participants critiqued the analyses of two different analysts concurrently, rather than sequentially. Third, and perhaps most significantly, participants critiqued analyses that were generated to fit within the context of the LNG Scenario. Due to these changes from the original method, the design of this study approach was a modified EBC methodology, embedded in a scenario walkthrough.

Each participant engaged in a two-part critique during a single elicitation session. In the first part of the study, critiquing focused on the analysis products, while in the second it focused on the analysis processes. The sessions also included an introductory overview of the study and a concluding debrief discussion.

A summary of the session protocol is found in Table 5. Note that the elicitation session procedure served as a tentative outline with respect to the amount of time spent on each step. Every participant progressed through all steps; however, in many cases there were deviations from the baseline time estimates, as dictated by the nature of the discussion generated by individual participants.

Phase	Step	Estimated Time (minutes)
Introduction	Consent to Participate Obtained	–
	Introduction to Study	5
Product Critique	Introduction to Scenario	5
	Participants Review Briefing Reports	15
	Discussion of Differences Between Products	20
	Supervisor's Dilemma Assessment	–
Process Critique	Discussion of Value of Process Documents in Inferring Rigor	10
	Participants Review Process Documents	15
	Discussion of Differences Between Processes	15
	Supervisor's Dilemma Reassessment	–
Conclusion	Study Debrief	5
	Years of Experience and Scenario Familiarity Obtained	–

Table 5. Elicitation Session Process

Each of the elicitation sessions was conducted with participants individually, with either one or two researchers present. The first five sessions included two researchers while the final four sessions each had one. The same two researchers were involved in all sessions, with participant feedback primarily collected as verbal report data in the form of written notes. With the exception of the pilot participant, audio recordings of all elicitation sessions were collected for later analysis using an Apple iPod equipped with a Griffin iTalk Voice Recorder.

The elicitation sessions were conducted in unclassified conference rooms, on-site at the home campus of the participants' respective intelligence organizations. Each session was scheduled for one and a half hours, with the exception of P8, whose session was limited to one hour due to time constraints. The study sessions were run consecutively over a four day period at times convenient for the participants.

The introductory overview focused on providing participants with a general understanding of the goals of the research study as well as a description of what participation in the elicitation session would entail. The primary objective of the study, as described to participants, was to discover the cues that expert intelligence analysts used to assess the level of rigor of an analytic process. Further, it was explained that participant inputs and assessments would be used to gain insight into the primary objective of discovery of rigor cues.

In accomplishing these objectives, participant analysts were asked to engage in an elicitation session in which they would analyze a scenario by (1) reading two written reports and comparing their quality, (2) assessing and comparing the rigor of the processes used to create each of the reports, and (3) participating in an open-ended, unstructured discussion of the cues used to assess analytic rigor. General questions about the study were addressed at this time and verbal consent to participate was obtained from all participants, as well as consent to record the discussion. All potential participants agreed to participate in the study and to be recorded.

During the initial critique cycle—focused on the analysis products—participants were first given a verbal description of the LNG Scenario. The authenticity of the scenario was also briefly commented upon, and the selection criteria used in choosing the scenario were explained. Participants were then given a one-page summary that introduced the study scenario, found in Appendix A, that succinctly defined their role as hypothetical supervisor in the context of the scenario.

Participants were also asked to remember the following during the scenario study: (1) There is no "right" answer for the scenario. It is not a test of knowledge of LNG or the current U.S. energy situation. Rather, the scenario is intended to help reveal the indicators used to assess rigor. (2) Avoid focusing too much on how this scenario differs from what they do as analysts. Instead, it should be used as a facilitator for exploring the dimensions of rigor. (3) Personal insights provide the grounding needed to explore design concepts that could meaningfully impact the way analysis is done in the future. Thus, the more discussion provided by participants, the more valuable was the elicitation session.

Participants were next presented with the two analysis briefings generated via Analysis Process 1 [A(1)] (Appendix A, Figures A.7–A.33) and Analysis Process 2 A(2) [A(2)] (Appendix A, Figures A.34–A.40). Note that the order in which the briefings were presented was randomized across sessions, such that for some participants A(1) was labeled as A(2), and vice versa. However, for the sake of clarity, throughout this paper A(1) always refers to the high-rigor analysis process and A(2) always refers to the low-rigor analysis process. Participants were instructed to read both reports, keeping in mind that they would be asked to "assess and compare the quality of the two written reports" and "comment on the 'rigor' of the processes that produced each of the reports" (Appendix A, Figure A.1).

Participants were then given up to fifteen minutes to individually review the two documents, though some took less than the full amount of time allotted. Each participant was provided with means to take notes about the reports as they deemed appropriate. They were also informed that they could mark directly on each briefing report. During this time, participants were left alone while they reviewed the analysis reports. After participants completed their review of the analysis briefings and were prepared to discuss them, they signaled for the researchers return.

At this time, participants were prompted to discuss the differences between the analysis products and critique the two briefings by (1) comparing and contrasting them, (2) commenting on what they could infer about the rigor of the process that produced each report, and (3) describing the approach they would use to better understand the rigor behind each report. In addition to pursuing these structured lines of inquiry, the researchers also interacted with participants to clarify comments and request elaboration on topics of interest raised in the course of the discussion. The first critique cycle concluded when participants were asked, in their role within the scenario as analyst supervisor, to decide if either, both, or neither of the analysis briefings were ready to be forwarded on to the decision maker—thus putting themselves into the Supervisor's Dilemma.

The second critique cycle—focused on assessing the analysis process—began when participants were provided with a list of process documents (Appendix A, Figure A.6) that could potentially be used in assessing analytic rigor. They were then asked to comment on the perceived value of having access to each type of process document in making an assessment of analytic rigor, ranking the seven options. In addition to verbal report data, ordinal preference rankings were collected from participants.

Next, participants were given access to two sets of process documents, reflecting A(1) and A(2) (Appendix A, Figures A.7–A.40). As in the first critique cycle, participants were then given time alone, up to fifteen minutes, to review the process documents. Before reviewing the documents, participants were advised that they were not required to read the entirety of information that was made available, but rather that they could review the information that seemed most critical to building an understanding of the analysis processes that generated each briefing report.

After examining the process documents and signaling for the researchers to return, participants were asked to critique the analysis processes by (1) comparing and contrasting the processes, (2) commenting on the rigor they saw in each process, and (3) comparing their revised assessments of rigor—based on insight into the actual analysis processes—to their prior, perceived assessments of rigor—made based on inferences from the analysis products alone. Once again, the researchers interacted with participants to explore related topics beyond these initial discussion points. The second critique cycle concluded with a reassessment of the Supervisor's Dilemma, with participants now able to take into consideration a more complete understanding of the rigor of the analysis processes.

During the concluding debrief discussion, data was collected from participants regarding two specific questions. First, participants were asked to provide an estimate of their years of relevant professional experience. Second, they were asked to disclose if they had any previous professional or personal experience related to the importation of LNG that might

bias their perspective toward the scenario. No participant indicated any significant background related to the scenario topic.

Participants were also asked to identify what they perceived to be the most significant challenge currently impacting the intelligence analysis community, prompting a wide variety of responses. The debrief also provided an opportunity to comment on the design of the study, which, as noted previously, some participants did. Finally, it provided participants with a chance to ask questions related to their participation in the research. Other outstanding concerns regarding the study were also addressed at this time.

Following the completion of the study, the data generated in the form of written notes were e-mailed to participants, via the sponsor contact, for review. Copies of the notes sent to participants are found in Appendix B, Figures B.1–B.29. This provided participants with an opportunity to verify that they did not divulge any classified information during their elicitation session, to correct any inaccuracies, and to offer any additional insights that may have emerged after the completion of the study. To date, no revisions or corrections to the original study data have been requested.

3.5 Data Analysis Methodology

The primary mechanism for eliciting comparable feedback across study participants was the prompt. The data collected during the sessions was analyzed by organizing the participant feedback relative to four such prompts designed into the study, which included two discussion prompts and two decision prompts.

The two discussion prompts, comparison of briefing reports and comparison of process documents, were part of the study critique cycles—in the product critique cycle and the processes critique cycle, respectively. These prompts served to elicit responses from participants about the cues they used to infer rigor relative to the various documents they interacted with throughout the study. The two decision prompts, rigor assessment and Supervisor's Dilemma, spanned across multiple phases of the study and were designed to capture how process insight influenced perceptions of rigor—relative to analysis process and product, respectively.

The comparison of briefing reports, the first discussion prompt that participants encountered in the study, focused on how participants responded to the differences between the briefings. At the outset of the study, participants understood that the two versions of the analysis briefing were created by two similar analysts working the same questions under similar constraints. Yet, the reports differed significantly in their responses to the LNG Scenario task question, requiring participants to resolve this discrepant information.

The differences between the two reports was reflected in the interaction of the three facets of tone of reports, obstacle set, and inclusion of figure, as described in the previous section (Table 3). The facets also represented the three embedded probes used to organize the study data relative to comparisons of the briefing reports. Embedded probes are latent aspects of the scenario that serve to push it beyond a standard case (Woods & Hollnagel, 2006). Probes differ from prompts, however, in that participants were not explicitly asked to

comment on or respond to them. Rather, embedded probes become informative by understanding which probes participants actually did attend to during the course of the study. Each of two discussion prompts built upon a set of such probes.

In comparing the process documents that described each briefing report, participants used the available documents in building an understanding of process. In the study, the two analysis processes were designed to be distinctly different, which was reflected in the process documents. One analysis process was performed via what was characterized as a high-rigor process, while the other was performed via a low-rigor process. This distinct difference between analyses again required study participants to cope with discrepant information. The differences between analyses were manifested in the process documents available to participants. Each of these seven unique types of process documents, listed in Table 4, also served as an embedded probe in the study. As in the comparison of reports prompt, the use of embedded probes further structured how study data were organized and subsequently analyzed.

Decision prompts were distinct from the discussion prompts in that, rather than reflecting specific phases, they were recurrent across phases of the study. The decision prompts were instantiated when participants made decisions both before and after gaining insight into the analysis processes. Additionally, unlike discussion prompts, decision prompts asked participants to make explicit judgments—by indicating which report or process was perceived as being better, rather than qualitatively comparing and contrasting them.

The rigor assessment prompt asked participants to decide which analysis process they believe to be more rigorous, both before and after reviewing the process documents. In assessing the analysis process before seeing the process documents, participants were limited to what could be inferred from the briefing reports in making assessments of analytic rigor. The prompt was fully realized when participants viewed the actual process documents, which allowed them to reinterpret prior assessments about report quality relative to the new information that had been revealed. This prompt required participants to quickly shift from thinking abstractly about analytic rigor, based on inference, to thinking very concretely about rigor, based on explicit evidence found in the process documents.

The Supervisor's Dilemma also served as a prompt in that it challenged participants to assume a role that they may not have on a regular basis—that of a supervisor who must decide if an analysis product is ready to go forward to a decision maker. This prompt spanned across the phases of the study, as participants were asked to make assessments of analysis report readiness after reviewing the briefing reports and after reviewing the process documents. In doing so, participants were confronted with a situation wherein the new information has either supported or contradicted their initial judgments of the rigor of the analysis products. Their attempt to resolve this potential second-level dilemma provided insight into their understanding of how process rigor relates to product quality.

3.6 Study Findings

A number of interesting findings emerged from the analysis of the data collected in the study. These results are described in this section, with the discussion of the broader implications of these findings is covered in the next section. The findings are organized by prompts, as described in the data analysis methodology. Also, throughout this section direct quotes from the analysts who participated in the study appear centered and in italics, revealing additional insight into the perspective of the professional information analyst.

3.6.1 Comparison of Briefing Reports Prompt

The comparison of briefing reports prompt organized participant data around responses that compared and contrasted the scenario briefing reports. Organizing the data relative to this prompt revealed that participants generally made qualitatively similar assessments of the A(1) and A(2) briefings. This conclusion was supported across report comparison probes, as participants expressed similar conclusions about both analysts and analysis processes based solely on the briefing reports. These findings are organized with respect to the three embedded probes, each of which structured the participant data around a different facets of report comparison—including tone of reports, obstacle set, and inclusion of figure.

The first probe explored in the comparison of briefing reports was based on the comments made regarding the tone of the briefing reports. This probe was broken down into three components, each of which aggregate certain types of feedback from participants about tone. The three components include analyst stance, writing style, and briefing form.

ID	A(1) Briefing Report	A(2) Briefing Report
P0	Against LNG Bias toward terrorism issues	Supports LNG Views economy as central problem
P1	Good hypotheses, but too narrow Energy and terrorism mindset	Poor hypotheses, but more broad
P2	Apparent anti-LNG bias Terrorism is bigger than it should be	Apparent pro-LNG bias Written to support an opinion
P3	Focus is terrorism, but did address other issues	Focus is environmental groups
P4	Terrorism focus is off topic Does not show a strong bias	–
P5	–	Has a political agenda Assumes reader holds same views
P6	Threat of terrorism focus	Economic focused
P7	Has a bias toward terrorism	Seems to be a data gatherer
P8	Has a social orientation	More math / economic oriented

Table 6. Summary of Responses to Comparison of Reports Prompt, Tone of Reports Probe, commenting on perceptions of author Analyst Stance

"It's not analysis to justify your biases."

The general perspective among participants was that, when assessing analysis products, it is important to consider the possibility that the stance of the author analyst can bias an analysis process. Regarding the scenario, the general opinion of participants was that neither report appeared entirely unbiased. Table 6 shows a similarity among participants in their inferences about author stance, relative to the broader tone of reports probe.

Note that seven of nine participants commented on a perceived bias in Analyst 1 toward terrorism as the primary obstacle, while three observed a bias in Analyst 2 toward economic factors as the central obstacle. P0 and P2 went even further, inferring the stances of the authors on the task question and identifying Analyst 2 as pro-LNG and Analyst 1 as anti-LNG, based on the briefings alone. P2 went further still, inferring that the A(2) briefing was written specifically to support the predisposition of the decision maker.

"I think the use of language is very important."

Table 7 captures those responses from participants about the tone of the analysis reports that addressed writing style. Aspects of writing style were mentioned by all participants during their comparisons of analysis products. The nature of the comments indicated a general view among participant analysts that the use of language was a critical cue for assessing the rigor of an analytic product.

This aspect of the tone of reports probe, however, yielded a more variable response than aspects of analyst stance. There was a split among participants as to which report was perceived as having the better writing style, with P5 and P7 indicating that the A(1) briefing was better, while P0 and P8 indicated that A(2) yielded a better briefing. Similarly, there was disagreement as to which report appeared more fact-based, as P1, P2, and P5 found the A(1) report to be more factual, while P0, P3, and P8 concluded the opposite, identifying the A(2) report as more sound.

"Essentially, if you're trying to answer a question for a policy maker, they want the question answered. They don't really want you to present them with the facts [that] cause them to have to do the analysis. In other words, they want you to tell them succinctly what the answer to the question is—not just give them a bunch of facts relating to the question. It's a matter of knowing who your audience is."

In responding to the organization and format aspects of the tone of reports probe, there was a clear similarity among participants regarding what was viewed as most important. As shown in Table 8, the common theme, stressed by nearly every participant, was that the format of the analysis briefing should focus on clearly conveying a concise answer to the decision maker—not just provide them with information about the task question. A common, related sentiment—identified explicitly by P0, P2, and P7—indicated that the form of the analysis briefing should be tailored specifically to the preferences of the analysis customer.

ID	A(1) Briefing Report	A(2) Briefing Report
P0	Too much background information Never left the first level	Got to the point much quicker Good instances of statistics and research
P1	Liked fact-based nature Likes quantifying of what was and was not part of analysis Intermixes solutions	Informal writing style is easier to read, but something is lost with this style Too heavy on conjecture, seems opinionated Uses words like “about” and “around” too often Goes off task by offering solutions, proposes policy
P2	Looks like parts of different papers Looks like cutting and pasting	–
P3	Did not like use of terms like “regasified” It took away from credibility	More casual, not as much detail Tried to be more qualitative
P4	Reads like a newspaper story without supporting documents, sensationalistic Has parts that do not help policy-maker Not technical enough to show analyst knows his stuff, not enough detail	First paragraph is not on subject Makes unsupported, extreme statements Environmental comments seem like rhetoric
P5	More cohesive explanations, good specificity Has an academic style, calm, not alarmist	Casual style Confusing, and inappropriate writing style Few or no facts, based on opinion Like an “opinion piece” from newspaper, alarmist
P6	Got too much into risk mitigation	Included irrelevant information Rambled on at first, went off topic
P7	Covered issues more thoroughly Tried to tell a story Pointed out areas not addressed	All over the map Picked out snippets, cut and paste Not as well as written, summarized sources
P8	Very scattered, more emotional	Tighter writing, more factual Good statistics on cost/benefit analysis

Table 7. Summary of Responses to Comparison of Reports Prompt, Tone of Reports Probe, commenting on Writing Style

ID	General Comments on Organization and Form	A(1) Briefing Report	A(2) Briefing Report
P0	Tailoring form to audience is key Form should be "a picture and a paragraph" Policy makers are looking for a critical idea that resonates Organization: state problem, offer a solution, and state what can be done about it, but should not "push policy"	–	–
P1	Form is not as critical unless mandated Level of detail reflects the type of report Should be one page for policy makers	–	–
P2	Form is key, different versions of a report are useful Must get in to mind of customer, customer has final say Answer must be clear, easy to find, focused on the issue Should include what is not known and what to expect	Answered wrong question	–
P3	–	–	–
P4	First paragraph should have answer, then expand Decision makers want answers	–	Did not answer question
P5	Form is important Reader must have confidence, proper form conveys confidence Should not make assumptions about the reader Must clearly state answer Should attempt to qualify what is not taken into consideration, identify the limitations	–	–
P6	Reader wants to know what their position should be on the issue Should focus on answering the question that is asked	Got off point from answering question	Did not answer question
P7	Must know audience Decision makers are looking for answers, not just facts relating to the question	Answered question more thoroughly	–
P8	Form is key in influencing policy decisions	–	Was not clear it answered question

Table 8. Summary of Responses to Comparison of Reports Prompt, Tone of Reports Probe, commenting on Organization and Form

The majority of feedback about the organization and form of the report was not focused specifically at either of the analysis reports within the scenario. Rather, participants made general prescriptive comments defining appropriate briefing form. What few report-specific comments there were tended to focus on whether or not the report was successful in explicitly answering the task question.

As a related observation, note that P3 did not make any significant comments relative to organization and form aspects of the tone of reports probe. This fact was potentially attributable to limited professional experience, given his status as the most novice participant analyst in the study.

Every participant attended to at least one of the three components of the tone of reports probe in comparing the briefing reports. Further, with some exception in writing style aspects, participants made many similar comments in comparing and contrasting the reports. An analysis of the obstacle sets probe also identified comparable patterns of response.

"Presumably the author of report two also came across, I would hope, some of the obstacles that are listed in paper one. They would have seen [those obstacles] in the course of their analysis."

Although similar, participant responses to the obstacle sets probe were not as numerous as they were to tone of reports probe. As shown in Table 9, only four participants made comments indicating that they recognized the set of obstacles cited in the briefing reports were incomplete. P3 and P5 noticed that the reports contained different obstacle sets, while P0 and P6 identified obstacles of interest that were not mentioned in either report.

In contrast, some participants responded to the obstacle sets from a different perspective. Three participants concluded that the obstacles identified in at least one of the reports were incorrectly classified. P2 and P8 noted that the A(1) report misclassified risks as obstacles, while P2 and P4 judged that the A(2) report focused on benefits rather than obstacles.

Two participants, P1 and P7, did not comment on the obstacle sets at all. As implied by the above quotation, this could potentially be due to the participants assuming that both analysts in the scenario encountered the same obstacles during their research, then further assuming that the analysts had justification for identifying the obstacles listed in their report as being those most primary.

The obstacles probe, of all the probes in the comparison of reports, generated the least response from participants overall—perhaps for the same reason noted above. Another possibility is that, given a scenario topic was designed to be outside their areas of expertise, the participants were less inclined to respond to this aspect of the briefing reports. Regardless, the responses that were given appeared to fit the pattern of similar responses shown in the tone of reports probe and the inclusion of figure probe.

"A graphic can be wonderful and tell you a lot."

ID	Comments Indicating Incomplete Set	Comments Indicating Misclassified Obstacles
P0	Neither report identified the counter-positions Neither hit on the alternatives to LNG A(2) report did not mention counter-terrorism	–
P1	–	–
P2	–	A(1) report must be clear about obstacles vs. risks vs. downsides, risk is not an obstacle A(2) report is more benefits focused
P3	A(2) report has info about environmental groups being in disarray not in A(1) report	–
P4	–	Too much about benefits, rather than obstacles Too much price focus, price is not an obstacle
P5	Reports indicate different obstacles A(2) report does not mention terrorism at all	–
P6	Energy sector is an obstacle not mentioned Both ignored key barrier of infrastructure	–
P7	–	–
P8	–	In A(1) report some obstacles are more like risks

Table 9. Summary of Responses to Comparison of Reports Prompt, Obstacle Set Probe

The final probe embedded in the comparison of reports prompt was the inclusion of figure probe. This probe, as with two previously described, showed a consistency of response across participants. In fact, nearly all participants indicated that they found the inclusion of a visual element to be a valuable part of developing an effective analysis briefing. However, even in acknowledging the value of the graphic, most participants recognized that the content of the graph did not relate directly to the scenario task question, making comments such as:

"This one looked a little more rigorous. They've got some charts here, which they obviously got from the internet or whatever."

"I like the picture... [It] has a poor graphic, but it draws me there."

"The chart helped focus the ideas, but it wasn't... labeled as far as obstacles."

"I think they pulled a nice graph. And so they were trying to at least create the illusion... that there was scientific evidence and research into the actual data."

"Then again, what's the point of this natural gas price chart in relation to the question that's being asked here? It has nothing to do with it."

"The use of the chart is gratuitous and does not even reflect the date range that they cite in the paragraph."

Thus, although the figure was seen as an important cue, the relationship between the inclusion of the visual and inferences that could be made about rigor were not as clear. Even so, the inclusion of figure probe did generate a strong response from participants.

Across the probes of the comparison of reports prompt, a similarity among participant responses was observed. Inclusion of figure and tone of reports seemed to show the most similarity, while comments regarding the differences between obstacle sets were more diverse. Generally, the responses were similar in that participants attended to similar cues in forming their assessments of the quality of the briefing reports. The caveat to this general finding, however, was that although many of the same cues were attended to in assessing the analytic products, the ways in which those cues were interpreted by participants as relating to analytic rigor tended to be quite varied.

3.6.2 Comparison of Process Documents Prompt

The second discussion prompt in the study focused on participants' perceptions of the process documents as valuable in revealing the processes behind the analysis briefing reports. In forming this assessment, participants used the available process documents to build an understanding of the analysis process. Each of the seven types of process documents also served as a probe in the sense that participants attended to and commented on some of the documents, while minimizing or disregarding others. The general finding of the comparison of process documents prompt was that, while participants valued the process documents similarly when ranking them, there were notable differences in how the documents were used to judge rigor.

*"It helped a lot to [see the process documents] because...
it confirms what I thought about the priority of these issues."*

In comparing the analysis processes, participants ranked the usefulness of each of the different process documents in making assessments of process rigor, assigning a rank of one to the most useful process document and a rank of seven to the least useful. Kendall's coefficient of concordance ($W = 0.526, p < 0.01$) indicated there was agreement among participants as to the order in which the process documents were valuable. The composite rankings of these documents, found in Table 10, point toward facets of the analytic process that are perceived as most critical in supporting an understanding of rigor.

Paired Wilcoxon Rank-Sum Tests ($p < 0.01$) order the data into three tiers of importance in judging rigor, with the first tier reflecting those most useful in assessing rigor and the third tier reflecting those least useful. Of the process documents available in the study, all but one participant ranked "Key Documents" and "Hypotheses Considered" as two of the top three most valuable sources of process information.

In contrast, all but one participant ranked "Where Documents Stored" as the least valuable. The four other types of process documents fell into an intermediate category, with some participants valuing them highly and others seeing them as minimally valuable. This data implies that, for some types of process information, there was a tacitly consistent distinction among participants as to which information sources were perceived as being meaningfully diagnostic of process rigor and which were judged as conveying little meaning.

Document	Tier	Mean	Range	P0	P1	P2	P3	P4 ^a	P5	P6 ^b	P7 ^c	P8 ^d
Key Documents	First	2.00	1–3	3	2	1	1	2	3	3	1	2
Hypotheses Considered		2.22	1–7	1	1	7	2	1	1	2	2	3
Collaborations	Second	4.00	2–5	2	3	5	4	5	4	5	4	4
Research Note-Sheet		4.06	1–6	6	4	2	6	6.5	5	1	5	1
Documents Read		4.17	2–7	5	6	3	3	3	2	6	3	6.5
Query Summary		5.00	4–6	4	5	6	5	4	6	4	6	5
Where Documents Stored	Third	6.56	4–7	7	7	4	7	6.5	7	7	7	6.5

Note. Rankings were standardized for participants whose rating method deviated from a 1–7 scale as noted.

^aParticipant did not rank "Research Note-Sheet" or "Where Documents Stored", noting that neither was perceived as valuable. ^bParticipant originally ranked "Research Note-Sheet" as 1 and "Hypotheses Considered" as 1A. ^cParticipant added an item to the list of process documents, ranking "Sources of Key Documents" after "Key Documents" but before "Hypotheses Considered." ^dParticipant did not rank "Documents Read" or "Where Documents Stored", noting that neither was perceived as valuable.

Table 10. Process Document Rankings

In addition to analyzing the process document comparisons by contrasting the rankings, another perspective on the data is gained in viewing the process documents as embedded probes. Insight into how participants transformed the partial information provided in the process documents into a more complete assessment of rigor is gained by organizing the participant feedback relative to these seven probes. This approach affords the exploration of the ways in which the process documents were used by participants to assess rigor.

"If [the analyst] did the research and came up with the conclusion that [a certain obstacle] is really not that big of a deal based on the research, therefore [it was] dropped... that's a much more rigorous process as opposed to the analyst [who] dropped it because he didn't do his homework."

While there was some agreement among participants about the order in which process documents were useful, there were differences in what those process information cues indicated to each participant about rigor. Insights from participants regarding the value of each type of process document revealed that they were viewed as providing both positive and negative diagnostic information about analytic rigor. Examples include:

"Hypotheses... show that the analyst looked for alternatives."

"I would want to know what hypotheses did they have going in or formulate while they were working. It's trying to get into their mindset as they did their work to try to determine if that... biased what they paid attention to or didn't pay attention to."

"Collaboration... gives you more, showing that the person did his homework."

"The fact that the analyst... discussed an initial search with somebody and that was it [shows] that he didn't have a grasp of the scope of the problem."

"I found the formal notes to be useful. They were helpful in understanding how the analyst went amiss... [and] gave me insight into the recovery process."

"The fact that they didn't use a note-sheet speaks to the fact that their presentation wasn't as good as it could have been."

Across types of process documents, the data show the same pattern of both positive and negative inferences made about process rigor based on the identical cues. That is, the data indicate that information in the process documents was valuable to participants in different ways. This finding parallels that indicated by the first discussion prompt in investigating assessments made based on product—while there was general agreement about which cues matter in making assessments of rigor, there were differences among participants in how those cues were transformed into overall judgments of analytic rigor.

3.6.3 Rigor Assessment Prompt

The first decision prompt participants addressed was rigor assessment, as they were twice asked to judge whether A(1) or A(2) was more rigorous. This decision was made both after comparing the briefing reports and after comparing the process documents. The general finding from comparing the participants' responses was that gaining insight into the

analysis process changed perceptions of analytic rigor—even in participants who commented that it should not or would not do so. This prompt also examined the approaches participants preferred to use to discover the rigor of an analysis process.

"I try to stress to the people I work with that the process does not have to be rigid. You don't have to do A then B then C. You can do A then F then B then G."

Table 11 shows participant responses both before and after reviewing the process documents. In assessing rigor, five of nine participants, after reviewing the process documents, altered their assessments of whether they perceived A(1) or A(2) as being more rigorous. Additionally, the data indicated that, despite the study design, neither analysis process was clearly more rigorous than the other, as two of nine participants identified A(2) as being more rigorous, even after seeing the process documents.

The table also gives brief descriptions of the primary reasons participants offered in making their original assessments of rigor and for revising their assessments of rigor. This data provides insight into what, at a glance, participants deemed as being most salient in judging rigor. A related finding, based on similar comments, was that the introduction of process insight seemed to influence perceptions of rigor even in participants who indicated that it did not, would not, or should not, significantly influence their assessment. For example:

"The process documents lined up with my expectations."

*"My opinion didn't really change of the quality of the product.
It confirmed what I thought."*

Of the analysts who made the comments such as these, half actually did change their assessment of which process was perceived as more rigorous after reviewing the process documents. The insight, then, is that access to analysis process information is, potentially, more powerful in shaping perceptions of rigor than many of the participants realized.

"Rigor is fleshed out in the review process. If there is a problem then we go deeper."

As part of the rigor assessment prompt, participants were also asked to describe the process they would use to discover the rigor of an analysis process, given unrestricted access to the resources they might request. This question was posed to analysts before they reviewed the process documents. As shown in Table 12, responses to this inquiry tended to fall into three categories: analyst interaction, analyst background, and process dimensions.

Analyst interaction describes comments from participants that indicated they would use a form analyst-to-analyst interaction to discover process rigor. Analyst background covers comments from participants indicating that they would want to know background information about the analyst who produced the briefing. Finally, process dimensions identify the aspects of the analytic process that participants would be most interested in understanding when judging rigor. As noted earlier, these perspectives were voiced before the analyst reviewed, or were made aware of, the available scenario process documents.

ID	Bfr.	Rationale	Aft.	Rationale	Chg.	Rationale
P0	A(2)	Tailored for policy-makers, looked at context issues, explored the issues more Confident in seeing a more extensive bibliography	A(1)	Better rigor, but does not make final report any better, prefers A(2) report Information heavy. Data is there, but not in proper format Analyst afraid of picking and choosing information	Yes	A(2) had enough sources, but seeing process documents added more questions
P1	A(1)	Good preciseness, objectivity, lack of bias	A(2)	Saw more rigor than was assumed, shows good collaboration, feels a little better about conclusions Confounded by thinness of documents available, still needs something behind it	Yes	A(1) had impressive number of documents, but they are still insufficient More reluctant to forward report, would tell analyst to expand
P2	A(2)	Higher quality shows more rigor, provided more information	A(1)	Better rigor, but still not good enough	Yes	A(2) did not have enough, would have liked to see more
P3	A(1)	Addressed broader concerns	A(1)	Quality is better because quantity is better But, terrorism focus implies analyst had idea going in and looked for confirmation	–	–
P4	A(1)	Seems to have greater relative rigor in comparison, but still a low "absolute" rigor	A(1)	Research documents indicated more rigor than report reflected, problems in sourcing and answering question	–	–
P5	A(1)	Not as much opinion, indicates good research	A(1)	Good documentation gave confidence in process, reflected a more rigorous process Didn't have as many doubts, had more stylistic questions	–	–
P6	A(1)	Evidence of research, indicates more organized process	A(1)	Documentation implied more rigor, which was reflected in report	–	–
P7	A(1)	–	A(2)	More balanced, better research on topic, needs to work on presentation, Did not really collaborate	Yes	A(1) has good presentation, but poor research, heavily biased toward terrorism issue
P8	A(2)	Tighter form, tailored to decision maker, included chart	A(1)	Good depth of research, obstacles focused, organized	Yes	A(2) style was good, but research was lacking

Note. "Bfr." lists the analytic process identified by participants as appearing more rigorous *before* viewing the process documents, while "Aft." lists the process they identified *after* viewing the process documents. "Chg." refers to whether or not the participant *changed* their assessment of rigor after viewing the process documents.

Table 11. Assessment of Rigor Before and After Viewing Process Documents

ID	Analyst Interactions	Analyst Background	Process Dimensions
P0	Would meet with author and specify problems, peer review	–	Outlines of report Hypotheses Collaboration Sources Client requirements
P1	Would ask questions in course of day-to-day work, responses point to areas that need work	–	Looking for varied levels of detail in understanding Sources, foundational documents, background information
P2	Discussion with analyst, ask them what they did it Would start with the task question, then go to “second level” questions	Would want to know analyst Wants analyst to “own” their analysis processes, do they believe these things?	Looking for thinking from a multitude of perspectives Justifications and key indicators Sources
P3	Directly ask analyst, “how did you come to these conclusions?”	–	Credibility of sources Due diligence, source of sources Collaboration
P4	Face to face meeting or sending notes with questions General collaborative peer review process	–	Sources Use of connections Stated confidence Evidence of thinking about “next step” obstacles
P5	–	Might be interested in analysts background, but maybe not	Sources, public vs. classified
P6	–	Would want access to their past work, is it improving?	Sources Research Collaboration
P7	Direct collaboration	–	Sources, how current are they? Source Diversity, verification that they cover all places they are likely to find information
P8	Asking questions, communication via e-mail	Knowledge of analyst background and qualifications	Sources

Table 12. Participant Preferred Approaches to Discovering Process Rigor

The general theme across comments about analyst interactions was that interpersonal feedback was viewed as a critical way, if not the way, participants preferred to discover the rigor behind an analysis process. Regarding process dimensions, every participant indicated a preference for seeing original source information. Collaboration was mentioned by a number of participants as well. However, beyond that, participants voiced many variants on the information to which they would like to have access when making a judgment of rigor. There were also mixed results as to whether or not knowing an analyst's background would be of value, with some citing it as important to know and others expressing ambivalence.

Although these comments were valuable, the overarching message of the rigor assessment prompt is that process insight can influence perceptions of rigor. This finding was observed even in participants who did not expect the information to influence their judgments and even though participants were given access only to limited, incomplete information about process in the form of process documents. This finding was similarly observed in the second decision prompt, the Supervisor's Dilemma.

3.6.4 Supervisor's Dilemma Prompt

The Supervisor's Dilemma prompted participants to decide whether or not the analysis reports in the scenario were ready to be sent to a decision maker. As in the rigor assessment prompt, participants made this decision both before and after viewing the process documents. Also similar to the rigor assessment prompt, the Supervisor's Dilemma found that insight into process produced a change in assessment, as revealed in Table 13. In this case, the observed change was in regard to the assessment of quality of the analytic product, rather than process.

ID	Order	Rigor Assessment		Supervisor's Dilemma		Comments Before Viewing Process Documents
		Before	After	Before	After	
P0	A(1)	A(2)	A(1)	A(2)	A(2)	A(2) report might be ready, needs "action items" first
P1	A(1)	A(1)	A(2)	A(1)	NR	A(1) report is ready for policy-maker
P2	A(1)	A(2)	A(1)	NR	NR	A(2) report is better, but neither is rigorous enough
P3	A(2)	A(1)	A(1)	NR	NR	Both reports need editing, hard to tell which is better
P4	A(1)	A(1)	A(1)	NR	NR	A(1) report is better, attempts to look at issues
P5	A(2)	A(1)	A(1)	NR	NR	A(1) report is better, but would still require edits
P6	A(2)	A(1)	A(1)	NR	NR	A(1) report was much better, but still not ready yet
P7	A(2)	A(1)	A(2)	A(1)	NR	A(1) report isn't perfect, but might be good enough
P8	A(1)	A(2)	A(1)	NR	NR	A(2) report closer to being ready

Note. A mark of "NR" reflects a participant who indicated that *neither report* was ready to send forward.

Table 13. Run Order and Rigor Assessment and Supervisor's Dilemma Probes Before and After Viewing Process Documents, Including Comments

Unlike the assessment of rigor prompt, however, the Supervisor's Dilemma had relatively few participants identify either of the reports as ready to send to a decision maker—a surprising result potentially attributable to the fact that, in this prompt, participants were asked for an absolute judgement of acceptability, rather than a relative judgement of quality.

Before seeing the process documents only three of the nine analysts indicated that either of the reports was ready for a decision maker. After seeing the process, only one thought that either report was acceptable for a decision maker. Interestingly, it was the A(2) briefing report that, after the review of the process documents, was the only one deemed to be acceptable. No participant indicated that both briefings were ready. Consequently, the data show that two of the participants altered their assessments as a result of insight into the analysis process.

"It seems to me there's more conjecture... in this [briefing report]. And so I would have to question: Am I reading opinions or am I reading facts? As opposed to this [other] one, I get more of a 'warm and fuzzy' out of. I'm not seeing opinions written in here. There's more to [analysis] work than providing a report to a policy maker."

Also shown in Table 13, the data did not indicate a strong relationship between the order in which the analyses were labeled for participants and the likelihood that they preferred one process over the other. While there was a slight tendency for participants to view the analysis process of the second report that as being more rigorous, at least in initial assessment, this minor relation was not seen as meaningful in the context of the study. Thus, as expected, the order in which the reports were labeled was not a major factor in influencing participants' decisions of report readiness for a policy maker.

Process insight, it seems, does have the potential to influence the ambiguous "warm and fuzzy" alluded to in the above quotation. This finding even seems to hold when, as instanced in the Supervisor's Dilemma, there is not a clear consensus as to which report is better. Taken together, the data from the decision prompts indicate that providing insight into an analysis process influences assessments of both analytical rigor and product quality.

3.7 Participant Insights

In addition to the structured feedback provided through the decision and discussion prompts, participants offered many other insights throughout the elicitation sessions that were not directly related to the prompts. In particular, during the debrief sessions, participants were asked to identify what they saw as the most significant challenge currently facing the intelligence community. As seen in Table 14, there were a wide variety of responses to this question.

"[Policy makers] are too far removed from the analysts that actually do the work... If there are questions or clarifications that are necessary they may or may not filter back down to the person who actually did the work. [Instead] they may be answered by some intermediary who really doesn't have the expertise to be answering the question, but think they do because they're the ones that conveyed the report."

ID	Challenge	Description
P0	Producing actionable intelligence, given constraints	There is never enough time to work a problem, often policy-makers “want it yesterday” and want information “now or never”, even for big complex questions. This requires a dynamic process. What happens if process time is shortened? Is there a way to short-circuit the process while still maintaining rigor?
P1	Lack of data visualization aids	Lack of stock tools that grab disparate data and collect it into meaningful visuals.
P2	“Good news doesn’t sell”	Nobody wants to hear good things. But, when you look for bad things, everything looks bad. We are here to warn people, not give the “warm and fuzzies.”
P3	Re-syndication of information	Citing of sources is an emerging global issue. Things just seem to emerge. “I read it so it has to be true.” Proponent of group documentation for facts and history, e.g., Wikipedia. Allows for multiple contributing perspectives.
P4	Policy makers see what they want to see	Difficult for policy makers to overcome their preconceived notions. They can ask for additional analysis until supporting information is found.
P5	Analysis could be taken out of context	Analysis could be misunderstood or misused by itself. Should be taken in combination with other INTS.
P6	Pressure to please customer	There is a pressure to give the right answer. There often is no “right” answer. But, making policies requires a right answer. If analysis process is influenced too much, there is potential for bad decisions. Policy makers may keep asking until they get the answer they want. Policy makers assume reports come from “the expert.” Really they are just getting “best guesses.”
P7	Policy makers are too far removed from people doing the actual work	Disconnect in producer and consumer relation. Person who did work should always be included in work that goes forward. There are barriers to getting back to the source. If a question or clarification is necessary, it may not filter back to original author. Policy makers are too busy, or it is “beneath” them to go to the source. Typically questions are answered by intermediaries. They hear frequently from people they are comfortable with.
P8	Getting info to policy maker about obstacles encountered in doing analyses	E.g., getting across what was not covered in an analysis. There is only so much information analysts have access to, given constraints.

Table 14. Participant Identified Primary Challenge Facing the Intelligence Community

Admittedly, given limited time to consider the question, it is unlikely that participants identified as the greatest challenge in intelligence what, upon further reflection, they would have named as being most important. Rather, most participants probably identified a significant, or salient, challenge to the analysis community relevant to the earlier discussions. Even so, participants generated many interesting observations that reflect some of their current concerns as intelligence analysts.

A common theme observed throughout those comments was the identification of challenges that arise during the transfer of an analysis product from analyst, as producer, to policy maker, as consumer. In fact, P0, P4, P5, P6, P7, and P8 each identified a challenge related to the difficulties in the interactions between analyst and policy maker—a finding that, it might be argued, directly supports the value of better understanding the role of rigor in intelligence analysis.

Across the results of the study, two general patterns emerged. First, the data support the finding that providing insight into the analysis process produces change in perceptions of rigor. Second, the data also indicate that there was variability in how participants converted cues to rigor into overall assessments of rigor, even though they tended to use similar cues in forming their judgments. In the next section, the implications of these findings are discussed in relation to the broader intelligence and information analysis contexts.

4. IMPLICATIONS OF THE FINDINGS ON RIGOR

This section presents a discussion of the contributions and findings that emerged from the study of professional analysts described in this thesis. In addition, it explores a revised definition of analytical rigor in intelligence analysis, also commenting upon an alternative perspective toward rigor that exists within the intelligence analysis community. Finally, the section includes a discussion of the limitations of the design methodology and identifies future research directions for the continued exploration of the concept of rigor within the contexts of intelligence and information analysis.

4.1 Methodological Contributions

The development of the LNG Scenario is a significant product of this research in that it represents a refined scenario case with potential applications that extend beyond the exploration of rigor in information analysis discussed in this work. As a scenario, it provides a reusable cognitive case whose critical dimensions can be manipulated and reshuffled in various ways to study different themes in information analysis. In the LNG Scenario, the critical dimensions of the case are manifested in the four interacting aspects of energy, siting, safety, and security—abstracted as the respective cognitive components of replanning, planning, analysis, and reanalysis. These dimensions, then, serve as the basic levers that can be manipulated to explore other facets of information analysis in other contexts.

The conceptualization of Supervisor's Dilemma also represents an important contribution of this research effort by highlighting the rigor judgement decision that occurs at the interface between analysis and replanning in information analysis. This framing avoids some of the controversies in the intelligence community surrounding the relationship between analysts and decision makers, by leveraging the supervisor position as an intermediate perspective that falls somewhere between these two roles. The dilemma is primarily valuable though, because it operationalizes a basic aspect of avoiding shallow analysis. That is, realizing when an analysis is too shallow—and telling when more needs to be invested in the analysis process—is a fundamental part of what it means cognitively to perform information analysis. The Supervisor's Dilemma captures this critical function in a way that is easily integrated into studies of rigor in information analysis.

Perhaps most importantly, this study represents a validation of the Elicitation by Critique approach as an effective method for generating feedback from expert practitioners about their work. This research applied the EBC method with a different study design and with a different type of analyst, yet it succeeded in eliciting significant amounts of data in a domain that is highly restricted by security concerns. Additionally, because participants critiqued the analysis processes of other analysts, rather than performing analyses

themselves, the format of the study was sensitive to the time considerations of the participants as practicing professionals. Even so, and in spite of their other commitments, all participants were quite willing to commit the full time allotted to the study—and most probably would have continued sharing insights if given additional time—further attesting to the value of the method.

A related benefit of the study was that, as a modified version of the EBC approach, it explored a number of refinements of the methodology. Most notably, the method used in this study incorporated a scenario walkthrough component through the LNG Scenario and a decision prompt component through the Supervisor's Dilemma. The result was a study format that generated both verbal and behavioral data. The modified method was also structured such that the process documents were revealed midway through the study, effectively producing a partial debrief in the middle of each elicitation session. These changes ultimately led to a study design that produced a more rich and faceted data set than might have been collected using the basic EBC method alone. Thus, not only did this study serve to validate the overall EBC approach, but it also went a step further by incorporating potential—and, based on the study findings, ultimately valuable—refinements to the basic method.

4.2 A Discussion of Findings

The results of the study are discussed relative to the overarching purposes of the research to refine the understanding of rigor in information analysis and to identify leverage points for improving the connection between analysis and replanning in intelligence analysis. The results are discussed first in relation to the two overarching research questions, as identified in Section 2, and second in relation to the broader goals of expanding and supporting the understanding of rigor in both intelligence and information analysis.

4.2.1 *Impact of Process Insight on Judgment of Analytic Rigor*

The basic finding of the study regarding the primary research question was that process insight did, in fact, influence judgement of analytical rigor. The study found that, relative to both the rigor assessment prompt and the Supervisor's Dilemma prompt, participants altered their perceptions of rigor based on this insight. This effect was observed even in participants who stated that process insight would not influence their judgement. Moreover, the results indicate that even partial, incomplete, and second-hand process information can initiate change in assessments of rigor, as participants in the study made their judgments of rigor based only on the review of process documents—and not on a direct observation of the analytic processes or on any direct interaction with the author analysts.

This highlights an important distinction between *perceived* rigor, based on cues inferred from an analytic product, and *effective* rigor, based on insight into an analytic process—indicating that they often may not be aligned. While it was found that professional intelligence analysts often made insightful assessments of perceived rigor, the results of the study indicate that these perceptions were apt to change with the addition of process insight. This finding both supports and extends the observation of Tufte (2003) that the form of an analysis product—in this case a briefing report, rather than a PowerPoint presentation—can distort the understanding of the process the produced it.

There are, however, two related caveats to these study findings that should be noted. First, there were some participants who were reluctant to revise their assessments of rigor, even in the face of seemingly conflicting data. For example, P0 continued to judge the A(2) briefing report as being better, even in acknowledging, after reviewing the process documents, that A(1) was the more rigorous process. This behavior is not entirely surprising, however, and might be characterized as a manifestation of fixation, as defined in the psychology literature, in that participants hypothesized that their perceived rigor judgments were accurate, even when new data suggested that they were not (Fraser, Smith, & Smith, 1992). This behavior might alternatively be viewed as resulting from the utilization of knowledge shield—in selectively attending only to the information that supports an initial hypothesis, for example (Feltovich, Coulsen, Spiro, & Adami, 1994).

The second caveat was the tendency for some participants to interpret weaknesses indicated by the process documents as being indicative of deficiencies in the abilities of the author analyst, rather than as deficiencies of analysis process. P3, for instance, commented that both reports reflected an unseasoned analyst. The emergence of this inclination in some participants was consistent with the research on attribution error, given that the cues available in the process documents were inherently ambiguous and could feasibly interpreted multiple ways (Ross & Anderson, 1982; Fraser, Smith, & Smith, 1992). Also contributing to the emergence of this behavior, at least in part, was the fact that participants were told at the outset of the study that they were critiquing the analysis processes of junior analysts—likely increasing the chance that they would make a dispositional, rather than situational, attribution of process weaknesses.

The overall message, then, is that simply providing process information does not guarantee a change in perspective. Rather, it is important to recognize that certain types of process information facilitate the realization of process insight, different types of which may be better or worse in influencing revisions of perceived rigor. While this study does not purport to define what is precisely the right process information to provide, the findings related to the second research question do point toward the facets of analytic process that are most critical in making judgments of rigor.

4.2.2 Cues for Inferring Rigor in Intelligence Analysis

The study data indicate that, while many of the same cues were used to make inferences about analytic rigor, there were substantial differences among participants as to which cues were perceived as being most relevant and in how judgments of rigor were drawn from these cues. For example, most participants tended to rank collaboration as an important cue for assessing rigor in an analysis process. However, some participants viewed it as a positive indicator of analytic rigor (e.g., as indicating that multiple perspectives were incorporated into an analysis process) while others viewed it as a negative indicator (e.g., as indicating that the analyst did not have a strong command of the subject matter and thus needed to seek out expert support). This contrasting interpretation of similar cues was found in participant's comparisons of briefing reports as well as comparisons of process documents.

This finding echoes an observation shared by a number of participants in the study—that there is no one right way to do analysis. Rather, an analyst must accept that others have

different practices that produce acceptable results and that their approaches can be equally valid, even if not completely understood. As described by one study participant:

"I'm not sure that there is one correct method to doing analysis. Sometimes, it's understanding, or not even understanding, accepting that someone else has practices that are different than yours. But when they follow those practices, they come out with solid results: that they're going to be repeatable, that they're going to be verified... that they're going to be valid. And it's different from mine; and I may disagree with the way they got it or may not understand how they did it, but they still come out with valid results."

This perspective seemed to influence how participants attended to briefing report cues as well as in how they attended to process document cues. In relation to comparison of reports, participants attended both to product formatting details, such as writing style, and to more subtle nuances derived from the content of the reports, such as the inferences that could be made about the perspectives and biases of author.

In comparing process documents, participants generally preferred to use "Key Documents" and "Hypotheses Considered" in assessing analytic rigor. It is perhaps not surprising that primary sources and hypotheses were viewed as being most critical in assessing rigor. From the perspective of participants, checking key documents was much the same as checking sources—which is among the most basic approaches a professional analyst is trained to use. The importance of hypotheses, then, are also unsurprising when viewed in light of the perspective among some in the intelligence community that the analysis of hypotheses is the primary path to analytical rigor (Heuer, 1999). In fact, this finding lends validity to this perspective, as it seems some professional analysts do perceive an understanding of hypotheses as being an important component of judging rigor.

Relative to the comparison of process documents prompt, there is also something to be learned from what participants did not prefer. In the study, analysts generally found the "Where Documents Stored in Folders" process documents to have very little value in assessing rigor. What became apparent in the discussions about this type of document, was that the participants were generally not interested in *how* analysts carried out their analysis processes, but rather, were interested in understanding *why* analysts did what they did in their analysis. One participant, for example, commented that, while seeing the hypotheses considered was useful, it would have been more valuable to see how those hypotheses changed during the course of the analysis process—in the form a "hypothesis timeline" for example.

There are two general findings that emerged from this study regarding the use of cues in assessing analytic rigor. First, participants tended to use the same cues in judging rigor, but interpreted them in diverse ways. Second, in judging rigor, participants were more interested in process information cues that could address questions of "why" rather than those that could address questions of "what."

The finding that key documents and hypotheses were deemed most critical in judging rigor is somewhat limited in generalizability, however, as it is unclear whether these cues were identified as being important because of factors acting within the intelligence community

or whether they reflect critical cues in judging rigor across information analysis domains. While this research does not purport to have identified the cues that contribute to assessments of rigor, it has helped to refine the general understanding of these cues, by exploring the aspects of analysis products and processes that are meaningful to professional analysts in judging analytic rigor.

4.2.3 *Informing the Design of Analysis Support Tools*

Given the inherent challenges of building and evaluating intelligence analysis support tools, an understanding of rigor is valuable in informing the design of software to assist the professional analyst (Elm et al., 2005; Greitzer, 2005; Billman, Convertino, Shrager, Massar, & Pirolli, 2006; Morse, Steves, & Scholtz, 2006). The findings of this research aid tool development in two primary ways.

The first insight from the study is that developers should design current support tools to reveal, rather than mask, the rigor of the analysis process. The catch, however, is that conveying an understanding of process is not the same as simply providing access to information about the process, in as much as providing observability is not the same as merely making data available (Woods, Patterson, & Roth, 2002). In fact, providing decision makers with ambiguous information about analytic process is apt to have the opposite impact of that desired, serving only to reinforce assessments of perceived rigor (Lord, Ross, & Lepper, 1979). Thus, process information must be framed in such a way that it conveys process insight, revealing the effective rigor of an analysis process in a way that challenges conceptions of perceived rigor.

The second way this research supports the design process is through the finding that process insight does, in fact, have an influence on judging rigor. Thus, this research potentially inspires the design of a totally new class of innovative tools that afford capturing and sharing of the analytic rigor inherent in intelligence analysis processes. In either case, additional research would be required in order to better define the critical components of rigor that need to be captured in building an effective analysis support tool. However, the findings of this study also provide initial guidance for such efforts, offering some initial insights into the nature of the cues that are used to infer analytic rigor.

4.2.4 *Extending the Findings Across Information Analysis Domains*

Perhaps the most surprising finding from the study was that—despite significant efforts in developing the scenario-based analyses and despite inputs from professional analysts in refining them as plausible analytic responses—very few of the participants thought either of the analysis reports was ready to send forward. As described in the previous section, before reviewing the process documents only three participants thought that either report might be ready to send forward. After seeing the process documents that number decreased, as only one participant thought either of the reports might be ready to go forward. More surprising still was the fact that this participant perceived the A(2) report—generated by the low rigor analysis process—as being more ready to send forward than the A(1) report.

The consequence of this finding, then, was a reconceptualization of the definition of rigor in intelligence analysis that contrasts with the traditional perspective. Rather than focusing on deviation from a baseline process, study participants instead identified a number of

different attributes that compose a rigorous analysis. Thus, rigor was not viewed as a single variable that reflected adherence to a particular process, but rather it was a composite, emergent property of many different aspects of process. The common theme across these aspects of the analytic process was that rigor was consistently framed as a measure of sufficiency. Thus, one of the more powerful implications of this work arises from the recognition that supporting an understanding of rigor is about supporting an understanding of the sufficiency of analysis in context, rather than about determining adherence to standard process.

This finding on rigor is meaningfully applied beyond the intelligence analysis community, as the important role of rigor is acknowledged in other information analysis contexts as well. In perhaps the most salient example, described in Section 1, the importance of effectively communicating analytical rigor was brought to the forefront of NASA's focus following the Columbia accident (Columbia Accident Investigation Board, 2003; Crippen, et. al., 2005; Woods, 2005). Private industry too is increasingly recognizing the value of understanding the appropriate level of rigor in information analysis processes, relative to decision criticality and resource priority (Krizan, 1999; Dubé & Paré, 2003). In health care, still others question the value of the traditional understanding of rigor in relation to qualitative social research (Davies & Dodd, 2002). Thus, the importance of recognizing rigor as a sufficiency metric, rather than process deviation metric, is a critical finding that extends meaningfully across information analysis domains.

4.3 Rigor in Intelligence Analysis

As noted in the previous section, the surprising finding that few participants judged either of the scenario reports as being ready to forward to a decision maker led to a reframing of the concept of rigor as a measure of sufficiency, rather than deviation. This finding also revealed that participants viewed rigor as an aggregate metric that emerged from the interaction of multiple facets of an analytic process. This feedback, in turn, pointed toward a very different, composite model for understanding rigor as a valuable concept in supporting intelligence analysis. In proposing this revised model of rigor, it is contrasted with the traditional understanding of rigor in intelligence analysis.

As noted in Section 1, defining rigor is difficult in most any information analysis setting. Intelligence analysis proves no exception, as the diverse nature of analysis work makes the identification of a standard process that can be applied across all intelligence contexts inherently difficult (Berkowitz & Goodman, 1991). In tactical military intelligence operations, Intelligence Preparation of the Battlefield (IPB) is often cited as the current standard for supporting the Military Decision Making Process (MDMP) (Intelligence Preparation of the Battlefield, 1994; Medby & Glenn, 2002). In strategic analysis—where, arguably, a similarly well-defined intelligence process does not exist—the identification of a comparable standard is ambiguous. There is, however, a perspective among many in the intelligence community that achieving rigor in the analysis process depends, most centrally, on the application of a formal method for weighing and comparing of hypotheses—commonly termed the Analysis of Competing Hypotheses (ACH).

Heuer (1999) defined the ACH approach as an eight step method that is "a rational, systematic process that avoids some common analytical pitfalls" and that is designed to "guarantee an appropriate process of analysis." Schum (1987) also recognized the important role of hypotheses, identifying them as one of the three "necessary ingredients of inferential intelligence analysis," in conjunction with evidence and assumptions. Although, Schum (1987) tended to emphasize how different types of evidence support or contradict individual hypotheses, common across both approaches is the understanding that rigorous analytic process is attained through a structured, deliberate connection of data to hypotheses and the subsequent comparison among viable alternatives.

Generally, advocates of this perspective support the more widespread application of structured methodologies, such as ACH, contending that their use is required to achieve rigor in the analytic process (Pirolli, Good, Heiser, Sharger, & Hutchins, 2006). Folker (2000), for example, conducted an exploratory study with analysts from four different joint intelligence centers, finding that analysts who employed even a simplified hypothesis testing method outperformed those who did not.

There is, however, also the perspective among many in the intelligence community that the application of the ACH method is impractical, among other criticisms, and thus not a reasonable standard for assessing rigor (Czerwinski, 1998). Practitioners holding this perspective contend that—as observed by Johnson (2005)—the use of structured methodologies are too restrictive to be routinely implemented in the "tradecraft" of intelligence analysis, noting studies that have found little, if any, benefit to using such methods (e.g., Cheikes, Brown, Lehner, & Alderman, 2004).

Even the dichotomous views on rigor presented here are inherently incomplete, however, as there are still others in the intelligence community who have entirely different perspectives on analytic rigor (e.g., Moore & Krizan, 2001). The important overall message then, is that the concept of rigor in intelligence analysis—as in many other information analysis domains—is traditionally, albeit debatably, viewed as adherence to a formalized standard process. The results of the study, however, support a different perspective on rigor. None of the participants in the study, in fact, directly questioned whether or not the junior analysts in the scenario followed a specific method, such as ACH, in assessing the analyses. Instead, the participants sought to understand many different, but interrelated aspects of their analysis processes in judging rigor.

In contrast with the traditional perspective, the revised definition of rigor that emerged from the study frames the concept as the composite of multiple process dimensions. This multi-attribute metric characterizes these indicators as independent components of the analysis process which, when aggregated, reveal a composite assessment of analytic rigor. In addition to the findings from the study, this framing of rigor was shaped by the traditional perspectives on rigor in intelligence analysis, the findings from other studies of professional intelligence analysts, feedback from a diverse group of professional analysts, and empirical insights that emerged from interactions with those analysts, all of which occurred during the study or as follow-ups to the study.

Attribute	Description	A(1)	A(2)
Hypothesis Exploration	Hypothesis Exploration describes the extent to which multiple hypotheses were considered in explaining data. In a low-rigor process there is minimal weighing of alternatives. A high-rigor process, in contrast, involves broadening of the hypothesis set beyond an initial framing and incorporating multiple perspectives to identify the best, most probable explanations.	L	L
Information Search	Information Search relates to the depth and breadth of the search process used in collecting data. A low-rigor analysis process does not go beyond routine and readily available data sources, whereas a high-rigor process attempts to exhaustively explore all data potentially available in the relevant sample space.	H	M
Information Validation	Information Validation details the level at which information sources are corroborated and cross-validated. In a low-rigor process little effort is made to use converging evidence to verify source accuracy, while a high-rigor process includes a systematic approach for verifying information and, when possible, ensures the use of sources closest to the areas of interest.	M	M
Stance Analysis	Stance Analysis is the evaluation of data with the goal of identifying the stance or perspective of the source and placing it into a broader context of understanding. At the low-rigor level an analyst may notice a clear bias in a source, while a high-rigor process involves research into source backgrounds with the intent of gaining a more subtle understanding of how their perspective might influence their stance toward analysis-relevant issues.	M	L
Sensitivity Analysis	Sensitivity Analysis considers the extent to which the analyst considers and understands the assumptions and limitations of their analysis. In a low-rigor process, explanations seem appropriate and valid on a surface level. In a high-rigor process the analyst employs a strategy to consider the strength of explanations if individual supporting sources were to prove invalid.	M	M
Specialist Collaboration	Specialist Collaboration describes the degree to which an analyst incorporates the perspectives of domain experts into their assessments. In a low-rigor process little effort is made to seek out such expertise, while in a high-rigor process the analyst has talked to, or may be, a leading expert in the key content areas of the analysis.	M	L
Information Synthesis	Information Synthesis refers to how far beyond simply collecting and listing data an analyst went in their process. In the low-rigor process an analyst simply compiles the relevant information in a unified form, whereas a high-rigor process has extracted and integrated information with a thorough consideration of diverse interpretations of relevant data.	M	H
Explanation Critique	Explanation Critique is a different form of collaboration that captures how many different perspectives were incorporated in examining the primary hypotheses. In a low-rigor process, there is little use of other analysts to give input on explanations quality. In a high-rigor process peers and experts have examined the chain of reasoning and explicitly identified which inferences stronger and which are weaker.	M	L

Note. "H" reflects *high* rigor, "M" reflects *moderate* rigor, and "L" reflects *low* rigor in an attribute of the process for Analysis Process 1 [A(1)] and Analysis Process 2 [A(2)] developed for the LNG Scenario.

Table 15. Dimensions of Rigor as Applied to the Study Analysis Processes

Specifically, the findings of the study led to the identification of eight critical attributes of analysis processes that contribute to assessments of rigor, as shown in Table 15. Also included in the table are assessments of the analyses developed for the LNG Scenario, relative to the proposed critical aspects of rigor, that are based on feedback generated by study participants. Interestingly, this reassessment of the scenario-based analyses helps explain why there was disagreement among study participants as to which analysis was most rigorous—and why so few were reluctant to pass them on in the Supervisor's Dilemma.

While A(1) and A(2) were designed to reflect high and low rigor processes respectively, within the revised framing the two processes actually differed more in their patterns of rigor than in absolute levels of rigor. Despite collaborative design efforts, A(1), it turned out, did not contain high levels of rigor across all dimensions, but rather, showed generally moderate rigor in most aspects of the process, while in fact even being low in one aspect. A (2) turned out to be low in many dimensions, as was intended, but also showed moderate or high rigor in a few dimensions.

This finding, perhaps, explains why some participants perceived the A(2) report as being the better report, even after seeing process information—they attended to and valued certain aspects of analytic rigor over others. One possible interpretation of this finding is that, while it is relatively easy to reach a moderate level of analytical rigor in information analysis, it is often quite hard to reach a high level of rigor in more than a couple dimensions. The corollary to this interpretation is that it is also quite easy to overlook an aspect of analysis, remaining low on a dimension of an otherwise moderate level analysis.

The general message, then, is that rigor in information analysis is not understood by assessing deviations of process, but rather, by assessing the contextual sufficiency of many different aspects of process. The results of the study were further used to identify these critical aspects of the analysis process, leading to a revised definition of rigor that encompasses the eight dimensions of process listed in Table 15. This proposed definition of rigor implies that, to the degree that there is rigor in an analysis, an individual assessing an analysis process would want to know something about each of these attributes in forming a composite judgment of the sufficiency of rigor. However, in positing this definition of rigor, it is noted that, as discussed in the next section, the generalizability of this and other findings of the study may, in fact, be somewhat constrained due to both pragmatic and methodological limitations of study design.

4.4 Limitations of Study Design

The research study discussed in this thesis was designed to explore the understanding of rigor in information analysis in the applied setting of professional intelligence analysis. While there are many reasons, as discussed in Section 2, that the domain of intelligence analysis is a representative context for the study of information analysis, there are, of course, limitations in the study design that restrict the generalizability of findings both within the domain of intelligence analysis and across domains of information analysis.

Many of the limitations resulted from pragmatic tradeoffs made in the course of designing and running the study. For example, as described earlier, the LNG Scenario was selected

based on its authenticity as a generic information analysis task, rather than its validity as a realistic intelligence analysis task. This reflected a decision to favor obtaining candid feedback over representing true domain authenticity, as selecting a scenario topic that was of real professional interest to a participant analyst would have, by definition, sharply limited his or her ability to discuss it in the unclassified setting of the study. This tradeoff, in conjunction with time constraints, also influenced the scope of the study, as the analysis processes and briefing reports critiqued by participants were smaller in scale than those that analysts actually deal with on a day-to-day basis.

Another pragmatically-driven tradeoff was in defining the population sample size of the study. Sample size was limited most notably by the inherent difficulties of identifying representative analysts to participate in the research study. Not only do professional strategic intelligence analysts represent a very small population, but the nature of their work is such that they are necessarily restricted from talking much about it. Additionally, given the immense importance and continuous pace of intelligence analysis, most analysts have limited time available to commit to research purposes. Consequently, it should be noted that any research within the domain of intelligence analysis will be limited in its ability to secure a representative sample of participants. And thus, the nature of the study sample might also be viewed as a strength, in that it was possible to identify a pool of highly experienced analysts to participate in an exploratory research study.

Other tradeoffs relating to study design were more methodological in nature. One limitation of note was that, given that there was no prescreening of participants, it was difficult to determine the extent to which perceptions about the LNG Scenario may have biased judgments of rigor. While this risk was somewhat reduced by the fact that no participant indicated a professional familiarity with the subject matter, there are certainly related issues that participants may have felt strongly about that could have predisposed them toward favoring one report over the other—for example, their stance toward dependence on foreign fuels or the impact of industrialization on the environment.

The potential influence of predisposition and bias on perceptions of analytical rigor is certainly important, although not new or unique to this study. Research in social psychology has long observed the tendency for people to perceive as more credible and valid those opinions that support their prior beliefs on an issue (Lord, Ross, & Lepper, 1979; Pyszczynski, Greenberg, & Holt, 1985). This tendency relates more broadly to the second of Kahn's (2001) two "all-encompassing, never ending... [and] ultimately unresolvable" problems in intelligence: "how to get statesmen and generals to accept information that they do not like," (the first problem being the inherent difficulties in making predictions about the future in an uncertain, dynamic world). Unfortunately, this is not a problem with much promise of ever being fully resolved, although there is some cause to believe that the negative impact of such a tendency might be assuaged through a better understanding of rigor. In fact, it is conceivable that future studies of rigor in information analysis would explore the influence of this very factor.

A second methodological tradeoff, the scenario-embedded Elicitation by Critique approach, as a form of Staged World study (Woods & Hollnagel, 2006), was used because it balanced the inability to directly observe (or talk about) real analysts doing real analysis work with the desire to explore the role of rigor, rather than test a specific hypothesis about rigor.

Additionally, the EBC method used in the study was modified in order to incorporate the LNG Scenario, another manifestation of the previously mentioned tradeoff between ability to collect data and task authenticity. Of course, there are inherent tradeoffs regarding generalizability of findings in choosing any study methodology over any other. In selecting the design of this study, it was determined that the theoretical tradeoffs stemming from the method were appropriate relative to the broader goals of the research.

There are still other study limitations that resulted from both pragmatic and methodological considerations, which perhaps more seriously restrict the ability to generalize the findings. Most notably, while one of the stated goals of the study was to better understanding the role of rigor in enhancing the connection between analysts and decision makers, it should be noted that no decision makers participated in the study. From a practical standpoint, it would have arguably been even more difficult to identify truly representative decision makers to participate in this study, as they represent an even smaller and more time constrained population than professional analysts. From a theoretical standpoint, an assumption was made that the way in which analysts and decision makers judge rigor was similar, at least in terms of the most critical dimensions.

It is a very valid and significant criticism to question the appropriateness of this assumption that analysts and decision makers view rigor similarly. In the context of the study, the impact of this assumption was somewhat mitigated by asking participants to critique the analysis reports from the assumed role of supervisor. In intelligence analysis, the analyst supervisor in many instances serves as intermediary between analysts and decisions makers and thus must view briefing reports with both perspectives in mind. Of course, one might argue that your average analyst is unable to truly assume the perspective of a supervisor—a position mildly supported by the results of the study.

Incidentally, a couple study participants, although possessing significant prior experience in the role of analyst, were in their present duties at the time of the study considered to be supervisors. Interestingly, these participants were, at least initially, more likely to identify the A(2) briefing as being the better, more rigorous report. Given that the A(2) report was generally judged by participants as being better relative to the overall presentation qualities, it is tempting to conclude that there was, in fact, a difference in perspective between analysts and supervisors. The veracity of this conclusion is tempered, however, by the fact that there were only two known analyst supervisors who participated in the study, making it difficult to determine whether this difference was significant or not.

Still, it could be reasonably concluded that this finding at least lends credence to the position that analysts and decision makers judge rigor in very different ways. Of course, it could also be reasonably concluded that, in a broad sense, the assumption is not all that consequential, given that it is still valuable to understand how analysts assess rigor, even if only to contrast their perspective with future research exploring how "real" supervisors and decision makers assess rigor. Although unresolved, this debate is perhaps even more relevant when viewed in light of an alternative perspective on the role of rigor within the intelligence community, as discussed in the following section.

4.5 An Alternative Perspective on Rigor

There is another perspective in the intelligence community on the value of understanding rigor that warrants mention. Simply put, this alternative perspective asserts that an understanding of rigor is not what matters—particularly to decision makers—and thus is not a valuable aspect of the intelligence cycle to explore. As framed by Betts (1978), the problem is this:

Intelligence consumers are political men who have risen by being more decisive than reflective, more aggressive than introspective, and confident as much as cautious... Even if they could be forced to confront scholarly evidence of the dynamics of misperception, it is uncertain that they could consistently internalize it... Moreover, the line between *perception* and *judgement* is very thin, and consumers cannot carefully scrutinize, compare, and evaluate the methodologies of competing analyses, for the same prosaic reasons (the problem of expertise aside) that impedes many proposed reforms: they do not have the *time* to do so. Solutions that require principals to invest more attention than they already do are conceptually valid but operationally weak. Ideally, perhaps, each principal should have a Special Assistant for Rigor Enforcement.

In fact, some participants in the study echoed this very sentiment. In its mildest form, some indicated that a decision maker simply would not look for indicators of rigor. Other participants expressed a variant on this view, noting that process quality does not change whether it is a good or bad product. As a more extreme position, one participant commented that often times, given the high visibility of their position, policy makers do not care much if the information provided in an analysis is "right," as it gives them somebody to blame if things go wrong.

In addressing this alternative perspective on rigor, there are at least two ways that one might respond. The first way would be to assert that rigor is still a valuable concept in the domain of intelligence analysis—just not to decision makers. Instead of being applied to enhance the connection between analysts and decision makers, an understanding of rigor would perhaps more usefully be applied in supporting the connection between analysts and supervisors or in analyst-to-analyst interactions.

As discussed previously, the Supervisor's Dilemma was, to a certain extent, developed to address this very issue. By framing the dilemma as belonging wholly to the supervisor, a tradeoff was made in selecting a spot in the information analysis and planning cycle that, in actuality, is sometimes real and sometimes notional. Thus, it does not really matter exactly where in the cycle the decision is made to invest resources or not, the more critical point is that somewhere in the chain this decision is being made, whether explicitly—as in the study—or implicitly—as in the case of the analyst who judges that an analysis is sufficient relative to resource pressures and time limitations.

A second way to respond to this alternative perspective would simply be to restate that, as supported by the findings of this study, an understanding of rigor is in fact valuable in influencing perceptions of rigor. As noted in the quote above, Betts concedes that such an approach is likely to be conceptually valid but, by creating additional demands for decision makers, it is also likely to err in its implementation. Consequently, the underlying issue may not be whether or not rigor is a valuable concept, but whether or not the concept can be

incorporated in a way that it makes judging the sufficiency of an analytic process easier and more intuitive, rather than more complicated and nuanced.

Thus, the general response to the alternative perspective on rigor is simple: rigor is important because it shows the potential to be useful as a general concept. However, in positing this view, it is also acknowledged that an understanding of rigor is not all that matters in improving the broader intelligence cycle, but one of many things that matter—a perspective that is apt to hold in other information analysis domains as well. The *Doctrine for Intelligence Support to Joint Operations* (2000), for example, identifies other critical attributes of intelligence—such as timeliness, usability, and relevance—that extend beyond the basic framing of analytical rigor advanced in this thesis. Thus, as it is very much a part of what is important, the understanding of rigor is a concept warranting continued exploration.

4.6 Future Work

As much as the findings of this research serve to refine the understanding of rigor in information analysis, so too do they expand the potential directions of future explorations of the concept. The study prompted three main directions for future inquiry. First, within the context of intelligence analysis, the research findings open the door for future explorations of the process cues that are used in judging rigor. Such studies would focus more specifically on understanding which cues are most relevant in judging rigor and on understanding how these cues could be leveraged to support the professional intelligence analyst. Additionally, future research might also involve a study of rigor using decision makers, rather than analysts, looking at how their perspectives are similar and different in forming judgments of rigor.

Second, because the research was based only on findings developed in the context of intelligence analysis, future work would focus on understanding how the findings of this study translate into other information analysis domains. Such research may run similar studies to that described in this thesis or may include entirely different studies that explore other aspects of rigor in other information analysis contexts. In either case, the methodological contributions of this study could prove invaluable, as the EBC methodology that was refined around the Supervisor's Dilemma is well suited for application in other information analysis domains, while the LNG Scenario offers a developed cognitive case that is flexible enough to be adapted for other research efforts.

Finally, the revised definition of rigor as an emergent and multi-attribute property of analysis serves as the basis for the future development of new tools and techniques for improving information analysis. As such, the potential directions for the continued study of rigor in information analysis are extensive, as the exploration of rigor is necessary to better understanding how the concept can be leveraged to improve analysis processes across domains of information analysis.

4.7 Conclusions

As the changing technological landscape of information analysis exacerbates the already difficult task of detecting when analysis is of sufficient rigor, it becomes increasingly easy for analyst and decision maker alike to be trapped by shallow analysis—perceiving it as being deeper and more rigorous than it actually is. A better understanding of rigor is an analytic broadening check to be leveraged against this constant risk. The research study discussed in this thesis explored the concept of rigor with this perspective in mind, producing many valuable contributions—both in methodology and in findings—that serve to advance the understanding of rigor in information analysis.

In the study, the LNG Scenario was developed as a context for the exploration of rigor. As a cognitive case, the scenario also shows the potential to be leveraged in the exploration of other aspects of information analysis. The Supervisor's Dilemma also emerged from the development of the study as a valuable framing for investigating the link between analysis and replanning in information analysis. The study also served to validate and refine—by embedding in the context of a scenario walkthrough study design—the Elicitation by Critiquing methodology as a valuable approach for generating insights from experienced practitioners that go beyond simple descriptions of the work.

The study also produced three general findings that contributed to the understanding of rigor in information analysis. First, the data showed that providing process insight to participants initiated change in perceptions of rigor. Second, it was found that professional analysts tended to use similar cues in making judgments of rigor; however, the ways in which those cues were transformed into composite assessments of rigor were more varied. Third, the surprising finding that few study participants perceived either of the scenario-based analysis reports as being ready to forward to a decision maker led to the development of a revised definition of rigor, reframing it as a multi-attribute, emergent measure of sufficiency rather than as a measure of process deviation.

There are many potential ways in which these contributions to the overall understanding of rigor might be leveraged to improve the process of information analysis. Most notably, understanding rigor offers direction for avoiding the trap of shallow analysis, by revealing opportunities to amplify the ability of both analyst and decision maker to more authentically judge the rigor of analysis products. Further, identifying the cues that are used to infer rigor provides guidance for directly supporting the professional information analyst. Perhaps most importantly though, this research into rigor reveals promising directions for the continued exploration of the challenges—those long-standing as well as those driven by recent technological change—that confound the process of information analysis.

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APPENDIX A
STUDY MATERIALS

***** UNCLASSIFIED *****

As a senior analyst, you might be asked to decide if junior analysts' reports are ready to be passed on to a policy-maker. Please:

- Assess and compare the quality of the two written reports
- Comment on the "rigor" of the processes that produced each of the reports

The two analysts were both asked: *What are the primary obstacles to using Liquefied Natural Gas to address energy needs in the U.S.?*

Figure A.1: Scenario Introduction Document, Page 1 of 1

***** UNCLASSIFIED *****

Question: What are the primary obstacles to using Liquefied Natural Gas (LNG) to address energy needs in the US?

There are varied uses for natural gas in the United States. The industrial sector accounts for the largest proportion, especially for power generation, but also in the pulp and paper, metals, chemicals, petroleum refining, and food processing industries. Natural gas also provides the base ingredients for products such as fertilizer, anti-freeze, plastic, and fabrics. In the residential and commercial sectors, natural gas is used primarily for heating, cooling, and cooking. The transportation sector is developing new technology but does not extensively use natural gas currently. Rising gasoline prices, oil price volatility, and the possibility of domestic oil shortages have increased U.S. demand for natural gas, despite being more expensive to produce and transport. Domestic natural gas reserves are no longer sufficient to satisfy the growing demand, so the U.S. relies on foreign natural gas imports, which tend to be cheaper, mostly from Trinidad.

Natural gas condenses into liquid, or LNG, when it is cooled to temperatures below -260° Fahrenheit. As a liquid, natural gas occupies only 1/600th the volume of its gaseous state, which allows it to be stored and transported more effectively. LNG is then “regasified” when it is warmed. The regasification process takes place at the nation’s four LNG terminals: Chesapeake Bay, Maryland; Lake Charles, Louisiana; Elba Island, Georgia; and Everett, Massachusetts. More than 30 new terminals are being planned, are in the licensing process, or are currently under construction in the United States.

There are four primary obstacles to using liquefied natural gas (LNG) to address energy needs in the United States: 1) risk of fire and radiation release from intentional terrorist attacks on stationary terminals and during shipping, 2) risk of fire and radiation release from unintentional release of LNG, 3) resistance to the use of lowly populated environmental areas for industrial purposes, and 4) reduced property values to local areas.

Terrorist groups, in particular The Jihadist Terrorist network of al Qaeda and similar groups, have the intent and capability to attack urban LNG facilities and tankers transporting LNG. The goals publicly articulated by these groups include 1) killing large numbers of Americans, 2) conducting attacks in the United States, and 3) damaging the US economy, and 4) damaging oil and gas infrastructure. The capabilities of these groups are extensive, as illustrated by the September 11th attacks. Those attacks required years for planning and reconnaissance, as well as specialized knowledge including how to fly and engage in close quarter combat. They demonstrated the ability to operate undetected in the U.S., and weapons and other capabilities to attack a carrier or terminal are readily obtainable in the US, including boats, scuba gear, general aviation aircraft, fertilizer based and commercial explosives, and large caliber rockets on the international gray arms market.

REPORT #1

1

Figure A.2: Analysis Process 1 [A(1)] Briefing Report, Page 1 of 2

***** UNCLASSIFIED *****

It is unlikely that deterrence or prevention measures would be adequate to defend against attacks from skilled terrorist groups, and they would significantly increase costs. Nevertheless, measures to reduce the risk of attacks on LNG facilities include 1) locating LNG terminals more than three miles away from highly populated areas, and 2) constructing structures around LNG facilities similar to those buildings required by the Nuclear Regulatory Commission around commercial nuclear reactors. To reduce the risk of attacks during shipping transport, measures include 1) locating the facility away from inland waterway transits, 2) armor plating the gas storage containers aboard the LNG tankers, and 3) transporting gas in tankers that do not freeze and condense the gas, thereby reducing the force and radius of an explosion.

The risk of an unintentional release of LNG is less than from a terrorist attack because the LNG release, and therefore the flammable vapor and thermal radiation hazards, would likely be far less. Nevertheless, severe negative impacts to life and property within a couple miles could result, including tens of thousands of deaths and injuries due to severe burns within the first few minutes of a spill of LNG, which forms a floating "pool fire" when ignited. Comprehensive evacuation plans and education of surrounding populations could reduce risks by delaying going outside before the pool fire evaporates, thereby reducing unnecessary exposure to high levels of thermal radiation.

In order to reduce the risks of intentional or unintentional releases of LNG, terminals are often recommended to be located several miles from highly populated areas. Particularly when national, state, or local parks are recommended locations, there is resistance to industrial development. The ability to address this issue depends upon the availability and accessibility of previously developed, lowly populated spaces within the vicinity of natural gas users.

The final barrier is concern about reduction of property values due to proximity to an LNG terminal. Industrial development in general is associated with a decrease in property values of properties within a two-mile radius due to visual effects, noise, light, traffic congestion, and odors. Decreases due to the perceived threat of terrorist strikes or unintentional fires are also possible. On the other hand, property values near existing LNG terminals have not significantly decreased. In any case, the perception of decreased property values by local residents has been a significant obstacle in several failed attempts to install LNG terminals. Measures such as by having companies provide protected shoreline access to private properties or highlighting increased tax revenue from a new terminal, may address this obstacle on a case by case basis.

This analysis does not include the front end of the LNG supply chain (i.e., the exploration, production, and liquefaction of gas from distant and isolated locations) or the features and permitting of small LNG facilities for vehicle fueling or peak-shaving purposes. It also does not discuss barriers due to local (i.e., state or regional) legislation

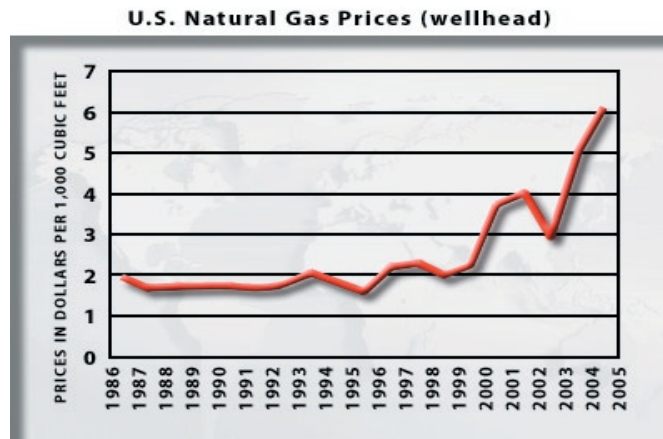
REPORT #1

2

Figure A.3: Analysis Process 1 [A(1)] Briefing Report, Page 2 of 2

Question: What are the primary obstacles to using Liquefied Natural Gas (LNG) to address energy needs in the US?

Natural gas is steadily becoming the U.S. energy source of choice. It now supplies about 24 percent of the United States' total primary energy mix. Natural gas is also among the most versatile of feedstocks and is integral to industries that produce plastics, fertilizers, antifreeze and fabrics. But not all is well in the world of natural gas in the United States, as prices have risen steadily over the past five years. In times past, U.S. natural gas demand was entirely satisfied by domestic, and then Canadian, production. That time has ended. Currently, the Department of Energy estimates the United States has about 189 trillion cubic feet of proven natural gas reserves — only enough to supply the country's needs for eight years at current consumption rates. If a long-term solution is not adopted quickly, wide swathes of U.S. industry will simply cease functioning.



Luckily for the United States liquefied natural gas, or LNG, provides a way to both plug the gap and bring down prices from their recent highs. Conventionally piped gas changes from its gaseous form into liquid when it is supercooled to around -260 degrees Fahrenheit. This LNG can be loaded onto specially designed tankers and shipped in a manner similar to any other liquid. Once the tanker arrives at its destination, a specialized facility offloads the LNG, at which point it can be loaded into any infrastructure that normally stores, transports or uses conventional natural gas. These LNG receiving terminals can be placed near any major consumption regions, making them short-term — and economical — solutions to long-term supply problems.

LNG also originates from states that are stable politically and economically. The barriers to involvement are steep, technical and expensive, so states with stability problems or

Figure A.4: Analysis Process 2 [A(2)] Briefing Report, Page 1 of 2

***** UNCLASSIFIED *****

questionable legal regimes simply do not attract the necessary interest. Consequently, the world's leading LNG providers — Algeria, Australia, Qatar, Oman and Trinidad and Tobago — are countries that largely buy into the U.S. way of doing things. The two notable exceptions are Indonesia and Nigeria, where political unrest has yet to scare away what have been the world's most successful LNG ventures ever. Other states that the United States "trusts" — most notably, Egypt and Norway — also are joining the ranks of LNG producers. Even Russia and Libya are getting into the act in a limited way.

LNG is more than merely cost competitive. It is far cheaper than American (or Canadian) piped natural gas. And the "global" price of LNG is heading down, not up. Since 2001 some 20 new LNG export projects have begun, the first of which came on line in just the past year. Proven reliable suppliers are all expanding their operations, and other states the United States considers political allies are also attempting to cash in by joining the suppliers' ranks. All told, export facilities currently under construction would add nearly 3,000 billion cubic feet of supply per year, but import facilities currently under construction would take in only half of that. The result will be a glut in supply that will drive domestic prices down for those states able to use LNG.

So the politics, security concerns and economics of LNG and the United States' energy needs match. Unfortunately for the United States, although its market-based energy system allows for efficient supply and transport of energy, the country lacks a unified energy policy capable of addressing long-term issues. That has allowed local — as opposed to national — environmental groups effectively to stall the development of LNG import facilities.

Though national groups tacitly approve of natural gas, and thus LNG, local and grassroots groups are another matter entirely. Most local groups simply do not care about the global environmental imperatives dominating the national groups' agendas. They instead see LNG facilities as bombs waiting to go off. National groups to date have not taken steps to rein in their local counterparts; their credibility is on the line. The net effect is that they are paralyzed and cannot say what they know to be true: For the sake of the environment, the country needs more LNG importation facilities.

To overcome these hurdles, U.S. President George W. Bush announced he would seek to extend the powers of the Federal Energy Regulatory Commission (FERC) so that it, and not the various states, would wield final authority over concerns related to LNG import developments. If that power is granted, the FERC would be able to override local decision-making, in favor of constructing LNG import terminals. Expanding FERC powers will not defeat local environmental groups in one fell swoop, of course. But the Bush administration's new policy represents the inflection point in the LNG debate. It is likely only a matter of time before it becomes law — as part of the energy bill or independent of it — and LNG begins streaming to the United States in massive amounts.

REPORT #2

2

Figure A.5: Analysis Process 2 [A(2)] Briefing Report, Page 2 of 2

***** UNCLASSIFIED *****

PROCESS DOCUMENTS AVAILABLE

The following documents are available, each of which details a part of the processes that were performed in developing the two written analysis reports:

- QUERY SUMMARY
- DOCUMENTS READ (IN ORDER OF READING)
- WHERE DOCUMENTS STORED IN FOLDERS
- KEY DOCUMENTS (RELIED ON HEAVILY)
- HYPOTHESES — CONSIDERED OBSTACLES TO LNG
- COLLABORATIONS WITH OTHERS DURING PROCESS
- RESEARCH NOTE-SHEET

DOCUMENTS AVAILABLE

1

Figure A.6: Process Documents Available, Page 1 of 1

***** UNCLASSIFIED *****

QUERY SUMMARY

Queries to get acquainted with area

- LNG energy
- LNG terrorism

Targeted search for documents:

- Sandia report LNG
- Clarke LNG

Targeted search to investigate claim that terrorism concerns are a shield for concern of reduced property values by local population:

- Property value LNG

Targeted search to get updated numbers on LNG terminals

- LNG terminals tankers

PROCESS #1

1

Figure A.7: Analysis Process 1 [A(1)] Query Summary, Page 1 of 1

DOCUMENTS READ (IN ORDER OF READING)

1. Advertisement; LNG - Evolution & Development Wallchart details the history of the LNG industry from 1914-2003; www.biz-lib.com/ZPELE.html
2. California energy commission website page on Liquefied Natural Gas (LNG); <http://www.energy.ca.gov/lng/index.html>
3. LNG: A Prized Energy Source, or Potent Terror Target? - Christian Science Monitor 6apr04; <http://www.csmonitor.com/2004/0406/p01s01-uspo.html>
4. Havens, Jerry. Ready to blow? (Terrorism). Bulletin of the Atomic Scientists, July, 2003; http://www.thebulletin.org/article.php?art_ofn=ja03havens
5. Study: LNG tankers make spectacular targets for terrorists. Institute for the Analysis of Global Security. January 21, 2004. <http://www.iags.org/n0121041.htm>
6. Energy security and liquefied natural gas. Institute for the Analysis of Global Security. September 29, 2003. <http://www.iags.org/n0929034.htm>
7. Consumer Protection Attorney Tim Riley Homepage. LNG Terrorism Danger To Our Communities. http://timrileylaw.com/LNG_TERRORISM.htm
8. Scott S. Greenberger and Rick Klein. Officials stop gas tanker as Boston reacts to alert. Boston Globe. January 23, 2003. http://www.boston.com/news/local/articles/2003/12/23/officials_stop_gas_tanker_as_boston_reacts_to_alert/
9. LNG Facilities in Urban Areas: A Security Risk Management Analysis for Rhode Island. Richard A. Clarke, May 2005; http://www.riag.state.ri.us/LNG_Good%20Harbor2.pdf
10. University of Houston Law Center, Institute for Energy, Law, and Enterprise, LNG Safety and Security, October 2003, p. 77-79, available at http://www.energy.uh.edu/LNG/documents/IELE_LNG_Safety_and_Security.pdf
11. Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, December 2004. http://www.pstrust.org/library/pdf/sandia_lng_1204.pdf
12. Statement of FERC Chairman Pat Wood, III, on 2004 Sandia report. <http://www.ferc.gov/whats-new/headlines/2004/2004-4/12-22-04.pdf>

PROCESS #1

1

Figure A.8: Analysis Process 1 [A(1)] Documents Read, Page 1 of 3

13. Battery Rock LNG: A Risk Assessment. GHC-BR-0306A. Richard A. Clarke, March 2006.
14. Report on Potential Economic and Fiscal Impacts on the Town of Harpswell, Maine of the LNG Terminal Proposed by TransCanada Pipelines and ConocoPhillips. Prepared for Fairplay for Harpswell by Yellow Wood Associates, Inc., 228 North Main Street St., Albans, Vermont 05478; <http://www.pstrust.org/lng/library/index.htm>
15. U.S. LNG Markets and Uses. Energy Information Administration U.S. Department of Energy, June 2004 Update; http://www.pstrust.org/library/pdf/inel_lngriskassess.pdf
16. The Global Liquefied Natural Gas Market: Status & Outlook December 2003 Energy Information Administration U.S. Department of Energy; http://www.pstrust.org/library/pdf/global_lng_market_2003.pdf
17. Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation Prepared by Congressional Research Services for U.S. Congress: May 2004; http://www.pstrust.org/library/pdf/crs_report_may_2004.pdf
18. Liquefied Natural Gas: History, Risks and Siting: The California Energy Commission's white paper. July 2003; http://www.pstrust.org/library/pdf/cec_lng_white_paper.pdf
19. Spills and Fires from LNG and Oil Tankers in Boston Harbor by MIT Professor James A. Fay: 77 Massachusetts Avenue, Rm. 3-258 Cambridge, MA 02139 March 26, 2003; http://www.pstrust.org/library/pdf/fay_lng_fire_impact.pdf
20. Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues Prepared by Congressional Research Services for U.S. Congress: September 2003. http://www.pstrust.org/library/pdf/crs_rpt_lng_infra_security.pdf
21. Qualitative Risk Assessment of LNG Refueling Station and Relevant Safety Issues Idaho National Engineering Laboratory report 1998.; http://www.pstrust.org/library/pdf/inel_lngriskassess.pdf
22. Girdis, Dean. Downeast LNG newsletter. Volume 1, Number 3. November 2005. http://www.downeastlng.com/docs/November_Newsletter_No_3.pdf

PROCESS #1

2

Figure A.9: Analysis Process 1 [A(1)] Documents Read, Page 2 of 3

***** UNCLASSIFIED *****

23. Finlaw, James. City decries LNG plan. Herald News. January 27, 2004.
[http://www.heraldnews.com/site/news.cfm?
newsid=10871297&BRD=1710&PAG=461&dept_id=99784&rft=6](http://www.heraldnews.com/site/news.cfm?newsid=10871297&BRD=1710&PAG=461&dept_id=99784&rft=6)
24. Save Passamaquoddy Bay: A 3-Nation* Alliance to Protect the Quoddy
Region. <http://www.savepassamaquoddybay.org/>
25. California energy commission website page on Liquefied Natural Gas (LNG);
<http://www.energy.ca.gov/lng/faq.html> (actually the second visit to this URL,
but doesn't realize it)
26. West Coast LNG Projects and Proposals. Downloaded from California energy
commission website. Excel spreadsheet with proposed West Coast terminals.
Status update as of March 13, 2006.

PROCESS #1

3

Figure A.10: Analysis Process 1 [A(1)] Documents Read, Page 3 of 3

***** UNCLASSIFIED *****

WHERE DOCUMENTS STORED IN FOLDERS

LNG obstacles (no subfolder)

Advertisement; LNG - Evolution & Development Wallchart details the history of the LNG industry from 1914-2003; www.biz-lib.com/ZPELE.html

California energy commission website page on Liquefied Natural Gas (LNG); <http://www.energy.ca.gov/lng/index.html>

LNG: A Prized Energy Source, or Potent Terror Target? - Christian Science Monitor 6apr04; <http://www.csmonitor.com/2004/0406/p01s01-uspo.html>

LNG obstacles/Fire Safety

Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, December 2004. http://www.pstrust.org/library/pdf/sandia_lng_1204.pdf

Statement of FERC Chairman Pat Wood, III, on 2004 Sandia report. <http://www.ferc.gov/whats-new/headlines/2004/2004-4/12-22-04.pdf>

Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues Prepared by Congressional Research Services for U.S. Congress: September 2003; http://www.pstrust.org/library/pdf/inel_ingriskassess.pdf

Qualitative Risk Assessment of LNG Refueling Station and Relevant Safety Issues Idaho National Engineering Laboratory report 1998.; http://www.pstrust.org/library/pdf/inel_ingriskassess.pdf

Spills and Fires from LNG and Oil Tankers in Boston Harbor by MIT Professor James A. Fay: 77 Massachusetts Avenue, Rm. 3-258 Cambridge, MA 02139 March 26, 2003; http://www.pstrust.org/library/pdf/fay_lng_fire_impact.pdf

LNG obstacles/Imports

The Global Liquefied Natural Gas Market: Status & Outlook December 2003 Energy Information Administration U.S. Department of Energy; http://www.pstrust.org/library/pdf/global_lng_market_2003.pdf

PROCESS #1

1

Figure A.11: Analysis Process 1 [A(1)] Where Documents Stored in Folders, Page 1 of 3

***** UNCLASSIFIED *****

LNG obstacles/LNG Background

U.S. LNG Markets and Uses. Energy Information Administration U.S. Department of Energy, June 2004 Update; http://www.pstrust.org/library/pdf/inel_ingriskassess.pdf

Liquefied Natural Gas: History, Risks and Siting: The California Energy Commission's white paper. July 2003; http://www.pstrust.org/library/pdf/cec_lng_white_paper.pdf

California energy commission website page on Liquefied Natural Gas (LNG); <http://www.energy.ca.gov/lng/faq.html>

West Coast LNG Projects and Proposals. Downloaded from California energy commission website. Excel spreadsheet with proposed West Coast terminals. Status update as of March 13, 2006.

LNG obstacles/Property Values

Save Passamaquoddy Bay: A 3-Nation* Alliance to Protect the Quoddy Region. <http://www.savepassamaquoddybay.org/>

Girdis, Dean. Downeast LNG newsletter. Volume 1, Number 3. November 2005. http://www.downeastlng.com/docs/November_Newsletter_No_3.pdf

Report on Potential Economic and Fiscal Impacts on the Town of Harpswell, Maine of the LNG Terminal Proposed by TransCanada Pipelines and ConocoPhillips. Prepared for Fairplay for Harpswell by Yellow Wood Associates, Inc., 228 North Main Street St., Albans, Vermont 05478; <http://www.pstrust.org/lng/library/index.htm>

Finlaw, James. City decries LNG plan. Herald News. January 27, 2004. http://www.heraldnews.com/site/news.cfm?newsid=10871297&BRD=1710&PAG=461&dept_id=99784&rft=6

LNG obstacles/Regulations

Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation Prepared by Congressional Research Services for U.S. Congress: May 2004; http://www.pstrust.org/library/pdf/crs_report_may_2004.pdf

PROCESS #1

2

Figure A.12: Analysis Process 1 [A(1)] Where Documents Stored in Folders, Page 2 of 3

***** UNCLASSIFIED *****

LNG obstacles/Terrorism

Havens, Jerry. Ready to blow? (Terrorism). Bulletin of the Atomic Scientists, July, 2003; http://www.thebulletin.org/article.php?art_ofn=ja03havens

Study: LNG tankers make spectacular targets for terrorists. Institute for the Analysis of Global Security. January 21, 2004. <http://www.iags.org/n0121041.htm>

Energy security and liquefied natural gas. Institute for the Analysis of Global Security. September 29, 2003. <http://www.iags.org/n0929034.htm>

Consumer Protection Attorney Tim Riley Homepage. LNG Terrorism Danger To Our Communities. http://timrileylaw.com/LNG_TERRORISM.htm

Scott S. Greenberger and Rick Klein. Officials stop gas tanker as Boston reacts to alert. Boston Globe. January 23, 2003. http://www.boston.com/news/local/articles/2003/12/23/officials_stop_gas_tanker_as_boston_reacts_to_alert/

LNG Facilities in Urban Areas: A Security Risk Management Analysis for Rhode Island. Richard A. Clarke, May 2005; http://www.riag.state.ri.us/LNG_Good%20Harbor2.pdf

Battery Rock LNG: A Risk Assessment. GHC-BR-0306A. Richard A. Clarke, March 2006.

PROCESS #1

3

Figure A.13: Analysis Process 1 [A(1)] Where Documents Stored in Folders, Page 3 of 3

***** UNCLASSIFIED *****

KEY DOCUMENTS (RELIED ON HEAVILY)

Terrorism with LNG terminals and tankers:

LNG Facilities in Urban Areas: A Security Risk Management Analysis for Rhode Island. Richard A. Clarke, May 2005; http://www.riag.state.ri.us/LNG_Good%20Harbor2.pdf

Safety (unintentional release of LNG):

Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, December 2004. http://www.pstrust.org/library/pdf/sandia_lng_1204.pdf

Environment (impact of facility on local population):

Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation Prepared by Congressional Research Services for U.S. Congress: May 2004; http://www.pstrust.org/library/pdf/crs_report_may_2004.pdf

Girdis, Dean. Downeast LNG newsletter. Volume 1, Number 3. November 2005

PROCESS #1

1

Figure A.14: Analysis Process 1 [A(1)] Key Documents, Page 1 of 1

***** UNCLASSIFIED *****

HYPOTHESES – CONSIDERED OBSTACLES TO LNG

H1: Terrorism

- H1A: Terminals
- H1B: Tankers
- H1C: Trucks (dropped)
- H1D: Pipelines (never seriously pursued)

H2: Safety (unintentional LNG release)

- H2A: Terminals
- H2B: Tankers

H3: Environment

- H3A: Property values
- H3B: Development of lowly populated areas such as national parks
- H3C: Pollution from facility (dropped)
- H3D: Economic impacts (dropped)

H4: Importing from foreign countries (dropped)

H5: Regulations (judged to be out of scope)

PROCESS #1

1

Figure A.15: Analysis Process 1 [A(1)] Hypotheses, Page 1 of 1

***** UNCLASSIFIED *****

COLLABORATIONS WITH OTHERS DURING PROCESS

1. Customer who Asked Question: Clarifies question via telephone call
2. Analyst Colleague: Frames LNG issues through e-mail exchange
3. Specialist Analyst: Consults with with in-house counter-terrorism experts on limited topics through e-mail and in-person interactions
4. Industry Consultant: Requests more information and context behind policy-making suggestions noted in reports
5. LNG Researcher: Explores divergent views regarding potential impacts of LNG release via telephone conversation
6. "Biased Study" Representative: Confirms that study results were biased due to desire to influence a policy decision
7. Senior Analyst: Review of report results in the addition of a fourth obstacle

PROCESS #1

1

Figure A.16: Analysis Process 1 [A(1)] Collaborations, Page 1 of 1

RESEARCH NOTE-SHEET

Tankers

<http://www.csmonitor.com/2004/0406/p01s01-uspo.html>

Energy analysts call LNG the "new prize" on the global energy scene. Japan and other energy-poor nations have long imported large amounts of LNG. The US expansion is part of a global boom, with at least 55 new LNG tankers under construction - a one-third increase in the world fleet to more than 200 vessels.

Past LNG explosions (not NG explosions)

- Algeria January 2004: 22 killed, 74 injured.

Energy companies

- Leading the charge are big energy companies such as BP and ExxonMobil - along with smaller concerns like Weaver's Cove Energy, which wants to build a terminal in Fall River. They argue that fears of terrorism and even human error in handling the fuel are vastly overblown, and point to strong safety records, tighter post-9/11 security, and robust LNG tankers. Two controversial studies since 9/11, one for the US Department of Energy (DOE) and another for the industry, suggest LNG tanker fires would be a smaller threat than many fear.
- "Look at the existing safety record [of LNG tankers] - it's sterling, extremely clean," says Martin Edwards of the Interstate Natural Gas Association of America, a trade group representing companies with current and proposed LNG terminals. "What we often find is that the safety, and lately the security, issues are a kind of shield" that masks opponents' deeper concerns, such as threats to property values.
- A plan to build a terminal at the Port of Long Beach is among the furthest along. "This is going to be the safest LNG receiving terminal in the world," Tom Giles, chief of Sound Energy Solutions, a Mitsubishi subsidiary, told the Los Angeles Times in January when describing the concrete and steel tanks it planned to build.

Number of terminals and tankers

- From 2004 report – need to update figures: Today there are four LNG terminals in the US: Everett, Mass., near Boston; Cove Point, Md.; Elba Island, Ga.; and Lake Charles, La. Because US supplies of natural gas are in short supply, more than 30 LNG terminals are under consideration, including some near densely populated areas like Fall River, Mass., Long Beach, Calif., Logan Township, N.J., and Providence, R.I.
- In addition to the Everett facility there are operational plants at Cove Point in the Chesapeake Bay, Maryland, in Savannah, Georgia, and in Lake Charles, Louisiana.

PROCESS #1

1

Figure A.17: Analysis Process 1 [A(1)] Research Note-Sheet, Page 1 of 17

***** UNCLASSIFIED *****

Trusted to be uptodate on March 14, 2006 from <http://www.energy.ca.gov/lng/international.html>:

Natural gas, one of the largest sources of energy, can be found all over the world. LNG comes from countries with large natural gas reservoirs including Algeria, Australia, Brunei, Indonesia, Libya, Malaysia, Nigeria, Oman, Qatar, and Trinidad and Tobago. The largest gas reserves can be found in the Middle East. Much of the natural gas reserves found around the world are separate from oil and as new reserves are discovered and processed, growth in the LNG industry will continue. Worldwide there are currently 12 countries that export LNG. There are approximately 40 LNG import terminals with many more planned. LNG import terminals exist in Japan, South Korea and Europe, as well as in the United States, which currently has five import terminals (including Puerto Rico).

PROCESS #1

2

Figure A.18: Analysis Process 1 [A(1)] Research Note-Sheet, Page 2 of 17

History of LNG

- Evolution & Development Wallchart details the history of the LNG industry from 1914-2003, providing more extensive detail on recent developments
- Tables list existing LNG export plants (country, project, start-up year, share holders, operator, capacity (m t/y), no. of trains) and import terminals (country, project, start-up year, promoter, operator, source, capacity (m t/y))
- Chart showing LNG exports and imports by country (Bn cm) from 1964-2002

The last time there was so much interest in LNG was in the 1970s, when the four current continental U.S. LNG import terminals were built. At that time three terminals were also proposed for southern California alone--at Los Angeles, Point Conception, and Oxnard. From environmental and health impacts to the consequences of a catastrophic event, each site was evaluated on the basis of public safety. The studies identified four areas of concern for catastrophic accident events:

- vapor cloud explosions,
- pool fires on the surface of the water or on land,
- flammable vapor clouds that can form if a spill does not ignite immediately, and
- rapid phase transition (RPT) accidents from rapid mixing of LNG with water.

The three California projects were shelved for economic reasons along with their safety studies, but not before raising public concern. As a result, Congress authorized approximately \$40 million to study the four catastrophic scenarios.

Rapid phase transitions. What can happen when LNG mixes with water is the least studied of the four hazards, especially at large scale. The hazard zones extending from an RPT would not be as large as either vapor cloud or pool fire hazard zones. RPT accidents are probably the lowest concern of the four mentioned here, but the potential for secondary damage resulting from an RPT accident should also be considered.

Flammable vapor clouds. Most experts believe that an accidental release of an entire LNG ship storage tank, such as might occur in a collision, would result in the immediate ignition of the released gas. This would prevent the development of extremely large, and potentially more catastrophic, vapor cloud fires. Nonetheless, current regulations require that this issue be addressed.

Vapor cloud explosions. LNG is usually at least 90 percent methane. Experiments have shown that if ignited, uncontained methane-air clouds could cause catastrophic fire damage, but they have low explosion potential. Research continues on the effects of partial confinement and turbulence in such clouds, but the results so far suggest that the vapor cloud explosion scenario is of considerably less concern than the fire scenario.

Pool fires. In my judgment, a large LNG pool fire--on water, and therefore uncontained--is of the highest concern.

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What do we know about the hazards of such pool fires? There have been no experiments with fires of such magnitude. By marine cargo standards, LNG marine carriage is relatively new, and there is no evidence of any pool fires on water larger than experimental spills of about 10,000 gallons performed during the 1970s and 1980s. These experiments resulted in roughly cylindrical fires approximately 50 feet wide and 250 feet high.

Although large-model extrapolations (from 10,000 gallons to 6.5 million gallons) can raise significant questions, it is reasonable to be concerned about the damage potential of such fires. Most predictions suggest that even the largest LNG tankers (typically more than 900 feet in length) might be completely enveloped in a pool fire following a complete spill of a single 6.5 million gallon tank. This raises questions about the vulnerability of the ship and the potential for additional releases. A typical LNG tanker contains as many as five tanks with a combined capacity of 33 million gallons.

We do know some things about such fires. They could not be extinguished and would have to burn themselves out. Unlike some other flammable liquids such as crude oil, the gas would burn itself out only when it was totally consumed. And such fires would be expected to burn more rapidly and with greater intensity than crude oil or even gasoline fires.

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Obstacles to LNG:

- Terrorism
 - Tankers

2003 article: There are only four LNG import terminals in the United States: Chesapeake Bay, Maryland; Lake Charles, Louisiana; Elba Island, Georgia; and Everett, Massachusetts. Tankers traveling to Everett, in Boston Harbor, pass near heavily populated areas. Along both inbound and outbound routes, LNG ships travel within several hundred yards of the Boston waterfront, past the end of the Logan International Airport runway from which two planes left for the World Trade Towers, and under a busy bridge. Even now, ships coming into Everett are subjected to greater scrutiny than before September 11.

In an interview with Energy Security Fay said a terrorist attack by a boat bomb - such as the one used against the USS Cole in 2000 or the French tanker Limburg off the coast of Yemen in 2002 - could cause at least half a cargo hold's worth of LNG to seep out of the ship and ignite. "In just over three minutes, the fire could spread two-thirds of a mile from the ship," Fay said. "There is nothing safety officials can do in such a case. They would have no time to evacuate people or to put out the fire." Fay also predicts damaging thermal radiation within a mile radius of the tanker which could set fire to thousands of homes and cause significant losses of blood and treasure. "Like the attack on the World Trade Center in New York City, there exists no relevant industrial experience with fires of this scale from which to project measures for securing public safety," he says. Fay insists the methodology of his modeling is sound.

LNG tankers are very conspicuous. Their distinctive storage tanks jut like humps on the decks; their identity cannot be mistaken. Terrorists attempting to target such a ship will have no problem identifying it.

Boston Mayor Thomas Menino recently decided to rid Boston Harbor of its long-standing LNG facility over safety concerns. "Everyone should be concerned about it because the Coast Guard, Boston fire department and other agencies do not have the equipment if something did happen with an LNG tanker. Everyone says there is no problems, but what happens when something does happen?" Menino said this past December when the national threat level was elevated to orange. Menino and other representatives of Boston-area communities had mounted an unsuccessful lawsuit to halt the LNG operations after Sept. 11, 2001. Professor Fay agrees. "Federal officials are at a state of denial right now. They ignore the scenario of tanker spill as a problem they have to deal with." Menino has no jurisdiction in the harbor so the tankers are still coming.

The Coast Guard however is not ignoring the threat. It has taken some precautions

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to minimize the risk of attack against LNG tankers. Fast escort boats shepherd each gas tanker as it travels to the terminal. A security zone extending 500 yards on each side, two miles ahead and a mile behind the tanker is imposed and other vessels are instructed to give the tanker a wide berth during its passage and 12-hour unloading process. Violators face arrest, fines of up to \$25,000 and prison terms of up to 10 years. But these penalties are unlikely to deter suicide terrorists such as those who flew planes into the World Trade Center and the Pentagon. It is not clear what procedures the Coast Guard would be willing to use once a terrorist boat penetrates into the security zone. Nor it is clear how rapidly security officials could respond to the threat. After all, well armed and vigilant military targets like the USS Cole could not prevent such an attack.

Intent of terrorists on tankers

As to intent to attack shipping, the al Qaeda network has used explosive laden small craft to attack a US destroyer in port and a double hulled French tanker at sea. They have planned or discussed attacks on shipping in other locations around the world. The FBI has warned that the al Qaeda network is interested in scuba gear for underwater attacks in the US.

In a recently released document known simply as the National Planning Scenarios, DHS indicated that a potential terrorist attack on chemical or gas tanker is the number six ranked doomsday scenario for the United States government. As a result, DHS is expected to spend at least an additional one billion dollars to secure against this form of terrorist attack. However even those within DHS believe that the United States is a long way away from true preparedness.³³

Currently, over 80% of the United States natural gas imports are shipped in tankers from Trinidad and Tobago, which are attractive targets to terrorist organizations.³⁴ As natural gas demands increase in the United States, natural gas-producing countries will increase their export. Interestingly, the same countries that currently provide much of the US's current oil supply will mostly likely be the same increasing their production of LNG: namely countries in West Africa and the Persian Gulf – areas where al Qaeda has an already established a foothold.

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Capability of terrorists on tankers and terminals
Al Qaeda and related groups have demonstrated an ability to operate in the US. Even since 9-11, terrorist groups have maintained a presence in the US. A recent report indicated that the FBI has over 1000 Full Field Investigations underway against al Qaeda alone. Illegal crossing into the United States is a commonplace activity.

Weapons and other capabilities needed to conduct an attack on an urban LNG off loading facility or an LNG tanker can be readily obtained in the US, according to US Government reports. A variety of boats and scuba gear can be easily procured. General Aviation aircraft can easily be rented or stolen at numerous small airports throughout the US. Explosives are readily available, both fertilizer based weapons, which can be procured without a license, and commercial explosives, which are frequently stolen and sold on the black market. Fifty caliber rifles with anti-armor shells are readily available in the US. Rocket propelled grenades (RPGs), light anti-tank weapons, mortars, and bazooka styled weapons are very easily and cheaply obtainable on the international gray arms market. Few containers entering the United States are inspected by US Customs.

Vulnerabilities to tankers

As to the LNG ship, the creation of restricted waterways around the LNG tanker and the use of armed Coast Guard (USCG) patrol craft provides little assurance that a determined terrorist group would be stopped before attacking the tanker with an explosives laden vessel. Narraganset Bay is home to thousands of small craft. The USCG and other law enforcement agencies would be reluctant to use lethal force against an apparently misguided pleasure craft. Moreover, the escorting patrol boats could themselves be attacked in a multi-boat terrorist operation. Counter-SCUBA operations in the Bay would also not offer high assurance of success.

Attacks involving stand off weapons could be mounted from boats or from numerous land locations along the route. To prevent the entry of weapons for land based, stand-off attacks, all vehicles entering the littoral would have to be

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searched not just during the tanker's transit, but at all times.

- Terminals

Intent of terrorists

The Jihadist Terrorist network of al Qaeda and similar groups have articulated goals including a) killing large numbers of Americans, b) conducting attacks in the US, c) damaging the US economy and infrastructure, and d) damaging oil and gas infrastructure.

The al Qaeda network has demonstrated the use of parts of the US civilian infrastructure as weapons to be used against US facilities.

Furthermore LNG installations can be attacked onshore by truck bombs with similarly damaging consequences.

There are two reasons why a terrorist would be interested in attacking an LNG tanker or facility, both of which fit al Qaeda's MO: the potential for high civilian casualties and the potential to bring substantial damage the American economy. Although the United States acquires roughly 2% of its overall gas consumption from LNG sources, some analysts predict that this amount is likely to increase at a rate of 2% a year.³¹ As LNG imports become a more important sector of our economy, terrorist organizations like al Qaeda will become more interested in attacking them. In addition, LNG tankers, which often travel in close proximity to metropolitan seaports, are undoubtedly attractive high casualty targets for al Qaeda planners.

In addition to its interests in attacking tankers, al Qaeda would have the motivation and could develop the capability to attack LNG facilities. MS-13, a Central American criminal organization with a large membership in East Boston, is feared to be targeting the LNG facility and tankers near Boston. MS-13 has a strong presence in harborside neighborhoods of East Boston alongside which LNG tankers pass on their way to the unloading facility in Everett. In January, these members were subject to a Homeland Security and Customs Department investigation after

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the Justice Department announced that al Qaeda operatives might be trying to get into the country through Mexico. MS-13 is believed to be involved in smuggling from Mexico to the U.S.³⁵ Though al Qaeda has yet to attempt an attack on the LNG facility in Boston, to most counterterrorism officials, the threat is clear and present.

Vulnerabilities

Both the proposed urban LNG off loading facility and the proposed LNG tanker transit through 29 miles of Rhode Island have security vulnerabilities that are unlikely to be successfully remediated.

The creation of permanent or temporary restricted flight areas around the urban LNG facility and the tanker will not prevent hijacked or stolen aircraft (commercial passenger, commercial freight, or general aviation) from successfully penetrating the restricted airspace and crashing into the facility and/or ship. No air defense system is planned, nor is it easy to imagine a system which would authorize the use of deadly force against an aircraft that might appear to have unintentionally strayed into the restricted air space.

- Jan 21, 2004: The safety concerns surrounding LNG installations pose difficulties for energy companies attempting to build new terminals. No such terminals have been built in the U.S. for two decades, but applications to construct 30 more have been made in recent years. Only half a dozen are likely to materialize in the next decade. ExxonMobil has announced plans to build a \$600 million plant on the Texas coast and wants to build three more in other states. ChevronTexaco announced plans to construct an off the coast of Baja California, Mexico and Royal Dutch/Shell and BP are among other companies driving to build new terminals in California, Texas, Alabama, Florida, Mexico, Nova Scotia and other locations. In most of these places opposition by local communities is mounting and it is not yet clear which consideration will prevail: public safety or economic need.

- Trucks
 - Fire Safety

But Sandia says the consequences of an intentional breach, in which the LNG release would likely be far greater, could

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have “severe negative impacts” in its damage to bridges, industrial/commercial centers, LNG terminals, harbors, and populated areas. In its DEIS, FERC tends to downplay the terrorist threat to the LNG industry in the United States. It is reluctant to acknowledge the potential for large-scale disaster should a worst-case scenario LNG release result from a deliberate attack on a tanker or a facility. FERC concludes its analysis of the terrorist threat by shifting the focus of the discussion away from LNG to other potential terrorist targets in the U.S. “At the national level,” the DEIS says, “potential terrorist targets are plentiful, many having national significance, while others with a large concentration of the public (major sporting events, skyscrapers, etc.) or critical infrastructure facilities.” FERC points out that the U.S. currently has over 500 chemical facilities operating near large populations, with over 100,000 shipments of hazardous cargo being shipped through U.S. waterways each year. FERC says that “resources can be directed to mitigate possible attack paths” for potential targets where the threat is perceived to be high, and that decision makers must determine “whether the resources required to manage the risks are justified by the benefits” provided by the potential target in question.

- Imports
- Property values

Consequences of attack (fire)

There is a spectrum of expert opinion on the precise extent of damage that would result from various levels of attack on an urban LNG facility and on an LNG tanker. There appears, however, to be a high risk that catastrophic damage could occur if a large breach were made in the urban LNG facility’s tank, if three of five containers aboard the LNG tanker were breached, or if an attack occurred involving both the facility and the tanker during unloading.

The consequences of a major attack could include fires that would damage homes, hospitals, a chemical plant, and other infrastructure, depending upon where the attack occurred. Many fires could exceed the 2000 BTU limit for the employment of fire fighters, necessitating a “let it burn”

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approach to many structures. There would be both prompt and delayed fatalities.

The delayed fatalities and the wounded could place a burden on the Rhode Island and South Eastern Massachusetts trauma, burn, and overall emergency medical response capability that the system would be unable to handle. It is unclear where the funding would come from to upgrade the region's consequence management capabilities to be able to deal with a possible catastrophic attack on the urban LNG facility and/or tanker. Governments could, however, place that burden on the facility owners and operators, similar to the Nuclear Regulatory Commission's approach to commercial nuclear reactors.

Financial cost

The financial cost of compensating victims and rebuilding damaged or destroyed facilities following a catastrophic attack on the urban LNG facility and/or LNG tanker would likely exceed any insurance carried by the owners and operators of the LNG facility and tanker.

In the absence of adequate insurance to pay victims and rebuild damaged or destroyed facilities, the LNG operators would be transferring the financial cost of the risk they would be creating either to the victims or to governments, or to some combination of both. Governments would also bear costs for greatly enhanced security and consequence management, including mass trauma and burn capabilities.

Terrorism obstacle hard to address

We judge that terrorist groups now have the intent to attack facilities in the US such as the urban LNG off loading facility proposed. We judge that they could relatively easily both obtain the needed capability and conduct an attack on the urban LNG facility and/or the LNG tanker during its transit of 29 miles of inland waterway. We judge that such attacks run a high risk of generating catastrophic damage, with which the region could not adequately cope during the consequence management or recovery phases.

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Measures to address terrorism obstacle

We doubt that deterrence or prevention measures could be designed and implemented for the proposed facility and ship routing that would be adequate against a determined and skilled terrorist group of the type that exists today. Possibilities for further investigation, however, include:

- armor plating the gas storage containers aboard the LNG tankers which transit inland waterways near populated areas,
- transporting gas along inland waterways near populated areas only in tankers that do not freeze and condense the gas, thereby significantly reducing the force and radius of an explosion
- constructing structures around LNG facilities in urban areas similar to those buildings required by the Nuclear Regulatory Commission around commercial nuclear reactors (an NRC design criterion is that a direct hit by a general aviation aircraft would not breach the reactor).

All of those measures would significantly increase the cost of building or operating the LNG facility or LNG tanker.

Alternatively, the LNG off loading facility could be sighted in a location that did not involve either an urban environment for the facility or an inland waterway transit for the LNG tanker. Locating the facility in a non-urban environment and eliminating the inland waterway transit would significantly reduce both the attractiveness to terrorists of an attack (because the attack would not generate large scale casualties) and the consequence management and recovery burdens on governments should an attack occur. We note that GAO, the investigatory arm of the Congress, recommended in 1979 that the Congress or Administration prohibit any additional large scale LNG facilities in or LNG tanker transit through urban areas.

The Federal Energy Regulatory Commission (FERC) produced a draft Environmental Impact Statement (DEIS) of the KeySpan proposal in November 2004 as part of the standard licensing process for the construction or expansion of energy facilities. The DEIS examined numerous technical aspects of the KeySpan proposal and the effect of the construction and

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operation of the facility on the surrounding area. The section of the DEIS upon which this report will focus is FERC's analysis of the potential threat and damage associated with a deliberate attack on a LNG tanker in transit to the facility, while docked and unloading, or an attack on the facility itself.⁸⁸

FERC determined that the risks of a terrorist attack can be "managed." While there is a level of risk associated with the transport of any hazardous cargo, the potential catastrophe that could ensue from an attack on a LNG tanker or on the facility is drastic enough to merit a serious reconsideration of building a LNG import terminal near the heart of downtown Providence.

Alternatives exist to the location KeySpan has proposed, and these alternatives – where the damage caused by a terrorist attack would be significantly reduced – should be strongly considered. FERC examined alternatives to the proposal, including locating the facility at a different site, expanding the pipeline system, or building an offshore terminal, and determined that while certain ideas would eliminate or reduce the safety risks associated with the current proposal, they would not meet the objectives for improved natural gas storage and delivery laid out in the current proposal.

Projections to LNG usage

The U.S. Department of Energy expects LNG to account for 15% of U.S. gas consumption by 2025, compared to 1% today. Consequently, LNG imports into the U.S. are expected to grow by about 8.2% a year over the coming decade. U.S. Federal Reserve Bank chairman Alan Greenspan testified repeatedly before Congress that LNG was the only solution on the horizon for the projected chronic natural gas shortage.

As the need for fuel continued to rise with consumer demand, LNG has become an increasingly important part of the energy sector. Once a relatively small market (with only 1% of the total U.S. gas consumption in 2002), expectations for growth in the LNG industry are high.⁷² Consumption is expected to increase significantly over the coming years, with estimates of the total global LNG trade increasing by 35-50% by 2020, assuming that appropriate facility and tanker capacity meets

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demand. 73,74 Although only accounting for 2.7% of the U.S. energy consumption and 13% of total imported energy sources, shipped LNG measures over 53 billion cubic feet per year (in 2003). 75

Who might attack

February 11, 2006: Q&A: Liquefied Natural Gas: A Potential Terrorist Target? New York Times "Are LNG ships and terminals potential terrorist targets? Yes, because of LNG's raw explosive power, experts say. Al-Qaeda, for example, has specifically cited LNG as a desirable target..."

August 12, 2005: Terror Alert Offers Specifics, Washington CBS News, The Early Show "The FBI's terror warning to police in New York, Chicago, and Los Angeles is different from many of the other alerts issued by Washington since the 9-11 attacks: It's detailed, according to Col. Randy Larsen, a CBS News consultant who heads the Institute for Homeland Security." "Larsen says the main concern is liquefied natural gas, known as LNG, which is so explosive it can engulf an entire building if a truck carrying it crashes into one. "

May 10, 2005: Report warns of 'catastrophic' risk at gas terminal Reuters - USA BOSTON (Reuters) - A terrorist attack on a proposed liquefied natural gas terminal in urban New England could cause "catastrophic damage," former U.S. counterterrorism official Richard Clarke said in a report released on Monday... READ THE ENTIRE REPORT: http://www.riag.state.ri.us/LNG_Good%20Harbor2.pdf

The shipments, which arrive about every 10 days during the winter, resumed on Oct. 29, 2001, under the watch of patrol gunboats, police divers, sharpshooters, bomb squads, and a helicopter. Officials yesterday did not indicate if they will take the same precautions this time, but on that trip, officials also halted flights at Logan International Airport and stopped traffic on the Tobin Bridge as the 860-foot Matthew lumbered into port. A typical tanker carries about 33 million gallons of gas.

Distrigas issued a written statement yesterday saying the company is "communicating and working in close collaboration with public safety officials to determine the best way to ensure the safety and security of our operation so we can deliver critical energy supplies to our customers in New England."

Romney said he and Menino agreed to delay the shipment of liquefied natural gas. "We have flexibility in the schedule on its arrival in the harbor," Romney said. "We plan to take advantage of that flexibility."

Diane Hernandez, 35, a Merrimack, N.H., resident who grew up in Chelsea, said she watched the tanker arrive last week when she and her mother were walking on the Boston waterfront.

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"There were cops everywhere. They blocked off the bridge, and there were at least eight Coast Guard boats out there," Hernandez said. "They are definitely taking it very seriously. They can't stop everything, but they're doing the best they can." Romney and Menino said certain public safety workers would be working overtime until the alert is over, but that there should not be many missed vacations. Romney said the antiterrorist preparations would cost millions of dollars, but the final tally will depend on how long the alert lasts. Between March 17 and April 17, when the war in Iraq prompted an orange alert, the state spent about \$200,000 a week, mostly on overtime for State Police. But the state deployed the National Guard during that alert, and Romney said he doesn't anticipate taking that step this time.

#19 History of attacks/fires - Terrorism

Although LNG tankers have not yet been the target of terrorist attack, there have been several notable events that illustrate the vulnerability of LNG tankers to accidents or attacks. Al Qaeda and other terrorist groups have shown intent to target the energy sector through previous actions and statements.³⁶ The rise in high seas piracy, discussed in further detail in section B I, particularly in Southeast Asia, is a disturbing trend. Additionally, al Qaeda was reported to have smuggled an operative into Boston on an LNG tanker from Algeria before September 11, 2001.³⁷

History of attacks/fires – Safety incidents

There has never been an accident involving a LNG tanker that has caused significant damage to the public or the environment,³⁹ and no fatalities have resulted from safety accidents involving LNG tankers.⁴⁰ Through 2002, there were 30 minor safety accidents, which include collisions, groundings, and leaks.⁴¹ Of those 30 accidents, 12 were leaks that caused some freezing damages, and two were leaks that resulted in small vent fires.⁴²

Although LNG tanker accidents have not resulted in any fatalities, there have been fatalities from accidents at LNG facilities. Two fatal LNG facility accidents have occurred in the United States and two in Algeria.

The following section catalogs the most noteworthy events. For a complete list of LNG safety incidents, see University of Houston Law Center, Institute for Energy, Law, and Enterprise, LNG Safety and Security, October 2003, p. 77-79, available at

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http://www.energy.uh.edu/LNG/documents/IELE_LNG_Safety_and_Security.pdf

Note descriptions of past energy infrastructure and attacks on pipelines, etc., are included in Clarke report

As previously noted, there have only been five significant LNG safety incidents (i.e., resulting in death) in either in port or at sea, with thirty incidents total in the 45 year history of the industry.^{80,81} The low incident rate is credited to regulation, improved tanker design and technology, improved tanker crew and ship management competency.⁸² In contrast, the Federal Aviation Administration posted for the Year 2003 a large aircraft carrier accident rate of 54 accidents per 100,000 flight hours, an incident rate of .3% for total flight time, vastly higher than the accident rate for LNG tankers.

Types of LNG incidents

Creating a destructive LNG incident through an intentional attack on an LNG facility an intentional could be achieved through several means:

- Vaporized LNG
 - o Using the gas in vapor form to cause physical harm to the surrounding population. As LNG is a colorless, odorless gas, it would be possible to have the gas spread.
 - o Using the gas in vapor form to ignite a fire.
 - o Using the gas in vapor form to cause an explosion
- Liquefied Natural Gas
 - Using the liquid gas to physical harm to surrounding population.
 - Using the liquid gas to ignite a fire.
 - Using the liquid gas to cause an explosion.

The body of literature on LNG breaches is additionally complicated by the vast amount of information that exists and by the fact that much of the research has been funded or initiated by interested parties, either private companies with LNG interests or groups that stand to gain or lose from the placement of LNG facilities. In creating this report, we have done an exhaustive literature search but in drawing our conclusions, we have relied on those studies done by independent and scientific research laboratories, to insure we have used unbiased findings.

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To date, the definitive study on intentional and unintentional LNG breaches is the Sandia Laboratories report released in December, 2004. The report was designed to be the definitive study that drew from the best existing research. It examines the report presents its own research and compares it with 3 additional spill modeling studies Sandia deems to be of sufficient scientific merit: The Lehr Study (2003), the Fay Study (2003), the Quest Study (2003), and the Vallejo Study (2003).

Other obstacles

City Decries LNG Plan says fire is the main concern of residents who oppose LNG facility, but also property values and local economy from reduction of cruise ships, taking land by eminent domain (not true), terrorist attack issues mainly raised by MIT professor report with 2 mile radius concern, loss of local neighborhoods close to facility through government buyout of 120% value for home, pipeline underneath golf course at country club

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QUERY SUMMARY

Queries to familiarize with domain

- Liquefied natural gas (LNG)
- LNG United States energy crisis
- LNG U.S. government agencies
- LNG risks, hazards
- LNG current policy

Queries targeted at quantifying natural gas issues

- United States natural gas consumption
- U.S. natural gas prices
- U.S. LNG imports

Queries focused on main hypothesis (local environmental / safety concerns)

- LNG environment
- LNG local pressure

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Figure A.34: Analysis Process 2 [A(2)] Query Summary, Page 1 of 1

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1. University of Houston Institute for Energy, Law, and Enterprise. Introduction to LNG. January 2003. https://www.piersystem.com/clients/crisis_569UniversityofHouston,IntituteofEnergy-INTRODUCTIONTOLNG.pdf
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Figure A.35: Analysis Process 2 [A(2)] Documents Read, Page 1 of 1

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WHERE DOCUMENTS STORED IN FOLDERS

LNG General Information

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LNG Issues & Obstacles

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Figure A.36: Analysis Process 2 [A(2)] Where Documents Stored in Folders, Page 1 of 1

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KEY DOCUMENTS (RELIED ON HEAVILY)

LNG Background Information:

University of Houston Institute for Energy, Law, and Enterprise. Introduction to LNG. January 2003. https://www.piersystem.com/clients/crisis_569UniversityofHouston,IntituteofEnergy-INTRODUCTIONTOLNG.pdf

LNG Quantifiable Statistics (Imports, etc.):

Energy Information Administration/Office of Oil and Gas. EIA - Natural Gas Data, Reports, Analysis, Surveys. http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html

Perspective on LNG Obstacles:

Center for Liquefied Natural Gas. Liquefied Natural Gas Proposal. January 2005. http://www.lngfacts.org/newsroom/LNG_proposal.pdf

PROCESS #2

1

Figure A.37: Analysis Process 2 [A(2)] Key Documents, Page 1 of 1

***** UNCLASSIFIED *****

HYPOTHESES – CONSIDERED OBSTACLES TO LNG

H1: Safety / environmental concerns

H1A: Global environmental concerns (dropped)

H1B: Local safety opposition

H2: Cost prohibitiveness (dropped)

H3: Political issues

PROCESS #2

1

Figure A.38: Analysis Process 2 [A(2)] Hypotheses, Page 1 of 1

***** UNCLASSIFIED *****

COLLABORATIONS WITH OTHERS DURING PROCESS

1. Analyst Colleague: Briefly discussed initial search strategies / queries

PROCESS #2

1

Figure A.39: Analysis Process 2 [A(2)] Collaborations, Page 1 of 1

***** UNCLASSIFIED *****

RESEARCH NOTE-SHEET

A compiled note-sheet was not used by this analyst.

PROCESS #2

1

Figure A.40: Analysis Process 2 [A(2)] Research Note-Sheet, Page 1 of 1

APPENDIX B
PARTICIPANT VERBAL REPORT DATA

Study Pilot Participant Interview Notes

Did two “fast reads” of documents

What are policy-makers looking for?

- Formatting -- wants a picture and a paragraph
- Looking for: what is the critical idea that resonates?
 - If it doesn't resonate, it's not pursued
 - Want 30 second sound bites -- for high speed processing
 - Similar to newspaper headline writing style (summary in first paragraph)
- Method contrasts with “Classic” style of reporting methodology
 - “policy-maker doesn't care about the methods”

Tailoring to audience is key

- Writing in best form for client to process
- Uses key terms

9/11 Report

- Not enough confidence level assessments
 - Low confidence in single data point assessments
 - Just because it fits in with biases ?

Sourcing -- Where did the information come from?

- Number of sources can give confidence
- Taken to extreme, every statement has to be validated

Problem --> Solution --> What to do about it

- Decision-maker needs to know what to do about it
- Reason needed for why to look at it
- One of two possible answers

There are other channels for rigorous reports that don't specifically go to policy-makers

Differences in policy-makers vs. regular staff (regular analysts)

- put up articles for others
- 1st level assessment of raw data
- goes into detail for later reports
- Senior Staff = policy-makers “right hand” people
 - Want things that are ready for policy-makers
 - Assumed?
- Issues Managers = responsible for handling a single topic within organization
 - “Big picture” people -- compile info. and distribute to customers
 - E.g. how could DoD help border control?
 - Might represent a commander, but not in a supervisory position
 - Looks across stovepipes
 - Should bring people together, not make new tasks

Figure B.1: Study Pilot Participant (P0) Notes, Page 1 of 5

- PIA (pee-ahh) = primary intelligence analyst (peer)
Make decisions on what to do
Stay / work in one area of "junior staff"
- SIA = senior intel analyst
Tries to breakdown stovepipes

People often don't question sources if things CHANGED -- how do you know if they did?

- Trust can stem from knowing a person / office
- There is some inferred trust in the process

Working the Area Hard

- Citing other reports, statistics, current policy actions, how put together (flow)
Does it give what is needed?

General comments on reports:

- Briefs "not in the right order"
Executive summary + "T-off" Statements (a "hook" to open a report)

Analysis of Reports:

Report 1

- Too much background
Never facts, not specific steps
Stops before getting to action
 - Too "top level", not for a policy-maker
 - Define problem > why they care > what can they do about it
Not "supposed" to advocate policy, but can be predictive
- Needs to be a "newspaper" format
- Never left the first level
Some things are not really options
Problems / solutions not well thought out
- Too many obvious questions left unanswered
Implies low rigor assessment
- Would want to meet with author and specify problems -- "this is what I need"
- Not formatted for policy-maker
Needs to know customer, primary client -- customer tailoring
Must write well to get them to listen
Must be careful (sympathetic) when dealing w/ counter-advocacy

Report 2

- Got to the point of "why" much quicker
- Liked the chart -- useful for policy-making
- Seemed like it explored the issues more
- Confident in getting a more extensive bibliography
- Seemed like multiple sources (the more the better)
- Liked list of supply countries

Figure B.2: Study Pilot Participant (P0) Notes, Page 2 of 5

- Report had more “warm fuzzies” for policy-makers
- Good instances of statistics & research
Clear that main problem is lack of unified policy

Composite Assessment of Report 1 & Report 2

- Thought Report 2 was the better report -- tailored for policy-makers
Implies that the report is more rigorous
It looked at context issues
Would follow-up as proponent of peer review
 - Would ask who else has seen it?
 - Would see if people with no vested interest agree

Intel. Analysis Process

- Number of peer reviews, and their responses are important
Critical to get feedback however you can
But feedback can come via any method (still important, regardless)
- Inputs in intel. aren't as clear as going into a library
Expert opinions can be a source (or e-mails)
 - Can add credibility with an expert source
 - If no collaboration, trying to work around ?
- Sometimes you may have to use a single source

Policy-Makers

- Sometimes want to see alternative options (“debate can be healthy”)
 - e.g. “we think this... other organization thinks that...”
 acknowledgment of other perspectives points to rigor
- Let policy-maker make the decision
Can't push for policy, but provide information

Comparison...

- Report 2 is closer to being ready to go, but would need...
Action items up front, summary items
Issues “bulletized”

Feedback on Available Options

- Liked hypotheses considered
- Key Documents
- Might discuss query summary, but not specifically asked for
- Would only push beyond #5 if there is reason to be suspicious
- Don't worry about cutting and pasting as long as you cite source

After reviewing supporting documents

- Report 2 didn't mention counter-terrorism paper
Report 1 got hung up on terrorism issue

Figure B.3: Study Pilot Participant (P0) Notes, Page 3 of 5

[Felt that order of documents did influence discussion]

Collaboration can lead you off the mark as well

- Report 1 had so much in the notes that didn't make it into final paper
Should "sprinkle in numbers" to show expertise
- Report 2 conclusion: need to solve problem of economy
- Report 1 conclusion: maybe we shouldn't do it [LNG] at all
Almost like different issues
- Found formal notes to be useful -- Looked at the notes
- Report 2, noticed no hypotheses considered
- Found low rigor sources to be credible
"Too much information got in the way"
- Report 1 was afraid of picking and choosing information
Intel analysts serve as filters
It is very information heavy, and this hinders the flow
- Report 2 gets "warm fuzzy" for policy-maker
- Report 1 has no bottom line -- i.e. influencing policy
Lost the client -- e.g. doesn't understand how regulations is not relevant
Tell me more about this?
- Didn't believe Report 2 could be written by the hypothetical process
[Technically, it wasn't]
- Are there other alternatives to LNG?
Neither of the papers hit on the alternatives
- Report 1 should add alternative energy sources and process of ruling out
What are the counter-positions? Identify them.
Articles "wet your whistle" for alternatives (comparing LNG to other things)
- Terrorism issue -- once attack occurs it is not too late
- Hypothesis list order indicates importance vs. hypotheses as an outline in order
- Saw focus on terrorism issue as an author bias in Report 1
- General preferences
Likes to see outlines of papers
Note-sheet was helpful in understanding in how they went amiss
 - Gave insight into recovery processThere is always the ability to verbally pull information from the author
 - List order still helpsOutlining, hypotheses / Collaboration / Key Documents
 - If there is a problem, then we go deeperWhat are client requirements

After seeing supporting documents...

- Thought rigor of Report 1 was higher after seeing process, but it was still not considered any better because of the good process. Author not given increased credibility.

Figure B.4: Study Pilot Participant (P0) Notes, Page 4 of 5

- Report 2 after seeing process, it added more questions (although enough sources)
- Report 1 process is flawed b/c data is there, but not in the proper format
Problem could be with individual agent or with director
- Having Report 1 supporting docs. pointed to a problem in analyst process...
Did not increase credibility of report
- In general, articles are reviewed in layers
Usually enough ? on the problem
Often not as concerned with rigor unless there is a disagreement
 - Rigor is often flushed out in the review process

Actionable Intelligence

- Never enough time to work a problem
Often policy-makers "want it yesterday", even big complex questions
This requires a dynamic process
 - What happens if process time is shortened?
 - What happens if 2 weeks -> 2 hours?
 - Often they want information now or never...
But can get best expert on the spot
- Is there a way to short-circuit the process while still maintaining rigor?
Coordination takes time -- but can't let it suck up a whole process
- Often time policy-makers don't care as much if the information is "right"
It gives them somebody to blame when things go wrong
- However, being rigorous is a good goal
Most effective on an "initiative piece" = investigation initiated by analyst
 - E.g. forecasting an emerging problem over the next few years
 - Big differences in time pressures
- QRT = Quick Reaction Time Process = squeeze process and do what you can

PILOT PARTICIPANT DEMOGRAPHICS

- Has technical background in aeronautical engineering
1986 - 2003 as analyst
Last 2 years as a supervisor

Other / Closing Participant thoughts

- Clarifying what you wanted
- Getting the analyst's "homework" package
- Seeing process didn't change rigor perceptions -- end result is what mattered
- Concerned about training new analysts -- the way writing changes
- BFC pressures
- Experienced agent's documents can look like Report 1 -- too much information

Figure B.5: Study Pilot Participant (P0) Notes, Page 5 of 5

Study Participant #1 Interview Notes

1) Comparison of Reports

- Drawn to Report 2 initially -- pictures are often valuable
 - Informal writing style is easier to read
 - But something is lost with this writing style
- But, rigor is more obvious in Report 1 -- preciseness indicates rigor
- Report 2 is question focused, offers solutions
- Likes Report 1 in that it quantifies what was and was not covered in report
 - This lets policy-maker understand limits
 - But, would try to condense to one page for policy-maker
 - With option to provide more as needed
- Report 1 is ready to go to policy-maker, Report 2 is not
 - Report 2 needs to be more precise
 - Uses words like “about” and “around” too often
 - Makes author look to be unaware of facts
- Drawn to Report 2 first because of the picture
 - Report 2 could be given in a brief
- Report 2 is too heavy on conjecture (e.g. “luckily for the U.S.”)
 - More opinion -- prompts one to ask “Am I reading opinion or fact?”
 - Report 1 gives the better “warm fuzzy”
 - Bias and objectivity served as indicators of rigor
- Condense Report 1
 - Also, need to know sources
 - It is not clear how obstacles listed were determined
- Footnotes could be useful for this “form” of the report
 - Other “forms” of report would include support material
 - Footnotes imply academic rigor
 - Academic rigor parallels analyst rigor (but is not exactly the same)
 - In some sense “rigor is rigor” -- in line with David Schum model
- Question is very specific to obstacles
 - Report 1 intermixes solutions with obstacles
 - Report 2 goes “off task” by offering solutions
 - What are the downsides of looking for full solution sets?
 - But, analyst still has role of problem-solver -- “here is a problem, solve it”
- Report 2 proposes policy in opening paragraph, so tone is more critical
- Analysis is more than just making reports -- e.g. It also involves requirements

Figure B.6: Study Participant #1 (P1) Notes, Page 1 of 4

2) Understanding of Process

- Wants to know what the sources were -- builds confidence
 - Process depends on "level of difference"
- Would ask questions in day-to-day work to develop understanding
 - E.g. ask "What did you do?"
 - Looking for varied levels of detail in response
 - Responses give ideas for what analyst needs to work on
 - Analysis is not a step-by-step process, a procedure
 - Response to "what did you do?" shapes expectations
 - Difference between "procedure" used and process of analysis
 - Level of detail reflects type of report
- Wants to see background information
 - Package of information that starts with a summary
 - Would go to foundational documents -- see original reports
- There is a working assumption that "I deal with competent people"
 - Assumed that someone else goes through verification process at that level
 - At their specific level of analysis
 - This is true even in agencies that produce different answers
 - Note the difference in obstacles between papers
 - When you get to a point, you just have to trust
 - Feedback loops draw out facets of analysis
 - "We all have blind spots and bad hair days."
- Would prefer to see alternatives after potentials in formatting
 - Gives as "full of a picture" as possible
 - Presumably, e.g. things not considered in paper
- Importance of Peer Review
 - E.g. impacts of "cold fusion" process
 - Lacked peer review
 - Reflected poorly on the physics community
 - They violated the process
 - But, must go beyond just peer review
 - It is not sufficient by itself
 - Peer review falls apart with the introduction of novelty

Figure B.7: Study Participant #1 (P1) Notes, Page 2 of 4

3) Improving Analysis Reports

- Hypotheses are important
 - Often times it is what is overlooked
 - Importance of the way an individual relates to analysis
- Analysis is not just a "task" -- there is more to it than that
 - There is no one "correct" method
 - Must accept that others have different practices that yield solid results
 - And that their approach is equally valid
 - You do not always have to completely understand their method
 - Cannot always teach it either
 - Personal experiences lead to intuitiveness
 - Which comes from "reading lots of stuff"
- "Documents stored" does not matter
- Sees analogies as useful to simplify the world
 - You can break down a complex thing into discrete, simplified chunks
- "CD Now" / Amazon approach to look at patterns -- Who else looked at it?
 - Finding people who do things similar to what I do

4) Assessment using Process Documents

- Understanding of Process 2 confounded by "thinness" of documents available
 - "Nothing really behind it"
 - Report 2 is acceptable, but still needs something behind it
 - Must be something behind visualizations (from Tufte seminar)
- Liked queries to familiarize -- from large to narrow
 - Likes to see a wide to narrow search process
- Liked seeing hypotheses -- hypotheses are critical
 - Not a whole lot of data in Report 2
- Liked collaboration insight
- But, would probably not forward either one
 - Report 1 has two mindsets: Energy and terrorism
 - Liked fact-based nature of Report 1
 - Report 1 process documents indicated analyst was too limited (in search)
 - Impressive number of documents...
 - But no evidence of supports from other obstacles
- Formatting is not as critical unless mandated
- Not clear in what order queries were generated
 - Did queries lead to hypotheses or did hypotheses lead to queries?
- Report 2 shows good collaboration
 - Makes analyst feel a little better about conclusions
- Detailed notes indicate documentation, not necessarily rigor
- Documents lined up with expectations -- saw more rigor in Report 2
 - Now more reluctant to pass on Report 1 as a result
 - Would tell Analyst 1 to expand / broaden
- Both processes had deficient hypotheses
 - Need to show that analyst at least looked for alternatives -- show an effort

Figure B.8: Study Participant #1 (P1) Notes, Page 3 of 4

- Can respond when manager says "Have you thought about this?"
- Process 2 hypotheses
 - More broad-based -- did not find they were well developed -- feels undone
- Process 1 had good hypotheses, but too narrow
 - "It's not analysis to justify biases"
 - "Biased study" representative

5) Participant Profile

- Approximately 18 years experience
- No previous LNG focus
- Order of documents read...
 - Did comparative reads, sentence-by-sentence, through first paragraph
 - Then read Report 1 first in entirety

6) General Thoughts

- Biggest problems in Intelligence Analysis
 - Lacks of tools to grab disparate data, convert to meaningful visualizations
 - Not providing single-point solutions
 - Things pull together into a good overview
 - Often training is on how to use a tool -- use was "self-evident"
 - Problem in tools if you cannot use them
 - Usability plus modifiability
- Thoughts relative to capturing process and playing it back
 - Assumption that people start with hypotheses...
 - But some start with requirements
 - Analogous to Chuck Yeager autobiography
 - A flat spin is bad for regular pilots...
 - But for test pilots it was a good sign of progress
 - Analogous to "trying to get to spots where I know what to do"
- Willingness to document occurs at different points in process of different people
 - There are also things to learn from people who do things differently
- How to support the briefing assembly process -- idea of a "keeper" document
 - E.g. Make it easy to produce graphics
 - Report 1 has a poor graphic, but it draws me there
- Related questions...
 - How could notes be used to make "data marts"?
 - Do they merge with other documents?

Figure B.9: Study Participant #1 (P1) Notes, Page 4 of 4

Study Participant #2 Interview Notes

1) Comparison of Reports

- Report 1: A risk is not same as an obstacle -- report does not answer question
Obstacles can be fixed, whereas risks can only be mitigated
Analyst answered the wrong question -- answer is not focused at question
- Report 2: Better because more precise, e.g. they identified countries
More benefits focused, identified few downsides
Listed obstacles, e.g. a lack of unified policy
Written to support an opinion
 - Must get into mind of customer
- Need to be clear about: obstacles vs. risks vs. downsides vs. benefits
- Neither report answers "how to get it done" -- how to overcome obstacles
- Report 2 looked more rigorous -- e.g. listed countries
But does not go to that next "obstacles" step
Not a lot of "3D" thought
 - Answer question, but then you think about it
 - Once you answer it -- then what?
 - Move ahead and say "Now what?"
- Report 1 wasted pages on terrorism stuff -- Why repeat what we already know?
- Getting at obstacles -- what supervisor would want to see:
A focus on policies
Why is fire and radiation more of a risk than anything else?
Comparison with existing risks
- Reports had different interpretations
Report 1 implied "No" to LNG
Report 2 implied "Yes" to LNG

Importance of Focusing on Customer

- Reporter needs to be unbiased and identify biases
- Have to know customer to know what is good
E.g. reports have no headers -- should be clear what they want to see
Should know customer, but should just answer question
- Tangent reasoning says the customer does not know the answer
Obstacles need to be very clear, can go back and clarify question
- Tailor to executive reader -- senior, no time to do a lot of reading
- Different versions of a report are useful
Everything needs to be in an executive summary

Study Reports Relative to Customer

- Report 2 is higher quality -- shows more rigor
E.g. listing countries gives more information, which is helpful
However, do not like the slant in Report 2 -- seems like marketing
- Report 1 is not focused on question -- largely does not apply
- Better customer focus translated into "better" rigor
- Would analyst forward either report on to decision maker? No, neither one.

Figure B.10: Study Participant #2 (P2) Notes, Page 1 of 4

2) Understanding of Process

- How could reports be fixed?
 - Discussion with analyst, e.g. focus on issues...
 - What are obstacles? Who has dealt with them?
 - Can they be overcome? Are they still obstacles?
- Going to “second level” questions is valuable
 - Follow on discussion might include...
 - “Why analyst got that conclusion?” and “What to do next?”
- Report sources need to be identified
- Looking beyond just the words...
 - E.g. branching out to future energy needs
 - Doing research -- need to know a lot about it
 - Relation to other indicators
- Need to include thinking from a multitude of perspectives
 - Who are the enemies and proponents of LNG and why?

General Difficulties of Analysis

- Good news does not sell
 - Must be extra specific when reporting positives
 - Must be careful when presenting view...
 - “They are NOT going to do something”
 - It requires more evidence
 - People looking for things that are bad -- it is Human Nature
- The “We report, you decide” Model
 - Trying to do “red cell” activity contrary to conventional wisdom
 - Not sure of usefulness
 - E.g. Jill is a good mom, but fudged her time card
 - In the end, CIA has the final word
- Looking at justifications and key indicators
 - Looking at what is important to me
 - “Indicators and warnings” -- look for bad things, want to see good things
 - Justification of key indicators plus knowledge
 - Level of certainty assessments

3) Improving Analysis Reports

- Would go through process of analyst
 - Build up a “pyramid”
 - People, places, problems, etc.
 - Pull factors to get a broad background
- Would ask how they did it?
- Making linkages to pyramid
 - Is it analyst’s own view or taken from other analysts?
- Always keep in mind the question -- focus on the issue
 - Build an understanding of topic before asking question
- There is a belief that process can be inferred from reports

Figure B.11: Study Participant #2 (P2) Notes, Page 2 of 4

- Paragraphs should have synergy
- Report 1 looks like parts of different papers -- like cutting and pasting
- Form / presentation is key -- sourcing is also key
- But, customer has final say

4) Assessment using Process Documents

- In Report 1 terrorism is big issue -- bigger than it should be
 - Paper went a different way than supporting documents indicated
- Found process documents helpful "in a way"
- Would want to see more about both processes
 - Especially looking at incorporating perspectives
 - Would form categories as "for" and "against" mentally
- Not really any surprises in process documents
 - But, hard to say without seeing actual (source) documents
 - Report 1 covered a bunch of topics that were not related
- Individuals would vary on how much they need to see about process
- Documents indicate that "rigor is still not enough"
 - Report 1 is more rigorous, but not good enough
 - Would have like to see more
- Not looking for indicators of rigor, looking for perspectives...
 - How do you look beyond this (question)?
 - How to delve into issues on your own?
- Looks for "360 Degrees of Perspective", e.g...
 - Why is it an obstacle?
 - Is it true today?
 - E.g. UAE port issues -- are a big deal now, but perhaps not before

5) Participant Profile

- Approximately 22 years experience
- No familiarity with LNG -- not all that interested in LNG as a general topic

6) General Thoughts

- Policy-Making and Analysis
 - It is the "Nature of the Beast" to looking for things that are bad
 - In intelligence community, no one wants to hear about good things
 - We are here to warn people, not give "warm and fuzzies"
- Also important to say what you do not know -- and also, what we should see
- Does not think that telling policy-makers what they want to hear is a "problem"
 - Nobody wants to be the one who says...
 - "He does not have WMDs"
 - "He will not fly a plane into that building"
 - Needs more information to decide -- it is not enough
- Number of documents is important, if it is known they were used
- Would want to know the person who did analysis
 - Prefers to talk to the person -- likes sit-down format
 - Gets people to get at what is wanted

Figure B.12: Study Participant #2 (P2) Notes, Page 3 of 4

- Analysis is not about copying and pasting -- must have understanding
- Questions analysts need to be asked:
 - Did you consider other alternatives?
 - What are the gaps?
 - Who is against it?
- Some kinds of questions can be used for most any task -- could use a form...
 - But not just a checklist
 - E.g. use common questions to make a form
 - Could have supervisor create "to be answered" questions
 - Supervisors typically have questions in mind
- Want analysts to "own" their process -- do they believe these things?
 - One must prepare to answer questions about a report when you do it
- As an analyst, participant...
 - Uses a method of developing the summary as the report is written
- Seeing hypotheses may hinder ability to be "blank slate" in critiquing analyses

Figure B.13: Study Participant #2 (P2) Notes, Page 4 of 4

Study Participant #3 Interview Notes

1) Comparison of Reports

- Report 1 was more qualitative at first -- or tried to be (use of figure)
But there was not as much detail
More casual
- In Report 2, did not like use of "regasified" -- took away from credibility
- Both reports...
Lacked sourcing
Have distracting writing styles
Are sensationalized, which made reports seem very opinionated. E.g...
In Report 2, 9/11 is "played out"
In Report 1 there is excessive focus on environmental groups

2) Understanding of Process

- Assessment of rigor...
- Report 1 used a graph -- tried to make it look like research (illusion of research)
Hard to say they did more than just an online search to pull data
- Difference in focus
In Report 1 it was environmental groups, in Report 2 it was terrorism
But, Report 2 also addressed other issues
- Both reflect an "unseasoned" analyst
Would not pass either one on -- both need editing
Looking for credible sources
But, Report 1 graph adds points
- Hard to tell which is more rigorous...
Maybe Report 2 because of broader concerns

3) Improving Analysis Reports

- Revising Process
At a peer level, feedback approach would change
Big issue is apparently credibility -- does data have credibility?
- Directly asking -- "How did you come to these conclusions?"
- Follow through on links -- make sure to do "due diligence"
- May not make sense to ask for older drafts -- they may not exist
- Who else did they work with? Resources close to problem?
Understanding team vs. group structure
- Both reports were opinionated -- how could it be lessened?
Neither report is unbiased
- Could do own bit of quick research to compare to the report...
Quick comparative research
Do not need to go to the library
Use this information to judge depth of report

Figure B.14: Study Participant #3 (P3) Notes, Page 1 of 2

- 4) Assessment using Process Documents
- Hypotheses timeline could be useful
 - How they developed
 - Did they just validate them? i.e. are they preconceived hypotheses?
 - Hypotheses serve as a window into mind of analyst
 - Can be an overlay onto other dimensions
 - Quality of Report 2 is better -- tells more about the process
 - Found search terms interesting -- seemed very specific in search
 - Number of documents read was important
 - First hypotheses for Report 2 was terrorism
 - This is not a surprise
 - Says that analyst had an idea going in, looked for confirmation
 - Report 1 was light in research, but started broader
 - Slightly more unbiased approach
 - Looked at less sources, but started on the "right path"
 - Seeing reports should not change analyst's perspective
 - Number of data points is valuable
 - Standout points in processes
 - Process 1 used mostly government sources (.gov and .org)
 - Process 2 sources mixed in evaluation (.edu, advertisement)
 - However, Process 2 had some articles from same sources as Process 1
 - Hypotheses page was confusing
 - Give the impression of linearity -- i.e. hypotheses generated in that order
 - Meta-data about hypotheses would be valuable
 - E.g. How were ideas influenced by what was read?
 - Seeing change over time is generally a valuable thing
- 5) Participant Profile
- Approximately 2.5 years experience
 - Not very familiar with LNG topics
- 6) General Thoughts
- Citing of sources is an emerging global issue
 - Re-syndication of information -- reissuing content?
 - Notion of plagiarism is becoming passé
 - Things just seem to emerge -- "I read it so it has to be true"
 - Likes group documentation
 - Setting up sources
 - Looking at issues unbiased -- Who do we trust to be unbiased?
 - Demanding practice to force self not to prematurely close
 - Could be more of a global problem -- more a broader reflection
 - What are the implications on training?
 - People are unlikely to watch things over time -- assume people will not do it
 - Parallels to collage artist mock-up...
 - Allows for seeing meta-data links

Figure B.15: Study Participant #3 (P3) Notes, Page 2 of 2

Study Participant #4 Interview Notes

1) Comparison of Reports

- Question is "What are obstacles?"
 - But, obstacles too buried into the middle
 - Where is the documentation?
- Form issues...
 - First paragraph "should" have the answer -- then expand from there
- Report 1 seems like a newswire story without supporting documents
 - Sensationalistic
 - Report has "silly" parts that do not help policy-maker
 - Not "technical enough" to show that person knows their stuff
 - Not enough detail
- Report 2 has a first paragraph that is not on subject (wants an answer)
 - "What's the point of price chart in relation to question?"
 - Not obstacles focused
 - Talks too much about benefits (rather than obstacles)
 - Lacks in backing for some statements
 - Also, too much price focus -- price is not an obstacle
 - Environmental comments seem like rhetoric
 - "What does Bush commission have to do with obstacles?"
- Report 1 is "better" -- it attempts to look at issues
 - Worried about the rigor "in both cases"
 - E.g. excessive terrorist focus in Report 1
 - Terms like "around" are indicative of a lack of knowledge

2) Understanding of Process

- Rigor...
 - Report 1 seems to have greater rigor than Report 2...
 - But not in an absolute sense
 - Graph indicates more effort for Report 2
 - Terrorist stuff in Report 1 is somewhat off topic
- Thinking about "next step" obstacles
 - E.g. need a radius that is clear of houses
- Neither report is ready for policy-maker
- Thought analysts should start over, would not want to look at process
 - Both lack obstacles
- Understanding of process stems from assumed training
 - Use of connections -- e.g. collateral information references
 - Stated confidence
- Junior analysts often do not get structured questions...
 - Must recognize emerging patterns in data

3) Improving Analysis Reports

- Face to face meeting, sending notes with questions
- Do not usually ask about process

Figure B.16: Study Participant #4 (P4) Notes, Page 1 of 3

- There are assumed expectancies
- Would go back to source material to understand process
 - Although there are sometimes issues with translation to foreign language
- Uses a general collaborative peer review process

4) Assessment using Process Documents

- Report 1...
 - A lot of what analyst would want to see was in the notes
 - Research documents indicated more rigor than report reflected
 - Important stuff was left off of report
- Report 2...
 - Rigor of process showed in bad document
 - Process 2 indicated not enough research
 - "Makes you wonder why they did what they did"
- Seeing process changed view of reports
 - But there are still problems with reports
 - Issues with sourcing and answering the question
 - Allows diagnosis of where help is needed
- Report 2 showed they needed to do more
 - Hypotheses stuff is missing -- where did it come from?
 - Collaboration shows analysts did his homework...
 - Otherwise, might not have seemed that critical
- Meets a certain standard on being a "reporter"
- Report Bias
 - Report 2 did not really answer question -- so do not know about bias
 - Report 1 does not show a great bias
 - i.e. a purposeful slant / preconceived notion
- Seeing the process changed assessment from "start over" to...
 - How do I restructure what you have done -- re-writing report

5) Participant Profile

- More than 25 years experience
- Not familiar with LNG
- Read Report 1, then Report 2

6) General Thoughts

- Do not think analyst should speak to policy-maker
 - In an ideal world, audience would not matter
 - Believes NSA is like that -- no audience focus
- Policy-makers biggest problem is seeing what they want to see
 - Overcoming preconceived notions
 - Asking for additional information until supporting info is found
- Design Seeds
 - Good response for ability to tag things as they go
 - Source overlap could be minimal
 - Limits to exposure to raw data

Figure B.17: Study Participant #4 (P4) Notes, Page 2 of 3

- Undermining (probably false) assumption: Long term reporting
Probably mostly events based
- Looking for ways to add to reports, rather than starting over...
Yet informing people that they are seeing something new

Figure B.18: Study Participant #4 (P4) Notes, Page 3 of 3

Study Participant #5 Interview Notes

1) Comparison of Reports

- Report 1: Would not send to decision-maker
 - Based on opinion
 - Casual writing style (confusing)
 - Inappropriate style -- few or no facts
 - "Gratuitous use of a chart" -- better use might be to contrast
 - Political agenda
 - Does not distinguish, alarmist
 - Implies LNG is from foreign sources
 - Has to "pull out obstacles"
- Report 2: Better, but would still require edits
 - More cohesive explanations
 - Clearly states obstacles
 - Would have structured differently
 - "Dies" at the end
 - Could have reduced paragraphs
 - Liked understanding limitations, but not integrated optimally
- Report 2 is better, but neither is ready

2) Understanding of Process

- Report 1 looks like a cursory gathering of information
 - Not sourced
 - Feels more like an opinion piece
 - Not very much rigor
 - Political slant
 - Takes a few facts and run with them
 - No pre-outline
 - Could be from a newspaper
 - Form / style important -- preference for "classic" form
 - Does not indicate much process (rigor)
- Report 2 indicates good research -- not as much an opinion
 - Academic style
 - Took time to think about obstacles
 - Likes specificity
 - Given some structure -- good basic overview
- Reports indicate different obstacles
 - Report 1 does not mention terrorism at all

3) Improving Analysis Reports

- Fixing Process 1
 - Looking for facts and figures together
 - What has analyst looked at?
 - Needs to do more research
 - Do not require chart -- would advise against using chart

Figure B.19: Study Participant #5 (P5) Notes, Page 1 of 4

- Fixing Process 2
 - Would mainly restructure report
 - E.g. justifications to the front
 - Mostly tweaking
- Would like to see sources
 - Would like to see a footnoted review copy
 - Source checking -- public versus classified
- Might be interested in analyst backgrounds
- Form is important
- Reader must have confidence in what is read
 - Structure / form conveys confidence
 - Analyst should not make assumptions about reader
 - Report 1 assumes reader holds the same views as analyst
 - "This is what they want to hear"
 - Making sure personal bias does not influence report
 - Use of language is very important

Evaluation of Available Documents

- Hypotheses, Documents Read, and Key Documents are most important
 - Do not care much about Query Summary, pending experience of analyst
- Analyst Experience
 - Rare to have access to note-sheet
 - List is good thing to keep (checklist of process)
 - Expected to produce bias in questions
 - Case-based review
- Check sheets for levels of documentation
 - Should accomplish things on a list
 - Most analysts have different ways to accomplish it
 - There is not a "common" process used
 - Especially for projects with "extra requirements"
 - Helps to protect analysts
- In hindsight situations, there is a potential need to recreate process
 - So a list is good to keep -- chance of it happening
- Informal check sheets -- different offices have different systems
- Can keep things in folder together
 - There are some efforts in progress to automate this process
- Difficult to implement -- e.g. query summaries
 - Could get some resistance
 - Resistance to keeping track of things
 - People do not always use note-sheets (maybe 1 in 10)
 - Not a natural habit to keep record
 - Time tracking issues could be useful, but not a high priority initiative
 - Documenting in figuring out where things go

Figure B.20: Study Participant #5 (P5) Notes, Page 2 of 4

- 4) Assessment using Process Documents
 - Opinions did not really change
 - Confirmed suppositions for Process 1
 - Analyst did not consider much
 - E.g. if had to consider hypotheses early
 - Good documentation on Process 2
 - Did not have as many doubts -- had more stylistic questions
 - Liked collaboration reports
 - Do not often see things like this -- people would not take the time
 - Rare to see except in special cases
 - Process reflects on person, so documents are useful
 - Documentation reflected a more rigorous process
 - Not sure rigor was in Process 1
 - Research important and collaboration and documentation
 - Writing style problem versus issue understanding problem
 - Wanted to see more from Process 1
 - Could merge documents and key documents
 - More useful to separate by type of report, rather than by order read
 - Analyst background not as critical in course of things
 - Would come to know experience of analyst
 - Wanted better understanding of overlap of issues
 - E.g. consequences similar despite intentionality
 - Gave confidence that process was used
- 5) Participant Profile
 - Approximately 23 years experience
 - Marginal familiarity with LNG, not focused on energy
 - Education in economics
- 6) General Thoughts
 - NSA is not primarily an "all source" agency
 - Policy makers may not see things in isolation
 - Taken with information from DIA / CIA perspective
 - Problem
 - Things could be taken out of context
 - Not taken in combination with other "Ints"
 - Could be misunderstood or misused by itself
 - Output often not formatted as sole output
 - Could be too technical
 - Often does not bring the breadth
 - Participant's perspective
 - Analyst can only inform, not act -- but can get the blame
 - Analysts like to think the president is reading all their stuff
 - Analysts often involved in briefing process
 - But cannot get into details
 - Building confidence -- briefing on process

Figure B.21: Study Participant #5 (P5) Notes, Page 3 of 4

Does not have to be a rigid process
Oversight matter versus actual concern
Training is not as critical

Figure B.22: Study Participant #5 (P5) Notes, Page 4 of 4

Study Participant #6 Interview Notes

1) Comparison of Reports

- Obvious that both analysts got off point from question
Answering questions they were not asked to answer
- Was not asked for risk mitigation
Too detailed on that portion
Should be follow up questions
- Report 1 did not answer question
Gave irrelevant information
Tried to set the stage, went off topic
- Both ignored a key issue, infrastructure
- Report 2 was a much better report
Much more organized
But, still not ready yet

2) Understanding of Process

- Report 1 has a graphic, which can be good
Would use a more relevant graph
Graph not focused on an obstacle
- Report 2 has a more “organized” process
But got too much into risk mitigation
Quantification of strengths of obstacles
- Question of what exactly what analyst is trying to do -- Documentation
What are their sources? information? research?
- Report 1 was very economic focused
- Report 2 is showing more for process
Does not specify infrastructure issues
Shows evidence of research
- Sources also include collaboration
Might need to actually see original report

3) Improving Analysis Reports

- Offices tend to have a culture of how they do things
Report 1 “rambled on” first
Culture issues in format
- Access to their past work? Consistency -- is it improvement?
Quality control mechanism for junior people
“This is how we do it and this is what we do”
Junior work subject to extra scrutiny
 - Questions “did you think of this?”
 - Feedback with senior analystCould be done in this case
- Reflects an analyst “not there yet”
- Also use feedback from other analysts
Generic feedback on an analyst

Figure B.23: Study Participant #6 (P6) Notes, Page 1 of 2

- Can assign a junior analyst to work with a senior analyst
 - Uses a journeyman model
 - Would work with grammar person, then content person, etc.
 - Learning to turn a question on its head
- 4) Assessment using Process Documents
- Hypothesis and Research
 - Assumes that there are obstacles to LNG
 - Are there obstacles?
 - Is it the right question?
 - Documentation implies that Process 2 is more rigorous
 - Reflected in the report
 - Collaboration
 - Shows a lack of grasp of the problem
 - Rigors depends on starting point -- related to hypotheses
 - Documents show they dropped topics in Process 2
 - Did not show they focused on that
 - Did not show it was looked into
 - What was the bases for dropping hypotheses?
 - Rationale for decisions indicates rigor
 - Dropping indicates they did not do their homework
 - Research notes for Process 2 were valuable
 - Seeing order of queries would be interesting
 - Process 2 is threat of terror focused
 - Do analysts get tied into hypotheses?
 - Assumption: Document order read is reflected by query order
 - But queries and read order did not really jive
 - Research notes and collaboration were very helpful
 - Might have rated collaboration more highly
 - Analyst 1 seems much more junior in approach
 - Process does not jive with "equal" analysts
 - Process 2 refined queries rather than searching around more rigorously
- 5) Participant Profile
- Approximately 19 years experience
 - LNG: remembers stuff from news -- but not much specific
- 6) General Thoughts
- Policy folk are assuming reports are coming from "the" expert
 - Pressure to "please" customer -- give right answer
 - There often is no "right" answer...
 - But making policies requires a right answer
 - If analysis process is influenced too much, you have potential for bad decisions
 - E.g. Policy makers may keep asking until they get the answer they want
 - Really just getting "best guesses"

Figure B.24: Study Participant #6 (P6) Notes, Page 2 of 2

Study Participant #7 Interview Notes

1) Comparison of Reports

- Report 2 is better than Report 1
 - It pointed out areas not addressed in the other report
 - Answered question more thoroughly
- Report 1 is "all over the map"
 - Not as well as written
- Report 1 is not ready to go on
- Report 2 is not perfect, but might be good enough
 - Covers issues more thoroughly
- Report 1 picked out "snippets"
 - Looks like a bunch of sources and cut out points
 - Looks like first pass at research -- trying to get themes
- Report 2 tried to tell a story
 - Reflects more experienced question asking analyst -- reflects experience
- Report 1 summarized sources
 - If done by same person, Report 1 is data gathering
- Answering a question is looking for an answer
 - Do not want to see all the facts
 - Looking for answers, not just facts
- Knowing your audience
 - Question as pretty straightforward
 - Not a collection of facts about LNG

2) Understanding of Process

- Limits of the analysis
- Trying to answer a question
 - No requirement to cite sources
 - Source issues -- Where they get it? How current is it?
- Multitude of sources in analysis business
 - Assumed primary perspective is "own business line"
 - Were sources in own business line?
 - Would not expect sources from other sources (not in their line)
 - Work back to sources
 - We should use those "special" sources
 - Expert organizational perspective
 - Assumed questions are asked to whole community
 - This type of question goes to multiple agencies
 - Perspectives go across community

3) Improving Analysis Reports

- Wants to know what researcher considered most important
 - And where they come from
- What hypotheses did they have going in vs. what they formulated in research
 - Knowledge of guiding impressions would be useful

Figure B.25: Study Participant #7 (P7) Notes, Page 1 of 3

- Alternative competing hypothesis (ACH)
 - Getting into the analyst's mindset as they work
 - Looking for evidence of bias
 - Did not attach much significance to how it was done
 - How you do it is not as critical
- 4) Assessment using Process Documents
- Seeing the documents did help
 - Confirms what was thought about quality of documents
 - Report 1 showed better research on topic
 - Report 2 was not so good at research, good at presentation
 - Report 2 did have a bias -- terrorism as primary hypothesis
 - Document was heavily biased toward terrorist issues
 - Report 2 analyst would be sent back to drawing board also
 - Major issues in reports
 - Report 1 to improve presentation
 - Report 2 to show less biased research
 - Combining the two would give different (better) report
 - Report 1 is more rigorous because it showed a balanced approach
 - But Report 1 did not do as many documents -- did not really collaborate
 - Only talked to one colleague -- a far cry from collaboration
 - Lack of note-sheet lead to a weaker presentation
 - Report looked more like note-sheets
 - In Report 1 it is not clear why stuff is dropped
 - There was not enough about why decisions were made
 - Report needs another cut
 - Liked query summarizes more -- query is useful in giving guidance to improve
- 5) Participant Profile
- Approximately 42 years experience
 - Not much LNG predisposition
- 6) General Thoughts
- Policy-makers are too far disconnected from analysis
 - Removed from people doing actual work
 - If question / clarification necessary, may not filter back to original
 - Person who did work should always be included in work that goes forward
 - Too busy or it is "beneath" them to go to source
 - Intelligence Community Network
 - Things are passed in soft-copy
 - Could contain links that go right to originator
 - E.g. e-mail the author -- links right back
 - Complicated because there is not even a common intelligence network
 - If it is admitted it is a problem, solutions must be easy
 - Seniors cannot even be bothered to make phone call -- helps open dialog

Figure B.26: Study Participant #7 (P7) Notes, Page 2 of 3

- Too often intermediaries try to flavor a report based on desired method
 - Dependent on support by person who produced original document
 - Too often documents are between intermediaries and decision-makers
 - They hear frequently from people they are comfortable with
- Barriers to getting back to the source
 - Linking from question to source could be valuable

Figure B.27: Study Participant #7 (P7) Notes, Page 3 of 3

Study Participant #8 Interview Notes

1) Comparison of Reports

- Report 1 is very scattered
 - Some obstacles are more like risks
- Report 2 is tighter writing
 - Has some statistical information about cost analysis
 - Chart helped express ideas
- Two analysts could have worked together to produce one report
 - One to write it, one to condense ideas
- Was not clear Report 2 answered question
- Neither one is ready to go forward
 - But, Report 2 is closer to being ready

2) Understanding of Process

- Report 2 is more math / economic oriented
 - E.g. Statistics and costs benefit analyses
- Report 1 shows a social orientation
 - E.g. How does it influence people?
 - What about risks?
- Report 1 was more emotional, while Report 2 was more factual

3) Improving Analysis Reports

- Would ask for references
- Knowledge of analyst background
 - Qualifications would be helpful
- In asking about reports would be expecting differences in personality
- Might require more development / discussion
- Not sure exactly what to look for
 - Would pursue communication via e-mail -- asking questions
- If deciding between report, Report 2 would be choice because tighter and chart
 - Form of document better tailored to decision maker

4) Assessment using Process Documents

- Key documents might indicate slant
 - What they read indicates feel
 - Hypotheses also influenced by what they read plus outside influences
- Note-sheets helpful
- Analysts should have worked together
 - Report 1 indicated heavy research
 - In Report 2 the style was good, but research was lacking
- Report 1 has an obstacles focus
 - More rigorous depth of research
 - Presence of notes on many documents

Figure B.28: Study Participant #8 (P8) Notes, Page 1 of 2

- Lack of collaboration is an issue
 - There are benefits of collaboration
 - And it is useful in understanding process
- Neither one is ready to go on
 - Report 1 was organized
 - Report 2 just pulled information
- Proper form is key in policy decision

5) Participant Profile

- Approximately 20 years experience (2 years in making reports)
- LNG not an area

6) General Thoughts

- Biggest problem is getting information to policy maker
 - About obstacles encountered in doing analyses
 - E.g. getting across what was not covered in analysis

Figure B.29: Study Participant #8 (P8) Notes, Page 2 of 2