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Section 1
What Makes Intelligence Analysis Difficult?
A Cognitive Task Analysis of Intelligence Analysts

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ABSTRACT

Intelligence analysts engage in information seeking, evaluation, prediction, and reporting behavior in an extremely information-intensive work environment. A Cognitive Task Analysis (CTA) was conducted on intelligence analysts to capture data that will provide input to support development of a computational model of the analyst's processes and analytic strategies. A hybrid method was used to conduct the CTA, including a modified version of the critical decision method. Participants were asked to describe an example of a critical analysis assignment where they had to collect, analyze, and produce a report on intelligence of a strategic nature. Procedures used to conduct the CTA are described in this chapter along with initial results. Several factors contribute to making the analyst's task challenging: (*i*) time pressure, (*ii*) a high cognitive workload, and (*iii*) difficult human judgments. Human judgments are involved in considering the plausibility of information, deciding what information to trust, and determining how much weight to place on specific pieces of data. Intelligence analysis involves a complex process of assessing the reliability of information from a wide variety of sources and combining seemingly unrelated events. This problem is challenging because it involves aspects of data mining, data correlation and human judgment.

INTRODUCTION

In this chapter we describe research involving a Cognitive Task Analysis (CTA) with intelligence analysts, in line with one of the themes of this book, namely, strategies used by experts who are confronted with tough scenarios and unusual tasks. We present what we have learned regarding how experienced practitioners deal with the extremely challenging task of intelligence analysis by summarizing a set of ten CTA interviews conducted with intelligence analysts to identify leverage points for the development of new technologies.

The challenges facing practitioners in the modern world where expertise gets "stretched" by dynamics and uncertainty, a second them for this book, also characterize the problems experienced by intelligence analysts. Part of the effort reported in this chapter is aimed at building up an empirical psychological science of analyst knowledge, reasoning, performance, and learning. We expect this will provide a scientific basis for design insights for new analyst technologies. In addition, this psychological research should yield task scenarios and benchmark tasks that can be used in controlled experimental studies and evaluation of emerging analyst technologies.

INTELLIGENCE ANALYSIS

An ability to sort through enormous volumes of data and combine seemingly unrelated events to construct an accurate interpretation of a situation and make predictions about complex, dynamic events represents the hallmark of the intelligence analysts (IA's) job. These volumes of data typically represent an extensive and far-ranging collection of sources, and are represented in many different formats (e.g., written and oral reports, photographs, satellite images, maps, tables of numeric data, to name a few). As part of this process, the analyst must make difficult judgments to assess the relevance, reliability, and significance of these disparate pieces of information. Intelligence analysis also involves performing complex reasoning processes such as inferential analysis, to determine "the best explanation for uncertain, contradictory and incomplete data" (Patterson, Roth, & Woods, 2001, p. 225).

The nature of the data, the complex judgments and reasoning required, and a sociotechnical environment that is characterized by high workload, time pressure, and high stakes combine to create an extremely challenging problem for the intelligence analyst. High levels of uncertainty are associated with the data, when "deception is the rule." Since the validity of the data is always subject to question, this impacts the cognitive strategies used by analysts (Johnson, 2004). Moreover, the complex problems to be analyzed entail complex reasoning, including abductive[1], deductive[2] , and inductive[3] reasoning. Finally, high stakes are associated with the pressure not to miss anything and to provide timely, actionable analysis. Potentially high consequences for failure — where analysis products have a significant impact on policy — also contribute to make the task challenging as decisionmakers, senior policy makers, and military leaders use the products of analysis to make high-stakes decisions involving national security.

A number of reports have emerged that provide normative or prescriptive views on intelligence analysis. There have been very few that provide empirical, descriptive

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1 Abductive reasoning is used to determine the best explanation (Josephson & Josephson, 1994) where if the match between data and an explanation is more plausible than any other explanation it is accepted as the likely explanation (Klein, this volume).

2 Deductive reasoning involves deriving a conclusion by logical deduction; inference in which the conclusion follows the premises.

3 Inductive reasoning employs logical induction where the conclusion, though supported by the premises, does not follow from them necessarily.

studies of intelligence analysis. It is likely that there are many CTA studies of intelligence analysis that will never become part of the public literature because of the classified nature of the work involved. Despite the spottiness of available literature, what does exist reveals that intelligence analysis is a widely variegated task domain. This means that it is important to be careful in making generalizations from any circumscribed types of intelligence tasks or types of analysts. It is equally important not to be daunted by the vastness of the domain, and to start the investigative venture somewhere.

Intelligence analysis is commonly described as a highly iterative cycle involving requirements (problem) specification, collection, analysis, production, dissemination, use, and feedback. It is an event-driven, dynamic process that involves viewing the information from different perspectives in order to examine competing hypotheses and develop an understanding of a complex issue. The critical role of the human is to add "value" to original data by integrating disparate information and providing an interpretation (Krizan, 1999). This integration and interpretation entails difficult, complex judgments to make sense of the information obtained. This "dis-aggregation and synthesis of collected and created evidence includes sorting out the significant from the insignificant, assessing them severally and jointly, and arriving at a conclusion by the exercise of judgment: part induction, part deduction, and part abduction." (Millward, 1993, in Moore, 2003).

Warning-oriented intelligence includes supporting the need for senior policymakers to not be surprised (Bodnar, 2003). Analysts need to "provide detailed enough judgments — with supporting reporting — so that both the warfighter and the policymaker can anticipate the actions of potential adversaries and take timely action to support US interests" (*ibid.*, p. 6). For example, the analyst needs to make predictions regarding what the adversary has the capability to do and how likely it is that he will act. These predictions need to include what actions can be taken to change, or respond to these actions, and the probable consequences of those actions (*ibid.*).

Table 1 presents an analysis of problem types that Krizan derives from Jones (1995) and course work at the Joint Military Intelligence College. A range of problem types, from simplistic to indeterminate, are explicated by characterizing each level of the problem along several dimensions, such as type of analytic task, analytic method, output, and probability of error.

Table 1. Intelligence Analysis Problem Types (Krizan, 1999).

Taxonomy of Problem Types **Source: Analysis course material, Joint Military Intelligence College, 1991**					
Characteristics	**Problem Types**				
	Simplistic	**Deterministic**	**Moderately Random**	**Severely Random**	**Indeterminate**
What is the question?	Obtain information	How much? How many?	Identify and rank all outcomes	Identify outcomes in unbounded situation	Predict future events/situations
Role of facts	Highest	High	Moderate	Low	Lowest
Role of judgment	Lowest	Low	Moderate	High	Highest
Analytical task	Find information	Find/create formula	Generate all outcomes	Define potential outcomes	Define futures factors
Analytical method	Search sources	Match data to formula	Decision theory; utility analysis	Role playing and gaming	Analyze models and scenarios
Analytical instrument	Matching	Mathematical formula	Influence diagram, utility, probability	Subjective evaluation of outcomes	Use of experts
Analytic output	Fact	Specific value or number	Weighted alternative outcomes	Plausible outcomes	Elaboration on expected future
Probability of error	Lowest	Very low	Dependent on data quality	High to very high	Highest
Follow-up task	None	None	Monitor for change	Repeated testing to determine true state	Exhaustive learning

Figure 1 presents another way of characterizing the domain of intelligence analysis developed by Cooper. Along one axis there are various types of *intelligence*, along a second are different *accounts* (topics), and along a third axis are different types of *products*. The different types of intelligence (or "sources") are functionally organized into:

- *human source intelligence* (HUMINT), which includes field agents, informants, and observers (attaches),
- *imagery intelligence* (IMINT), which includes photo, electro-optical, infrared, radar, and multispectral imagery from sources such as satellites,
- *signals intelligence* (SIGINT), which includes communications, electronic, and telemetry,
- *measurement and signatures intelligence* (MASINT), which includes acoustic and radiation signals,
- *open source intelligence* (OSINT), which includes public documents, newspapers, journals, books, television, radio, and the World Wide Web, and
- all-source intelligence, which involves all of the above.

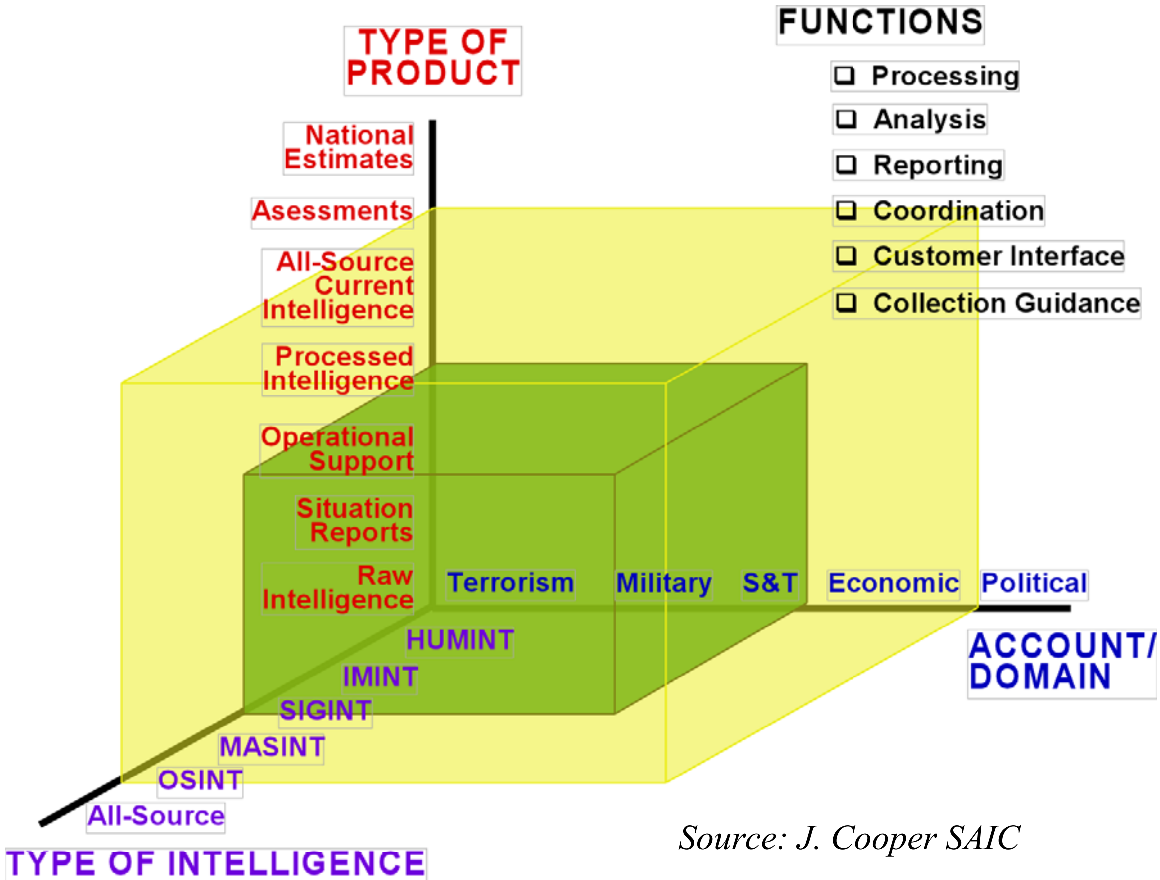

Figure 1. Types of Intelligence, Domains, Functions, and Products.

Domains (or topics) may address terrorism, military, politics, science and technology (S&T), or economics. Product types range from those that are close to the raw data, through those that involve increasing amounts of analysis that may eventually lead to national-level estimates and assessments. As in any hierarchically organized information system, this means that information is filtered and recoded as the analysis process progresses from lower to higher levels.

Techniques to Enhance Processing of Intelligence Data

Recent world events have focused attention on some of the inherent challenges involved in performing intelligence analysis (*viz.,* The 9/11 Commission Report). As a result, increased research is being conducted to develop new training, tools, and techniques that will enhance the processing of intelligence data. As one example, support and training in the organizing and piecing together aspects of intelligence analysis and decision making has been identified by the Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD/NII) Research Program as an area that is greatly in need of more basic and applied research. One current research thread that seeks to address this need is the Novel Information from Massive Data (NIMD) program where the goal is to develop an “information manager” to assist analysts in dealing with the high volumes and disparate types of data that inundate intelligence analysts. The NIMD research program seeks to develop techniques that “structure data repositories to aid in revealing and interpreting novel contents" and techniques that can accurately model and draw inferences about (1) rare events and (2) sequences of events (widely and sparsely distributed over time).

Connable (2001) asserts that the intelligence process would be well served by enhancing the ability to leverage open sources, particularly since open sources provide the Intelligence Community with between 40-80% of its usable data (Joint Military Intelligence Training Center, 1996). As an example, one of our study participants, who worked on a strategic analysis assignment regarding the question of whether President Estrada, of the Philippines, was going to remain in power or be removed from office, indicated that 80% of the information he needed was found in open-source material. Information foraging theory (Pirolli & Card, 1998; Pirolli & Card, 1999) is being applied in this research on tasks that involve information-intensive work where the approach is to analyze the tasks as an attempt by the user to maximize information gained per unit time. A computational model of the intelligence analysis process will be developed as a result of this CTA research and used to support tool prototyping and testing.

The goals for the research described in this chapter are threefold. One purpose of this first CTA phase is to yield "broad brushstroke" models of analyst knowledge and reasoning at a large grain size of behavioral analysis. A second purpose of this research is to identify leverage points where technical innovations may have the chance to yield dramatic improvements in intelligence analysis. A third purpose of the CTA phase is to guide the development of benchmark tasks, scenarios, resources, corpora, evaluation methods and criteria to shape the iterative design of new analyst technologies. A CTA is typically used to identify the decision requirements, and the knowledge and processing strategies used for proficient task performance. The following section presents a brief description of CTA and describes specific techniques that are representative of CTA methods.

COGNITIVE TASK ANALYSIS

CTA refers to a group of methods that are extensively used in naturalistic decision-making applications. Klein's (2001, p. 173) definition of a CTA is "a method for capturing expertise and making it accessible for training and system design." Klein delineates the following five steps: (1) identifying sources of expertise; (2) assaying the knowledge; (3) extracting the knowledge; (4) codifying the knowledge; and (5) applying the knowledge. System design goals supported by CTA include human-computer interaction design, developing training, tests, models to serve as a foundation for developing an expert system, and analysis of a team's activities to support allocation of responsibilities to individual humans and cooperating computer systems.

Different CTA methods are used for different goals. Our goals for conducting a CTA are twofold. Our first goal is to capture data that will provide input to support development of a computational model of the intelligence analyst's processes and analytic strategies. Our second goal is to identify leverage points to inform the development of tools to assist analysts in performing the most demanding aspects of their tasks. CTA extends traditional task analysis techniques to produce information regarding the knowledge, cognitive strategies, and goal structures that provide the foundation for task performance (Chipman, Schraagen, & Shalin, 2000). The goal of CTA is to discover the cognitive activities that are required for performing a task in a particular domain to identify opportunities to improve performance by providing improved support of these activities (Potter, Roth, Woods, & Elm, 2000).

Our overall approach for the first phase of this research involves the following steps: review of the intelligence literature, use of semi-structured interviews, followed by the use of structured interviews and review of the results by subject matter experts (SMEs). The second phase for this research, conducted in the summer of 2004, involved developing and comparing several alternative hypotheses based on material presented in a case study. A prototype tool developed to assist the intelligence analyst in comparing alternate hypotheses was introduced and simulated tasks were performed to empirically evaluate the tool's effectiveness. A follow-on study will involve the use of think-aloud protocol analysis while using a more advanced version of this tool. This multiple-phase plan is in line with the approach employed by several successful CTA efforts (Hoffman, et al., 1995; Patterson, Roth, & Woods, 2002). We are using a "balanced suite of methods that allow both the demands of the domain and the knowledge and strategies of domain experts to be captured in a way that enables clear identification of opportunities for improved support." (Potter, et al., 2000, p. 321).

Types of activities that typically require the resource intensive analysis frequently required when conducting a CTA are those domains that are characterized as (*i*) complex, ill-structured tasks that are difficult to learn, (*ii*) involving complex, dynamic, uncertain, and real-time environments, and (iii) sometimes include multitasking. A CTA is most appropriate when the task requires the use of a large and complex conceptual knowledge base; the use of complex goal/action structures dependent on a variety of triggering conditions, or complex perceptual learning or pattern recognition. Intelligence analysis involves all of these characteristics.

When considering which knowledge elicitation technique is most appropriate, the differential access hypothesis proposes that different methods elicit different types of knowledge (Hoffman, Shadbolt, Burton, & Klein, 1995). Certain techniques are appropriate to "bootstrap" the researcher and generate an initial knowledge base and more structured techniques are more appropriate to validate, refine and extend the knowledge base (*ibid*). A direct mapping should exist between characteristics of the targeted knowledge and the technique/s selected (Cooke, Salas, Cannon-Bowers, & Stout, 2002).

A detailed, accurate cognitive model that delineates the essential procedural and declarative knowledge is necessary to develop effective training procedures and systems (Annett, 2000). This entails building a model that captures the analysts' understanding of the demands of the domain, the knowledge and strategies of domain practitioners, and how existing artifacts influence performance. CTA can be viewed as a problem-solving process where the questions posed to the subject-matter experts, and the data collected, are tailored to produce answers to the research questions, such as training needs and how these training problems might be solved (DuBois & Shalin, 2000). A partial listing of the types of information to be obtained by conducting a CTA includes factors that contribute to making task performance challenging, what strategies are used and why, what complexities in the domain practitioners respond to, what aspects of performance could use support, concepts for aiding performance, and what technologies can be brought to bear to deal with inherent complexities.

Use of Multiple Techniques

Analysis of a complex cognitive task, such the intelligence analyst's job, often requires the use of multiple techniques. When results from several techniques converge confidence is increased regarding the accuracy of the CTA model (Cooke, 1994; Flach, 2000; Hoffman, et al., 1995; Potter, et al., 2000). Flach (2000) recommends sampling a number of experts and using a variety of interviewing tools to increase the representativeness of the analysis. During the initial bootstrapping phase of this research, several CTA approaches were examined with an eye toward determining which approach would be most productive for our domain of interest. The remainder of this section describes two CTA techniques that were used for the initial phase of this research.

Applied Cognitive Task Analysis Method. Our initial set of interviews drew upon the Applied Cognitive Task Analysis (ACTA) Method (Militello & Hutton, 1998; Militello *et al.*, 1997) and the Critical Decision Method (Hoffman, Coffey, & Ford, in press; Hoffman, Crandall, & Shadbolt, 1998; Klein, Calderwood, & MacGregor, 1989). The ACTA collection of methods was developed explicitly as a streamlined procedure for instructional design and development (Militello et al., 1997) that required minimal training for task analysts. ACTA is a collection of semi-structured interview techniques that yields a general overview of the SMEs' conception of the critical cognitive processes involved in their work, a description of the expertise needed to perform complex tasks, and SME identification of aspects of these cognitive components that are crucial to expert performance.

The standard ACTA methodology[4] includes the use of three interview protocols and associated tools: (a) the Task Diagram, (b) the Knowledge Audit and (c) the Simulation Overview. The ACTA Method uses interview techniques to elicit information about the tasks performed and provides tools for representing the knowledge produced (Militello & Hutton, 1998). Discovery of the difficult job elements, understanding expert strategies for effective performance, and identification of errors that a novice might make are objectives for using the ACTA method. The focus for researchers using the ACTA method is on interviews where domain practitioners describe critical incidents they have experienced while engaged in their tasks and aspects of the task that made the task difficult.

Our use of the ACTA method produced valuable data for the initial bootstrapping phase of this research where the goal was to learn about the task, the cognitive challenges associated with task performance, and to determine what tasks to focus on during ensuing phases of the CTA research. Products typically produced when using the ACTA method include a Knowledge Audit and a Cognitive Demands Table. After conducting this first group of CTA interviews we opted to use a different method to capture the essence of the IA's job. The IA's task places greater emphasis on deductive and inductive reasoning, looking for patterns of activity, and comparing hypotheses to make judgments about the level of risk present in a particular situation. We felt it was necessary to broaden the scope of the interview probes used with intelligence analysts.

[4] Software available from Klein Associates provides rapid training plus interview materials for ACTA.

Critical Decision Method. The Critical Decision Method (CDM) is a semi-structured interview technique developed to obtain information about decisions made by practitioners when performing their tasks. Specific probe questions help experts describe what their task entails. CDM's emphasis on non-routine or difficult incidents produces a rich source of data about the performance of highly skilled personnel (Hoffman, Crandall, & Shadbolt, 1998; Hoffman, Coffey, & Ford, in press; Klein, Calderwood, & MacGregor, 1989). By focusing on critical incidents, the CDM is efficient in uncovering elements of expertise that might not be found in routine incidents and helps to ensure a comprehensive coverage of the subject matter.

Our use of the CDM was tailored to develop domain-specific cognitive probes that elicit information on how analysts obtain and use information, schemas employed to conceptualize the information, how hypotheses are developed to analyze this information, and the types of products that are developed as a result of their analysis. A strength of the CDM is the generation of rich case studies, including information about cues, hypothetical reasoning, strategies, and decision requirements (Klein, et al., Hoffman, Coffey, Carnot, & Novak, 2002). This information can then be used in modeling the reasoning procedures for a specific domain.

In the remainder of this chapter we describe the development and use of an adapted version of the CDM and results derived from use of two CTA methods, ACTA and CDM.

METHOD

Procedures used to conduct the CTA, using ACTA and the CDM, are described in this section as study 1 and study 2, respectively. In the first study we learned about the task, the cognitive challenges associated with task performance, and determined what tasks to focus on during ensuing phases of the CTA research. In the second study we revised the methodology and used a different group of IAs. Interview probes were developed and used to conduct an adapted version of the CDM where participants were asked to describe a strategic *analysis* problem in lieu of a critical decision problem.

STUDY 1

Participants

Six military intelligence analysts, currently enrolled in a graduate school program at the Naval Postgraduate School (NPS), Monterey, CA, were interviewed for the first study. Participants were contacted via e-mail with the endorsement of their curriculum chair and were asked to volunteer for this study. (No rewards were given for participation.) These U.S. Naval officers (Lieutenant through Lieutenant Commander) were students in the Intelligence Information Management curricula at NPS.

Participants in both studies had an average of ten years experience working as intelligence analysts. Thus, they were considered experts as the literature generally defines an "expert" as an individual who has over ten years experience and "would be recognized as having achieved proficiency in their domain" (Klein, et al., 1989, p. 462).

Materials

Study participants (study 1 and 2) had pen and paper, and a flip chart or white board. After a brief introduction to the study participants were asked to complete a demographic survey.

Procedure

The CTA process for all study participants took place in a small conference room at NPS. Semi-structured interviews were conducted with the first group of interviewees where intelligence analysts were asked to recall and describe an incident from past job experience.

ACTA. Domain experts were asked to draw a task diagram, to describe critical incidents they had experienced on their job, and identify examples of the challenging aspects of their tasks. They were asked to elucidate why these tasks are challenging, and to describe the cues and strategies that are used by practitioners, and the context of the work. Interviews were scheduled for one and one-half hours at a time that was convenient for each participant. Three interviewers were present for each of the first six interviews. The interviews were tape-recorded and transcribed and the analysis was performed using the transcription and any other materials produced during the interview, e.g., task diagrams.

This first group of intelligence analysts had a variety of assignments in their careers, however the majority of their experience was predominantly focused on performing analysis at the tactical level. (Tactical level analysis refers to analysis of information that will impact mission performance within the local operating area, e.g., of the battle group, and generally within the next 24 hours.) During this bootstrapping phase of our CTA effort, we learned that there are several career paths for intelligence analysts. These career paths can be categorized as either having more of a technology emphasis where the focus is on systems, equipment, and managing the personnel who operate and maintain this equipment or an analytical emphasis where the focus and experience is on performing long-range, or strategic, analysis.

Information gathered during the initial phase served as an advance organizer by providing an overview of the task and helped to identify the cognitively complex elements of the task. The ACTA method produced valuable data for the initial phase of this research. After analyzing the data from the initial set of interviews, we determined that we needed to broaden the set of interview probes and tailor them for the specific domain of intelligence analysis to uncover the bigger picture of how intelligence analysts approach performing their job. Thus, tailored probes were developed specifically for the domain of intelligence analysis.

Concurrent with the decision to use an adapted version of the CDM was the decision to switch to a different group within the intelligence community, specifically analysts who had experience at the strategic, or national, level.[5] National level intelligence is more concerned with issues such as people in positions of political leadership, and the capabilities of another country. In contrast, at the tactical level, the user of intelligence information may only be concerned about a specific ship that is in a particular area, at a certain time; that is, the information will only be valid for a limited time. Descriptions of experiences at the tactical level did not provide examples of the types of problems or cases that could benefit from the technology envisioned as the ultimate goal for this research.

STUDY 2

Participants

Four military intelligence analysts from the National Security Affairs (NSA) Department were interviewed for the second study. In the NSA curriculum there is a stronger analytical emphasis and the analysts have had experience with analysis assignments at the strategic level. We were fortunate in that this second group of participants was very articulate in describing assignments where they had performed

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[5] The term 'strategic analysis' can have several definitions. We are referring to intelligence problems that have implications of strategic importance and those that require more time than is devoted to tactical questions, i.e., analysis tasks that require anywhere from several weeks to many months (or even years) to complete.

analysis of critical topics at the strategic level. Several researchers have noted the issue of encountering problems with inaccessible expert knowledge (Cooke, 1994; Hoffman, Shadbolt, Burton, & Klein, 1995).

Procedure

Structured interviews were conducted with the second group of interviewees where intelligence analysts were asked to recall a strategic analysis problem they had worked on. Participants were asked to describe what they did step-by-step to gather the information and analyze it, and to construct a timeline to illustrate the entire analysis process.

Modified Critical Decision Method

Many CTA techniques have been developed and used for tasks that involve the practitioner making decisions and taking a course of action based on these decisions, e.g., firefighters, tank platoon leaders, structural engineers, paramedics, and design engineers. A goal

for many CTA techniques is to elicit information on actions taken and the decisions leading up to those actions. However, the IA's job does not fit this pattern of making decisions and taking action/s based on these decisions. One finding that emerged during the initial phase of this research was that making decisions is not a typical part of the IA’s task. The major tasks consist of sifting through vast amounts of data to filter, synthesize, and correlate the information to produce a report summarizing what is known about a particular situation or state of affairs. Then, the person for whom the report is produced makes decisions and takes actions based upon the information contained in the report.

A modified version of the critical decision method (CDM) was developed and used for this task domain where the emphasis is on performing analysis (e.g., comparing alternative hypotheses) versus making decisions and taking a course of action. Thus, interview probe questions provided in the literature (Hoffman, et al., in press) were tailored to capture information on IA's approach to gathering and analyzing information. Domain-specific probes were developed to focus the discussion on a *critical analysis assignment* where the analyst had to produce a report on intelligence of a strategic nature. Examples of such strategic analysis problems might include assessments of the capabilities of nations or terrorist groups to obtain or produce weapons of mass destruction, terrorism, strategic surprise, political policy, or military policy. Interview probes were developed to capture information on the types of information used, how this information was obtained, and the strategies used to analyze this information.

CDM. A structured set of domain-specific interview probes was developed specifically for use with the second group of participants. One interviewer conducted the initial interviews; each interview lasted approximately one and one-half hours. Once the initial interview was transcribed and analyzed, the participant was asked to return for a follow-up interview. All three interviewers were present for the follow-up interviews with this second group of intelligence analysts. This approach, requiring two separate interviews, was necessitated by the domain complexity and the desire to become grounded in the case before proceeding with the second interview where our understanding was elucidated and refined.

Deepening Probes. Domain-specific cognitive probes were developed to capture information on the types of information the IA was seeking, the types of questions the analyst was asking, and how this information was obtained. Additional information was collected on mental models used by analysts, hypotheses formulated and the types of products that are produced. Table 1 lists the questions posed to the participants during the initial interview. Topics for which participants conducted their analyses included modernization of a particular country's military, whether there would be a coup in the Philippines and the potential impact on the Philippines if there was a coup, and the role for the newly created Department of Homeland Security.

Table 2. Modified Critical Decision Method: Deepening Probes

Probe Topic	Probe
Information	What information were you seeking, or what questions were you asking? Why did you need this information? How did you get that information? Were there any difficulties in getting the information you needed from that source? What was the volume of information that you had to deal with? What did you do with this information? Would some other information been helpful?
Mental Models/ Schemas	As you went through the process of analysis and understanding did you build a conceptual model? Did you try to imagine important events over time? Did you try to understand important actors and their relationships? Did you make a spatial picture in your head? Can you draw me an example of what it looks like?
Hypotheses	Did you formulate any hypotheses? Did you consider alternatives to those hypotheses? Did the hypotheses revise your plans for collecting and marshalling more information? If so, how?
Intermediate Products	Did you write any intermediate notes or sketches?

Follow-up Probes. Once the data from the initial interviews was transcribed and analyzed, participants were asked to return for a follow-up interview. The goal during this session was to elaborate our understanding of the IA's task. The analyst was asked to review the timeline produced during the first interview session and to elaborate on the procedures and cognitive strategies employed. Probes used during the follow-up interview are listed in Table 3.

Table 3. Follow-up Probes Used for Modified Critical Decision Method

Probe Topic	Probes
Goals	What were your specific goals at the time?
Standard Scenarios	Does this case fit a standard or typical scenario? Does it fit a scenario you were trained to deal with?
Analogues	Did this case remind you of any previous case or experience?
Hypotheses and Questions	What hypotheses did you have? What questions were raised by that hypothesis? What alternative hypotheses did you consider? What questions were raised by that alternative hypothesis?
Information Cues for Hypotheses and Questions	As you collected and read information, what things triggered questions or hypotheses that you later followed up?
Information Tools	What sort of tools, such as computer applications, did you use? What information source did you use? What difficulties did you have?

Probes included questions about the participants' goals, whether this analysis was similar to other analysis assignments, use of analogues, and how hypotheses were formed and analyzed. Other probes asked about the types of questions raised during their analysis, methods used, information cues they used to seek and collate information, and the types of tools, e.g., computer software, they used to perform their analysis. During this second interview we went through the same intelligence analysis problem with the goal of obtaining additional details to refine our understanding of the entire analysis process. This included the types of information they used, and how they structured their analysis to answer the strategic question they had been assigned.

Table 4. Cognitive Demands Table: NPS#2

Cognitive Demand	Why Difficult	Cues	Strategies	Potential Errors
Synthe-sizing data	• Lack of technical familiarity with different types of data • Domain expertise is needed to analyze each class of data (HUMINT, SIGINT, ELINT, IMAGERY, etc.)	Difficult to know how to weight different kinds of data	Emphasize type of data analyst has experience with, and disregard other data	• Potential for errors • Tendency to focus on type of data analyst has experience with and to ignore data you do not understand
Synthe-sizing data	• No one database exists that can correlate across systems • No one database can correlate all inputs from many different analysts to form one coherent picture	Systems produce different "results," e.g., mensuration process produces different latitude/ longitude coordi-nates from other systems	Different commands rely on different databases in which they have developed trust	• Users develop comfort level with their system and its associated database; this can lead to wrong conclusion
Synthe-sizing data	• Databases are cumber-some to use: Poor correlation algorithms • System presents results that users do not trust, tracks are "out of whack."	Users don't always understand infor-mation system presents. Too many levels in system are not transparent	Use own experience	• Rely on trend information
Noticing data	• Time critical information is difficult to obtain • Need to assimilate, verify and disseminate in a short time window	Need to decide whether imagery is current enough to proceed with strike How long has it been there?	Need to rely on other sources to verify current	• Refer to other sources to verify

RESULTS

A description of what has been learned during the first phase of this CTA research with intelligence analysts is presented in this section.

<u>STUDY 1</u>

The ACTA method was used with a group that primarily had experience at the tactical level of analysis, thus the discussion was focused on developing a product to support operations at the tactical level. Using the ACTA method, participants focused on providing descriptions of the cognitively challenging aspects of the task.

Applied Cognitive Task Analysis

The initial set of knowledge representations for the IA's job (produced using the ACTA method) provided the basis for the more detailed CTA. Table 4 presents an example of one of the formats used to codify the knowledge extracted during the CTA using the ACTA method. This Cognitive Demands Table was produced based on analysis of data captured during an interview with one participant. A Cognitive Demands Table provides concrete examples of why the task is difficult, cues and strategies used by practitioners to cope with these demands and potential errors that may result in response to the challenges inherent in the task.

Table 5 presents an example of a Knowledge Audit, which includes examples of the challenging aspects of the task and the strategies employed by experienced analysts to deal with these challenges. A challenging aspect described by several IAs includes the need for the analyst to understand the capabilities and limitations of the systems employed for collection. Understanding the systems' capabilities is important because the systems used to collect data and the tools used to process data can make mistakes due to conflicting databases, complexities of the system that are not transparent to the user and other human-system interaction issues.

Table 5. Knowledge Audit for Intelligence Analyst: NPS#4

EXAMPLE	CUES & STRATEGIES	WHY DIFFICULT?
<u>Collection</u> **Ex: Task involves much technical knowledge coupled with experience.**		
Start formulating a picture right away	Know what system can do/ limitations Constantly think about nature of the collection system Ask: What do I expect to see here? Constantly checking all data coming in	• Need to understand systems to assess validity of information • All data is not 100% accurate • Collection systems and processors make mistakes: e.g., radar signatures can be similar
<u>Collection</u> **Ex: Need to question all data for validity**		
Assess validity of information	Correlate signals with what is already Known. Look for incongruent pieces of information.	• Deluged with signals in dense signal environment
<u>Collection</u> **Ex: Constant pressure not to miss any little bit**		
Huge amount of raw data	Try to extend the area that is monitored to maintain wide area situation awareness	• Analyst has to find the "little jewels" in huge data stream
<u>Collection</u> **Ex: Can't miss the radar contact which is the enemy coming out to conduct reconnaissance, or attack the battle group. Want to know 10-12 hours ahead of time when the enemy aircraft was coming.**		
Under pressure not to miss anything	Look at *everything* recognizing that probably 90% is going to be of no use.	• Can't afford to let anything slip by without looking at it
<u>Analysis</u>**: Focus on what additional information is needed**		
Multiple ways to obtain certain kinds of information	Think about what still need to know	• Need some familiarity with different types of sources • Requesting assets to get information may be expensive and conflict with other ongoing things • Potential political ramifications to requesting asset to get something
<u>Analysis</u>**: How to present information to customer**		
Interpretation can be challenging	Good analyst drives operations Do not just pass all the information without some level of interpretation included.	• Need to ensure customer will take appropriate action as a result of report • Are almost dictating what customer is going to do
<u>Analysis</u>**: Pressure to reduce the time to respond**		
Analyst brings a lot of knowledge to situation that goes beyond sensor-to-shooter approach	What is the priority of this target vs. others that are out there? Is it the most important thing to do right now? What has occurred in the past week? 2 months? 2 years?	• Things need to be interpreted in *context*

EXAMPLE	CUES &STRATEGIES	WHY DIFFICULT?
<u>Disseminate/ Provide Reports</u> Ex: Time-critical spot reports need to go out to people who need it right away **Pick out event-by-event pieces**	What does customer need to know	• Need to pass time-critical information right away
<u>Disseminate/ Provide Reports</u> Ex: See something they don't expect, doesn't fit an established picture **Times when event does not fit in with what analyst has been observing recently**	Try to develop coherent picture based on other things that have been occurring in past 1-2 hours. What do I think will happen in the next hour? How does the last one event fit in with all the other recent pieces?	• Need to assess how this fits into slightly bigger picture • More likely to discount information if see something you don't expect
<u>Disseminate/ Provide Reports</u> Ex: See something outside a pattern of what expected	Always call operator : "We saw X but here is why we don't think it is necessarily the truth." Look for reasons why it might not be correct	• Need to watch your back (not look bad)
<u>Dissemination</u>: Push vs. Pull Technology	Simply pushing reports out to people does not always work Pressure on analyst to ensure all high-level decisionmakers have same picture/ information	• High-level decisionmakers want individual, tailored brief: generates differential exchange of information

Another theme that was addressed by many study participants was the constant pressure not to let anything slip by without looking at it. They described this aspect of their task as trying to find the "little jewels in the huge data stream," while knowing that 90% of the stream will not be relevant. An issue germane to analysis, also reported by several analysts, was the tendency to discount information when they see something they don't expect to see, i.e., to look for confirming evidence and to discount disconfirming evidence. An additional pressure experienced by IAs is the need to ensure the customer will take appropriate action as a result of the report (i.e., you are "almost dictating what the customer is going to do.")

Cognitive Challenges

The remainder of this section summarizes what was learned from the ACTA interviews. The IA task is difficult due to the confluence of several factors, including characteristics of the domain and the cognitive demands levied on analysts. The following paragraphs describe the cognitive challenges involved in performing intelligence analysis.

Time Pressure. Decreasing timelines to produce reports for decision-makers is becoming an increasingly stressful requirement for analysts working at all levels, from tactical through strategic levels. An example at the tactical level is provided by a participant who described how the effect of timeline compression coupled with organizational constraints[6] can sometimes "channel thinking" down a specific path.

An example of time pressure at the strategic level is provided by one participant (from study 2) who had six weeks to prepare a report on a matter of strategic importance when he had no prior knowledge of this area and he did not have a degree in political science. The assignment involved the question of whether President Estrada, of the Philippines, would be deposed as President, and if so, would there be a coup? This assignment was to include an analysis of what the impact would be on the Philippines. Six weeks was the total time he had to gather all the necessary information, including the time needed to develop background knowledge of this area. He began by reading travel books and other ethnographic information. This finding is in accord with those of Patterson, Roth, & Woods (2001), i.e., that analysts are increasingly required to perform analysis tasks outside their areas of expertise and to respond under time pressure to critical analysis questions.

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[6] This form of organizational constraint, that channels thinking, has been referred to as the "intelligence-to-please" syndrome, a tendency to produce intelligence estimates that support current policy even though information indicates that policy is failing." (Wirtz, 1991, p.8)

Synthesizing Multiple Sources of Information. One aspect of the IA's task that is particularly challenging involves merging different types of information — particularly when the analyst does not have technical familiarity with all these types of information. As an example, two analysts looking at the same image may see different things. Seeing different things in the data can occur because many factors need to be considered when interpreting intelligence data. Each type of data has its own set of associated factors that can impact interpretation. In the case of imagery data, these factors would include the time of day the image was taken, how probable it is to observe a certain thing, and trends within the particular country.

Multiple sources of disparate types of data (e.g., open source, classified, general reference materials, embassy cables, interviews with experts, military records, to name a few) must be combined to make predictions about complex, dynamic events — often in a very short time window. To accomplish the data correlation process, analysts need to be able to combine seemingly unrelated events and see the relevance. The cognitive challenges involved in synthesizing information from these different sources and distilling the relevance can be especially difficult, particularly when different pieces of data have varying degrees of validity and reliability that must be considered. Furthermore, domain expertise is often needed to analyze each type of data.

Human intelligence, electronic intelligence, imagery, open source intelligence, measures and signals intelligence can all include spurious signals or inaccurate information due to the system used or to various factors associated with the different types of data. Analysts described situations where they gave greater weight to the types of information they understood and less weight to less understood types of information. They acknowledged this strategy could lead to incorrect conclusions.

Coping with Uncertainty. Regarding data interpretation, a strong relationship typically exists between the context in which data occurs and the perspective of the observers. This critical relationship between the observer and the data is referred to as context sensitivity (Woods, Patterson, & Roth, 2002). The relationship between context and the perspective of the observer is an essential aspect of the data interpretation process. People typically use context to help them determine what is interesting and informative, and this, in turn, influences how the data are interpreted. Context sensitivity is the framework a person uses to determine which data to attend to and this, in turn, will determine how the data are interpreted. This relationship between context and data interpretation is the crux of the problem for intelligence analysts: When high levels of uncertainty are present regarding the situation, the ability to interpret the data based on context sensitivity is likely to be diminished.

High levels of ambiguity associated with the data to be analyzed produce an uncertain context in which the analyst must interpret and try to make sense of the huge data stream. For instance, data that appear as not important might be extremely important in another situation, e.g., when viewed from a different perspective to consider a competing hypothesis. In general, people are good at being able to focus in on the highly relevant pieces of data based on two factors: properties of the data and the *expectations* (italics added) of the observer. (Woods, et al). However, this critical cognitive ability may be significantly attenuated for professionals in the intelligence community, as they may not always have the correct "expectations" while conducting their search through the data due to the inherent uncertainty associated with the data.

High Cognitive Workload. One of the most daunting aspects of the IA's job is dealing with the high cognitive workload that is produced when a constant stream of information must be continuously evaluated, particularly when the information often pertains to several different situations. Relevant items must be culled from the continual onslaught of information, then analyzed, synthesized and aggregated. An additional contributor to the high workload is the labor-intensive process employed when an analyst processes data manually — as is often the case — because many tools currently available do not provide the type of support required by analysts. For example, no one single database exists that can correlate across the various types of data that must be assimilated.

IAs often wind up synthesizing all the information in their head, a time-consuming process that requires expertise to perform this accurately, and something that is very difficult for a junior officer to do. Moreover, it is stressful to perform the analysis this way because they worry about missing a critical piece of data and doing it correctly: "Am I missing something?" and "Am I getting the right information out?"

IAs must assess, compare, and resolve conflicting information, while making difficult judgments and remembering the status of several evolving situations. These cognitive tasks are interleaved with other requisite tasks, such as producing various reports or requesting the re-tasking of a collection asset. A request to gather additional information will often involve use of an asset that is in high demand. Re-tasking an asset can be costly and may conflict with other demands for that asset, thus, tradeoffs must be made regarding the potential gain in information when re-tasking the asset to satisfy a new objective. Potential political ramifications of requesting an asset to obtain data to satisfy an objective must also be considered.

Potential for Error. The high cognitive workload imposed on IAs introduces a potential for errors to influence interpretation. For instance, the potential for “cognitive tunnel vision" to affect the analysis process is introduced by the high cognitive load that analysts often experience. As an example, they may miss a key piece of information when they become overly focused on one particularly challenging aspect of the analysis. Similarly, the analysis process may be skewed when analysts attempt to reduce their cognitive load by focusing on analyzing data they understand and discounting data with which they have less experience. Additionally, discrepancies regarding interpretation may result when decision-makers at different locations (e.g., on different platforms, different services) rely on systems that produce different results. Moreover, the sheer volume of information makes it hard to process all the data, yet no technology is available that is effective in helping the analyst synthesize all the different types of information.

Data Overload. While data overload is a relatively new problem for the intelligence community, it is a major contributor to making the task difficult. It was once the case that intelligence reporting was very scarce, yet with technology advances and electronic connectivity it has become a critical issue today. A former Marine Lieutenant General, describing the situation in the 1991 Persian Gulf conflict commented on the flow of intelligence: "It was like a fire hose coming out, and people were getting information of no interest or value to them, and information that was (of value) didn't get to them." (Trainor, in Bodnar, 2003, p. 55). Data overload in this domain is attributed to two factors. The explosion of accessible electronic data coupled with a Department of Defense emphasis on tracking large numbers of 'hot spots' that place analysts in a position where they are "required to step outside their areas of expertise to respond quickly to targeted questions," (Patterson, et al., 2001, p. 224).

Complex Human Judgments. Difficult human judgments are entailed when (*i*) considering the plausibility of information, (*ii*) deciding what information to trust, and (*iii*) determining how much weight to give to specific pieces of data. Each type of data has to be assessed to determine its validity, reliability, and relevance to the particular event undergoing analysis. Analysts must also resolve discrepancies across systems, databases, and services when correlation algorithms produce conflicting results or results that users do not trust. Evidence must be marshaled to build their case or to build the case for several competing hypotheses and then to select the hypothesis the analyst believes is most likely. Assessing competing hypotheses involves highly complex processes.

Insufficient Tools. The sheer volume of information makes it hard to process all the data, yet the tools currently available are not always effective in helping the analyst assimilate the huge amount of information that needs to be analyzed and synthesized. Many of the systems and databases available to analysts are cumbersome to use due to system design issues. For example, users don't always understand information presented by the system, i.e., when there are discrepancies across system databases (within the ship, within the service, or across services) or the system presents results that users do not trust, e.g., tracks that don't make sense. Tools currently available for use by analysts include poor correlation algorithms and have too many levels within the system that are not transparent to the user.

Organizational Context. Several themes related to organizational context emerged from the interviews. The first involves communication between the analyst and their "customers" (a term used to refer to the person for whom the report or product is produced). When the customer does not clearly articulate his or her need — and provide the reasons they need a specific item — the analyst has an ill-defined problem. When the analyst does not have an understanding of the situation that merits the intelligence need this will make it more difficult for the analyst to meet the analysis requirement/s. A second organizational context issue is that a goal for analysts is to ensure that all high-level decisionmakers are given the same picture, or information. Yet, high-level decisionmakers will often demand an individual, tailored brief. This generates a differential exchange of information between the analyst and various decisionmakers.

Organizational constraints are placed on analysts to maintain the "status quo," such that new information is filtered through a perspective of being considered as not falling outside of normal operations. There is pressure not to be "the boy who cried wolf." This is in accord with other findings (Vaughan, 1996) who describe organizations that engage in a "routinization of deviance, as they explain away anomalies and in time come to see them as familiar and not particularly threatening." (Klein, et al., this volume). Finally, there is a perception among analysts of feeling unappreciated for their work: Because people often do not understand what is involved there is a perception among IAs that people question "why do we need you?" This credibility issue results in part because different data in different databases produce discrepancies. Intelligence officers feel they loose credibility with operational guys because of these system differences. We now turn the discussion to present results from analysis of data gathered using the modified CDM.

STUDY 2

The modified CDM method was used with a group of analysts who had experience working on analysis problems at the strategic level. When using the CDM, the emphasis was on having IAs describe tasks where the focus was on analysis of intelligence in order to produce a report to answer a question of strategic interest. The length of time our second group of interviewees had devoted to the assignments that they described ranged from six weeks to three and one-half years (in the latter case, this time was spent intermittently, while serving on a US Navy ship followed by attending graduate school at NPS).

Example 1: Likelihood of a Coup in the Philippines

In this example the person described his task of having to build a brief to answer a political question regarding whether President Estrada would be deposed from the Philippines, whether there would be a coup, and if there was a coup, what the implications would be for the Philippine Islands? What would be the implications for the US? He was asked to complete this analysis task within a time span of six weeks on a topic that was outside his base of expertise (i.e., the geo-political area).

From the initial search of raw reports he produced an initial profile of what was known. Many additional searches and follow-up phone calls were conducted to fill in the gaps in his knowledge and to elaborate on what was learned during the initial set of queries. This step resulted in producing a large number of individual word files on each political person or key player. These included biographies on approximately 125 people, including insurgency leaders, people in various political groups, people with ties to crime, etc. The information in these files was then grouped in various ways to consider several hypotheses. Next he developed a set of questions to use to work backwards to review all the material from several different perspectives to answer a series of questions related to the main question of interest: Will there be a coup? Will it be peaceful or not? Will it be backed by the military? Will the vote proceed, or will the military step in, prior to the vote? What is the most likely scenario to pan out?

Schemas

A schema is a domain-specific cognitive structure that directs information search, guides attention management, organizes information in memory and directs its retrieval, and becomes more differentiated as a function of experience. Schemas are a way of abstracting the information that has been found so far into a representation. The schema summarizes the external information by abstracting and aggregating information and eliminating irrelevant information. Schemas are structured to efficiently an effectively support the task in which they are embedded.

Figure 2 depicts the schema used to represent the dual-problem space of various information sources that the analyst researched to develop a comprehensive understanding of the issue. The analyst began, in week one, by reading general background information to develop knowledge on the history and cultural ethnography of the country and also by examining prior Naval Intelligence on the previous history for political turnover in the Philippines. During week two he began contacting Intelligence Centers and reading U.S. Embassy cables, an important source for this particular topic. Although this step provided valuable information, because this material was from a secondary source it had to be corroborated. Thus the analyst had to decide which of these reports were to be given greater emphasis and in which reports he did not have much confidence.

One way the analyst structured his analysis was to sort people according to whether they were pro-Estrada or anti-Estrada, which figures would be likely to drop allegiance to the constitution, and so on. The analyst structured, and re-structured, all the information to see how it might support various scenarios associated with the analysis questions. For example, if the US invests money, will the country remain stable? How should the US react? What is the most dangerous potential outcome? Most/ least likely?

The analyst had five hypotheses that he used to organize his material. Previous coup attempts that occurred around the time of past-President Aquino were reviewed to examine how the allegiance of these people who were involved in past coup attempts might develop. Voting records provided another way to sort people. For a portion of his analysis he used nodal analysis software to examine relationships between people. He used a whiteboard to play "20 questions" to come up with new questions to pursue. Relationship diagrams were constructed for each scenario and tables were developed to facilitate comparison of hypotheses. Many other sources were examined, such as political figures' ties to certain newspapers to determine which camp they would fall into

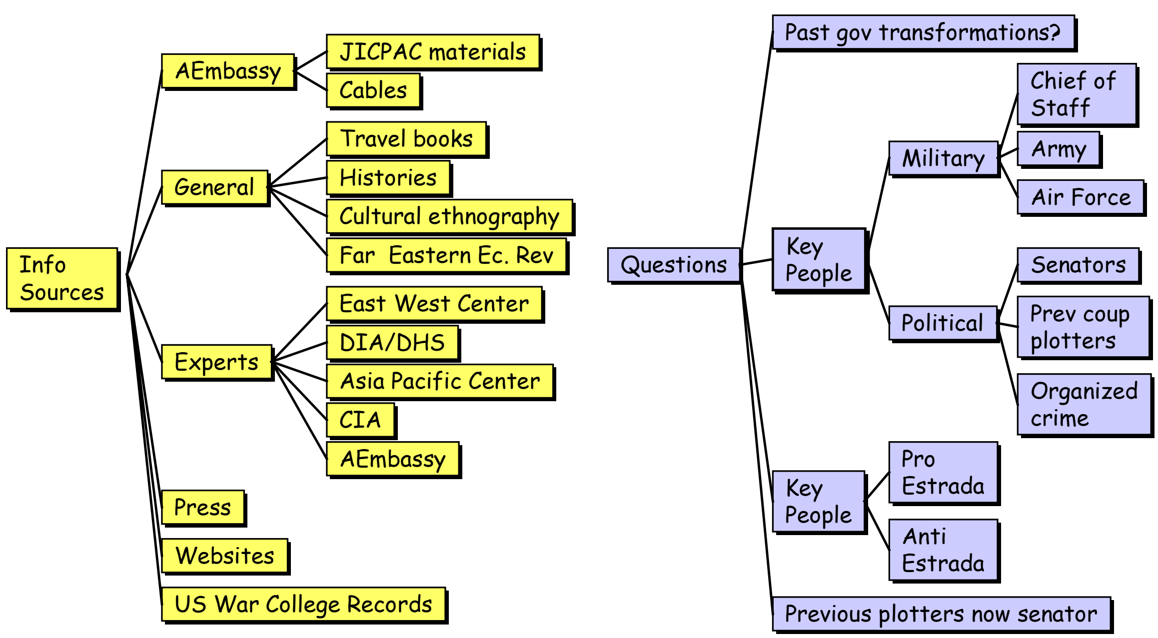

Figure 2. Information Foraging: Dual Problem Space

Figure 3 depicts the information schema used by this analyst. Multiple ways of grouping people were used by the analyst to consider competing hypotheses on how their allegiance would “fall out” based on their various associations. This analyst grouped key people in both the military and civilian sectors according to their military associations, political, family, geographic region, and various other associations, e.g., professional groups and boards they belonged to, to try to ascertain their loyalty. The analyst developed many branches and sequels between people and events in his attempt to examine their affiliations from many different vantage points.

SCHEMAS

·KEY PLAYERS

MILITARY
ARMY
REGION 1
<Commander>
·FAMILIES
<Assistants>
REGION 2
<Commander>
<Assistants>
. . .
LOGISTICS
INTEL
PERSONNEL
AIR FORCE
. . .

POLITICAL
SENATORS
CLERGY
PREV COUP PLOTTERS

POLITICAL PARTIES
POLITICAL ACTION GRPS
POLITICAL FRONT ORGS

OTHERS
ORGANIZED CRIME
PRESS
PROMINENT

INVOLVED SOME WAY

·CLIQUE ASSOCIATIONS
SAME UNIT
SAME REGION OF ORIGIN
CLASSMATES
FAMILTY RELATIONSHIP
PAST CO-PLOTTER
BOARD CO-MEMBERSHIP
BUSINESS TIES

■ SOURCES
GENERAL LIT
JICPAC
CABLES
WEBSITES
EXPERTS

■ ATTITUDES
PRO-AQUINO
ANTI-AQUINO

Figure 3. Schemas Used to Analyze the Intelligence Problem

Example 2: Modernization of Country X's Military

This analysis problem evolved as a result of a discrepancy the analyst observed between the stated political military objectives of country X and the observations made by this analyst during a six-month deployment on an aircraft carrier. During his time as strike-plot officer he spent a lot of time collecting and sifting through raw message traffic and interpreting its meaning for the Battle Group. He had developed a considerable knowledge base for this part of the world and was aboard the carrier during the EP-3 crisis, in 2001, when it landed on Hainan Island. During the EP-3 crisis, he was able to provide background information on what had been occurring up to that point as well as during the crisis.

When this analyst reported to NPS to focus on Asia he noticed a disconnect between what professors described in terms of this country’s political stance and things he had observed, while operating in this part of the world. Things discussed in his courses were incongruent with the types of military training exercises he had observed this country engage in and the types of military equipment acquisitions made by this country. He began with two or three factors that he knew could be used to support a separate hypothesis to explain the incongruity between what the political leaders are saying and what they are doing. His task was to compare the publicly stated policy of country X regarding their planned military modernization with other possible scenarios for how things might evolve.

This analysis was based on a comparison of this country's officially stated military policy with data collected during detailed observations, and the associated daily reporting, that occurred over a six-month period while the analyst was onboard the aircraft carrier. Table 6 presents a Cognitive Demands analysis of this IA problem. For analysis of this intelligence problem, the Cognitive Demands analysis described in the ACTA methodology was modified to represent the process that was used by this analyst. Since intelligence analysis involves an iterative process of data analysis and additional collection, we arranged the table to focus on specific data inputs and outputs. Additional columns include cues that generate processes that operate on data, and the strategies or methods used by the analyst to achieve goals when working with specific inputs and outputs. In addition, the table includes expert assessments of why specific inputs and outputs might be difficult. This provides indications of potential leverage points for system design. Finally, the table records specific examples mentioned by the analyst. These examples might be used as task scenarios to guide design and evaluation of new analyst strategies.

Analysis for this task included building the case for several other possible military scenarios regarding actions that might be taken by this country in the future. A comprehensive analysis of two competing hypotheses was developed to take into account future changes in political leadership, the economy, and sociopolitical factors. Data obtained on factors including economic stability, system acquisitions, and military training exercises conducted were manually coded on a daily basis, placed in a database, and aggregated over larger periods of time to depict trends.

Table 6. Cognitive Demands Table for Case 2: Develop Competing Hypothesis Regarding Military Modernization Efforts of Country X

Inputs	Outputs	Cues/Goals	Strategy	Why Difficult?	Examples
Observations that support hypothesis that country X has embarked on a different modernization effort for a number of years.	Data files that depict country X's trends	Compare stated modernization policy and economic trends within the country	Evaluate the political land-scape of country X, by examining economic and cultural shifts in leadership to gain insight into ways they are looking to modernize.	Stated (public) policy says one thing: Observations point to potentially very different goals.	Types of military training exercises, equipment acquisitions.
Observed modernization efforts	Determine country X's military capability to conduct precision strike	Does the political/ economic/ cultural environment support this operation?	To consider other possibilities beyond their stated military modernization goals	To build a case for possibilities	Use observa-tions from exercises, purchases, etc. to see a different perspective, supported with data
Many prior products: Intel- ligence sources, e.g., unclassified writings, interviews with political leaders	Documents describing discrepancies between observed activities and stated policy.	Notice discrepancies between stated policy and observed activity	Match up things seen in open press with what is occurring militarily	How do observations relate to each other and to the stated policy?	Stated policy of country X does not align with activities observed during exercises.
Classified sources; personal observations; anecdotal memories of deployments and experi-ences from past deployment	Data files of detailed observations gathered over a 6-month period	Help operational side of Navy explore a different view that is not based on established norms of thought	Avoid "group think." Despite the mountain of evidence to the contrary, you don't want to "spool people up."	Difficult to distill the relevance of the informa-tion: Take 100 reports and find the five gems.	Tendency is to report every-thing and treat everything as of equal importance
Read message traffic all day	Two seemingly unrelated events are reported on individually	Take analysis to next level of what is occurring	Ask: "Does this make sense?"	Answer question: "Is this relevant?"	Goes against organizational constraints, i.e., events are "not to be considered outside normal routine training activity."
Volume of information is constrained to the geographic area	Graphs to depict trends of different types of activity	Factor in Army or ground troop movement in addition to Navy activity	Classify infor- mation as relevant or irrelevant. Maintain data-bases of activity, e.g., by day/ week/ months	Several hours a day sorting through message traffic; If had a crisis would be completely saturated.	Group all different categories of activity, e.g., local activity, aggressive activity, exercise activity
Read every-thing can find	1. Brief for the Commander each day 2. Daily Intel Analysis Report	Pick out things that are relevant	Take raw message traffic (w/o anyone's opinion associ-ated with it)	Databases do not match up (even capabilities listed in them)	Extract what think is relevant and highlight activity thought to be relevant
Based on observations of activities that did not match up with what others believed	Form a model of the situation; imagine events over time	To force people to look at a different possibility	Build "Perry Mason" clinch argument	Organization-al constraints not to "go against the grain"	Had lots of documented real world observations
Data on emerging political environment in transition	Understanding of relation-ships between important actors	Paramount to understand who is driving what action	New leadership person is still "driving" things: Added credibility to thesis that there is a split	Could not get access to all material (databases) needed for analysis	Inconsistent capabilities listed in different databases
Location of US forces; geo-political landscape; economic decline affecting country X	Build timeline to depict more aggressive posture	West will not have same influence on economy which leads to political unrest: Political rivalry between old/ new leadership	Describe political factors that could set off a change in direction. Set stage for how things could go in a fictional scenario	Credibility issue: operational guys rarely understand analysis, especially strategic	When presented brief on threat, operational personnel did not perceive information as representative of a threat.
Difference between what they're saying and what they're doing	Revised hypothesis	Initially 2-3 factors that will support a separate hypoth- esis from the accepted hypoth-esis on what is transpiring.	Marshall evidence to support alternate hypothesis	Selecting which pieces of information to focus on	Fact that found so many pieces to support hypothesis indicates hypothesis has to be considered

For this intelligence problem the analyst was looking for evidence to build the case to support several competing hypotheses regarding future political-military scenarios. Several types of information were viewed as indicative of the type of data that could be used to develop and substantiate alternative hypotheses and several methods were used to represent his analysis of the data. For example, a timeline was developed that depicted the following information: (1) location of U.S. forces; (2) geo-political landscape of the world; and (3) the economy, based on economic decline affecting industry in the country. One scenario depicted a situation where the West would not have the same influence on the economy and the fallout will be some political unrest. Political rivalry between the old and new leadership will ensue and the scale will tip to the negative side as a result of political factors that have "gone south." Congressional papers were used, in addition to all the information developed by this analysis, to write a point paper on an assessment of this country's military activity and the kind of threat he saw as a result of his analysis.

<u>Sensemaking</u>

Sensemaking describes one of the cognitive processes performed by the IA to understand complex, dynamic, evolving situations that are "rich with various meanings." Klein, et al, (this volume) describe sensemaking as the process of fitting data into a frame (an explanatory structure, e.g., a story, which accounts for the data) and fitting a frame around the data. The story, or frame, adopted by the IA will affect what data are attended to and how these data items are interpreted. When the IA notices data that do not fit the current frame the sensemaking cycle of continuously moving towards better explanations is activated. Sensemaking incorporates consideration of criteria typically used by IAs: plausibility, pragmatics, coherence, and reasonableness (*ibid*).

Sensemaking applies to a wide variety of situations. As Klein, et al, describe it, sensemaking begins when someone experiences a surprise or perceives an inadequacy in the existing frame. Sensemaking is used to perform a variety of functions, all related to the IA's job, including problem detection, problem identification, anticipatory thinking, forming explanations, seeing relationships, and projecting the future (*ibid*).

DISCUSSION

Intelligence analysis is an intellectual problem of enormous difficulty (Wirtz, 1991).

Many opportunities for tool development to assist the processes used by IAs exist. Prototype tool development has begun and will continue in conjunction with the next phase of the CTA. Because the ultimate goal is to develop a computational model of the IA's tasks, detailed data must be captured on analysts performing their tasks. Use of process tracing methods, e.g., verbal protocol analysis, in conjunction with the Glass Box software, developed for the NIMD Program (2002), should provide a rich source of data to develop a detailed model of the IA's processes. NIMD's Glass Box is an instrumented environment that collects data on analyst taskings, source material, analytic end products, and analytic actions leading to the end products (Greitzer, 2004)

Use of an instrumented data collection environment in conjunction with think aloud protocol analysis will enable us to gather detailed knowledge about the knowledge and cognition entailed in intelligence analysis. The next phase of this CTA will involve asking SMEs to perform an analysis task while thinking aloud. This technique typically provides detailed data concerning the mental content and processes involved in a specific task.

Identification of an appropriate sample of problems or tasks is essential to ensure sufficient coverage of critical skills and knowledge. The initial set of interviews was conducted to develop a foundation of knowledge regarding the IAs' task domain. During the next phase of this research additional empirical data will be gathered to further refine the CTA model of intelligence analysis.

Our next phase for this research will involve knowledge elicitation by observing skilled practitioners performing an analysis task using open-source literature. Working within a system development process, to support critical system design issues, additional data and empirical evidence will be collected. The CTA process is an iterative process that builds on subsequent design activities. New tools and training will impact the cognitive activities to be performed and enable development of new strategies. One goal for this phase will be to predict the impact the technology will have on cognition for the intelligence analyst.

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