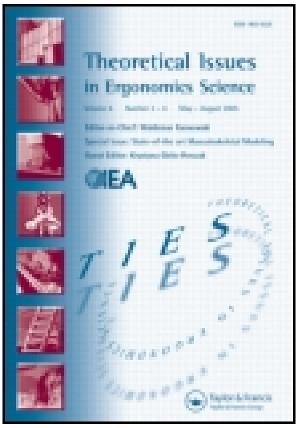

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Reasoning difficulty in analytical activity

Robert Hoffman [a], Simon Henderson [b], Brian Moon [c], David T. Moore [d] & Jordan A. Litman [e]

[a] Institute for Human and Machine Cognition, 40 South Alcaniz St., Pensacola, FL 32502-6008, USA

[b] Human Influence Team, Building A5, Room 1026, Cody Technology Park, Ively Road, Farnborough, Hampshire, GU14 OLX, UK

[c] Perigean Technologies, 725 Jackson Street, Suite 218, Fredericksburg, VA 22401, USA

[d] Suite 6158, National Security Agency, 9800 Savage Road, Fort George G. Meade, MD 20755, USA

[e] Department of Psychology, University of South Florida, 140 7th Avenue South, St., Petersburg, FL 33701-5016, USA

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Reasoning difficulty in analytical activity

Robert Hoffman[a]*, Simon Henderson[b], Brian Moon[c], David T. Moore[d] and Jordan A. Litman[e]

[a]Institute for Human and Machine Cognition, 40 South Alcaniz St., Pensacola, FL 32502-6008, USA; [b]Human Influence Team, Building A5, Room 1026, Cody Technology Park, Ively Road, Farnborough, Hampshire, GU14 OLX, UK; [c]Perigean Technologies, 725 Jackson Street, Suite 218, Fredericksburg, VA 22401, USA; [d]Suite 6158, National Security Agency, 9800 Savage Road, Fort George G. Meade, MD 20755, USA; [e]Department of Psychology, University of South Florida, 140 7th Avenue South, St., Petersburg, FL 33701-5016, USA

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We review the consensus of expert opinion concerning the psychology of intelligence analysis, as a form of critical thinking. This consensus details a number of ways in which the cognitive work is difficult. Many senior analysts have commented upon the requirements of intelligence analysis – the reasoning traps to which novices fall victim, and the required knowledge and skills of experts. There remain gaps in our understanding, not just because the research is classified. There simply has not been that much systematic research. If the empirical base were broadened, headway might be made in training and techniques to help analysts cope with difficulty. We hope that this article contributes by presenting an overview and rationale for empirical study of the cognitive ergonomics of intelligence analysis.

Keywords: critical thinking; intelligence analysis; causal reasoning; sensemaking; cognitive work; decision-aids

1. Introduction

The theme of this article is intelligence analysis as a form of critical thinking, and what makes it difficult. Some sources of difficulty have to do with the nature of the critical thinking itself, specifically the challenge of anticipating human activity, which we call 'indeterminate causation'. Other reasons why the cognitive work is difficult have their origins in the software tools that are provided to analysts and the organisation (policies and procedures). We start with a brief presentation of the expert consensus about the psychology of intelligence analysis with respect to the required knowledge and reasoning skills. Next we discuss the aspects of intelligence analysis that make the work difficult. These derive from aspects of the world, aspects of the work and aspects of cognition. We conclude by discussing the implications for research and some prospects for software ergonomics.

*Corresponding author. Email: rhoffman@ihmc.us

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2. Claims about the psychology of intelligence analysis

Empirical research on the reasoning in intelligence analysis has been underway since at least the late 1970s. At that time, researchers sponsored by the US Army Research Institute for the Behavioural and Social Sciences and the US Army Intelligence and Security Command developed 'a descriptive model of the cognitive processes involved in analysis' (Katter *et al.* 1979). Similar work continued during the 1980s, notably a continuation of US Army efforts that detailed the cognitive basis of intelligence analysis and offered a model of reasoning (Thompson *et al.* 1984). In that model, analytical activity was described as a sequence of defining the goals, formulating hypotheses, identifying uncertainties, gathering information, testing hypotheses, revisiting the goals and then formulating a product.

Inquiry about analytical activity appears to have abated during the mid-1980s until the late 1990s. The publication of Richards Heuer's *The Psychology of Intelligence Analysis* (1999), an integration of essays written in the late 1970s, marked a resurgence of interest in the cognition of intelligence analysis. Indeed, the US intelligence community and the Department of Defense have sponsored many efforts explicitly aimed at inferring the state of analysts and the analytic process from analysts' activities. In recent years there have been investigations of intelligence activity from the perspective of work ethnography (Johnston 2005), there have been empirical studies of the accuracy of analyst predictions (Mandel *et al.* 2009) and many discussions of the cognitive and motivational characteristics of successful analysts (e.g. Marrin 2003, Moore and Krizan 2005, Swenson 2005). A number of relatively small-scale but very informative cognitive task analyses have been conducted (see, e.g. Klein 2001, Hoffman and Cañas 2003, Hutchins *et al.* 2007, Pirolli and Card 2005); there have been simulation studies (Patterson *et al.* 1999) and some objective experiments on the efficacy of analytic methods (Cheikes and Taylor 2003, Cheikes *et al.* 2004).

The intelligence community's understanding of cognition has followed the wider scene in cognitive psychology. The early research reflected an information processing theoretical foundation. Later came a wave of 'heuristics and biases' research, which profoundly influenced Richards Heuer. Most recently, some of the research takes the perspective of Naturalistic Decision Making, which focuses on the study of highly proficient experts and superior performance, rather than reasoning biases and limitations of novices (Patterson and Miller 2010). Yet, despite the parochial differences of these research paradigms, a consensus has emerged.

A frequently mentioned skill required of 'all source' intelligence analysts is cultural knowledge and language skill. The expert analyst is steeped in the history and culture of a region (Garst and Gross 1997, Turner 2003, Moore and Krizan 2005). Also frequently mentioned are the requirements of persistence and creativity (Satterthwaite 2005). Intelligence analysts have to be capable of 'critical thinking', a requirement that is made salient by intelligence failures. For example, US Army Major Nathan Murphy recently expressed concerns about the counterterrorism effort saying that 'We have neglected the single point of failure which is to be able to think critically' (quoted in Ricks 2010), suggesting a gap in the cognitive capacities required to overcome problem difficulty and complexity.

Moore and Krizan (2005; see also Thompson *et al.* 1984) provided a deep hierarchy of the requirements, categorised at the highest level into knowledge, abilities, characteristics and skills, for example:

- successful analysts possess huge amounts of knowledge, and are voracious learners,

- successful analysts are highly motivated and have insatiable curiosity,
- successful analysts are good collaborators and team members,
- successful analysts 'know the ropes' of their own and other intelligence organisations (policies, procedures, and mission structures)
- successful analysts are good at reasoning (i.e. critical thinking),
- successful analysts organise their knowledge around conceptual models, and can reason top-down and abductively,
- successful analysts do not have access to more or better information than the less able analyst, but are better able to chunk the available items of information into significant patterns,
- successful analysts see their work as a form of research, having strategies and designs, and reliant on information exploration and the evaluative measurement of process and product.

The critical thinking aspect of intelligence analysis has been described in many ways: connecting the dots; finding the needle in the haystack; separating the wheat from the chaff; putting together a puzzle even when you see only the back and you are not given any of the edges; and transforming data into information into knowledge (e.g., Senator 2002). The cognitive work of analysts is often compared to that of scientists (Heuer 1999, Johnston 2005), medical diagnosticians (Marrin and Clemente 2005) medical generalists (Mihelic 2005), investigative journalists (Warner 2007), rhetoricians (Mills 2003) and legal investigators (Attfield and Blandford 2010).

Having expressed this consensus concerning the cognition of intelligence analysts, we can focus on the issue of what makes analysis, as a form of critical thinking, especially difficult. We recognise that our arguments are based on partial information and limited experience. We draw on: (1) the experience some of us have had in analytical work, (2) our experience in evaluating new technologies intended to improve analysis, (3) our observations and work analysis of a laboratory chartered with intelligence transformation and (4) some dozens of knowledge elicitation interviews we have conducted with practicing and retired intelligence analysts.

3. What makes analysis difficult?

It can certainly be said that analytical work is difficult because it is a form of critical thinking, and critical thinking is difficult (Cohen and Freeman 1997, Cohen *et al.* 1998, Feltovich *et al.* 2001, Elm *et al.* 2005, Moore and Krizan 2005, Moore 2006, 2010, Elder and Paul 2007, Henderson *et al.* 2010, Klein (this issue)). Research and theory on critical thinking in the field of psychology highlights the fact that critical thinking is difficult (for people in general), the fact that critical thinking is not put to use nearly as often as it should be (by people in general), and the fact that it links strongly to curiosity, a motive that varies considerably in strength from person to person (Litman *et al.* 2005, Litman 2005, 2008, Litman and Silva 2006, there is a large literature on critical thinking and critical thinking training, see http://www.au.af.mil/au/awc/awcgate/awc-thkg.htm#critical).

Combined with the fact that sound critical thinking often has desirable consequences (i.e. difficult problems are solved), critical thinking, like sound intelligence analysis, is 'highly prized' (Smith 2010). Courses are offered to teach students to 'think like scientists' (e.g. McLean *et al.* 2007). The field of critical thinking has populated bookshelves with texts offering tools for reasoning (e.g. Jones 1998, Halpern 2003, Facione and Facione

2007, Sternberg *et al.* 2007). Likewise, numerous studies have examined the field of intelligence analysis as a form as critical thinking, also asking questions about teaching analysis as a form of critical thinking, and also offering suggestions for methods and models (e.g. Moore, 2006).

As Smith (2010) points out, consensus about the nature of critical thinking is that it requires: (1) the ability to identify assumptions and (2) the ability to conceive of alternative assumptions. An identical understanding seems to be a consensus in the study of intelligence analysis, although the 'recognition of assumptions' is more often framed as the recognition of perspectives, mind sets' or world views. These can serve a biasing function and the conception of alternatives is framed in terms of alternative hypotheses (e.g. Heuer 1999).

Intelligence analysis is especially difficult for a variety of additional reasons.

3.1. *The organisation actually makes it difficult*

An organisational context can sometimes be disincentivising and demoralising, especially when the analyst is pressured by the need to avoid error and blame. Historically, intelligence organisations have their unique legacies, methods and allegiances.

> Analysts know that outcomes are often caused by accident, blunder, coincidence, the unintended consequence of well-intentioned policy, improperly executed orders, bargaining among semi-independent bureaucratic entities or following standard operating procedures under inappropriate circumstances (Heuer 1999, p. 120).

Efforts to integrate analytical activity across various agencies in the US have recently placed analysts in awkward positions of having to navigate multiple responsibilities and constraints. Numerous authors have outlined the organisational and cultural aspects of resistance to change in the intelligence community (e.g. Johnston 2005, Henderson *et al.* 2008a,b). The analyst's audiences (policy makers, decision makers) are dynamic and non-monolithic in that they too have multiple and contingent responsibilities and allegiances. Different people and different organisations work to different time frames – they have different planning windows, and only look so far into the future. Syncing these people/levels causes problems, especially during times when the tempo of work is increasing. A series of cognitive task analysis interviews with experienced analysts (Hoffman 2005) revealed a number of stories about how the analytical reports get shaped by top-down policy considerations or impositions (see also Marrin 2003).

3.2. *The work is inherently difficult*

The cognitive difficulty of critical thinking and sensemaking are amplified by the broader context of the work, that is, the ways in which jobs are specified. Researchers who have studied intelligence analysis and related domains of information synthesis and analysis (e.g. emergency response), show a clear consensus that analysis is difficult because of a cluster of factors including workload, time pressure, high stakes and high uncertainty (Cohen and Freeman 1997, Pascual and Henderson 1997, Schrodt and Gener 1998, Hutchins *et al.* 2007, Song *et al.* 2010).

The domains of human affairs that are subject to analysis and the work of analysis are 'moving targets', constantly changing in demands, focus and goal. In the years since 9/11, intelligence analysis has become 'grappling with mysteries' rather than the 'discovery of secrets' (Swenson *et al.* 2005). The capabilities of an experienced analyst take years to mature and '…usually involves the analyst playing catch-up for most of his career' precisely because the work and its demands are constantly changing (Ricks 2010, p. 1).

On top of all this, intelligence work often focuses on events that transpire quickly, and so analysis leaves little or no time for introspection or reflection on the processes of intelligence collection and production (Swenson *et al.* 2005b). The modern intelligence organisation must be a self-reflective 'learning organisation' (Garin 2003).

The collection and integration of information at the start of work on an analytical tasking requires a facility at exploring electronic multimedia (Turner 2003). The subsequent analysis and integration of information relies primarily on the common text, spreadsheet and presentation software. Many structured analytical techniques can be conducted on paper. Heuer and Pherson (2010) provide a detailed catalogue of techniques. As in any toolkit, there are methods that are easy to use (e.g. creating simple matrices) and methods that take practice to do well (e.g. Concept Mapping; see, for example, Moon *et al.* 2010).

3.3. *The tools actually make it more difficult*

Experimental-cognitive psychology has generated a great many studies documenting the occurrence of reasoning biases, many dozens of them, in fact (Tversky and Kahneman 1973, 1974, Evans 1989, Gigerenzer *et al.* 1999). This research has had a significant impact on the intelligence community, largely due to the influential book, *The Psychology of Intelligence Analysis* by Richards Heuer (1999). Heuer claimed that intelligence analysts, especially the less experienced ones, are subject to a number of biases, including salience bias, confirmation, anchoring bias hindsight bias and availability bias. A consequence of this emphasis, and the drive to avoid error (so-called intelligence failure), there was a huge infusion of funding to in the US support the creation of software tools designed to help analysts overcome biases, primarily by using methods of probability estimation and analysis. Many new 'transformational' technologies and concepts have been created, including eye candy tools for navigation through massive data, and decision support tools for the systematic analysis of judged probabilities associated with sets of hypotheses (e.g. Bayesian methods).

Intelligence analysts have reported many difficulties associated with these new software tools (Hutchins *et al.* 2007). The process of information collection is made difficult because considerable technical facility is often needed to use the search tools. The various software tools sometimes talk to one another, and sometimes do not. Analysts report that they generally find it difficult to synthesise different data types and databases. Decision support systems often trigger automation surprises, in that the software generates results that are not transparent to the analyst, and thereby spawn trust issues.

One reason why new software is not up to par is that the development activity was based on assumptions about the cognitive work of intelligence analysts. Experience shows that the new software tools often do not tie sufficiently (or at all) to the actual work requirements of analysts (McGroddy and Lin 2004, see also Hoffman and Elm 2006). Worse still, tools can actually impede intelligence analysis. In studies conducted by ourselves and our colleagues we have seen many instances where:

- tool use is labour intensive with no obvious value-added, e.g. high cognitive effort in building argument templates for specific problem sets.
- confusion about, gaming of or outright disregard for fusion algorithms (which are intended to support deductive reasoning),

- uncertainty and mistrust concerning the equations that are 'riding under the hood', and that magically generate conclusions (in the form of yet more probability numbers),
- lack of standards of judgment for answering and/or scoring questions within the structured arguments,
- disruptions and impediments to collective problem solving,
- a focus on one person-one machine contexts of work leads to underspecification of collaborative processes,
- inappropriate requirements for low-level judgments within the 'zone of indifference' – i.e. requiring analysts to make precise, numeric judgments that otherwise could 'go either way',
- discomfort with the inflexibility of argument structures or templates.

3.4. *Causal reasoning is inherently difficult*

There is a consensus that intelligence analysis is difficult because predicting is difficult.

> Prediction is a difficult endeavor, even in modern times with seemingly sophisticated methods... In 1984 *The Economist* asked 16 individuals to make some elemental economic forecasts out to ten years. The subjects in question concerned such basic data as average growth rates, average inflation rates, and the price of oil... In 1994, *The Economist* unsealed the predictions and measured them against what had actually happened. On average, the forecasts turned out to have been more than 60 percent too high or too low. The 16 individual forecasters represented four groups: finance ministers, chairmen of multinational corporations, Oxford University economics students, and, as a control group, four London garbage collectors. Every group did poorly; the garbage collectors, as it happened, turned out to be the most accurate. Such a result is more than humorous; it is sobering. It forces us to acknowledge that single-point predictions about the future, even by experts, are parlous (US Commission on National Security/21st Century 1999, *The Economist* 1995).

And in referring to the same study, Williamson (1999, p. 117) said:

> The unpalatable fact is that no one can predict the long-term economic and market environment with any real accuracy. Yet many strategic plans are meticulously constructed on these foundations of sand, perched on top of forecasts that, in all probability, will prove to be hopelessly off the mark.

A way of visualising some of the challenges of short-term and long-term projection is presented in Figure 1. In this Figure imagine the central diamond to be some effect happening now and that is to be explained (e.g. the watch broke). Looking back, one might be able to see precursor events that are fairly specific causal mechanisms (e.g. the watch was hit by a hammer.) Looking even further back one might find broader determinants (e.g. the watch was in a testing lab), and eventually reach back to trends and pressures that transcend specific events (economic competition driving product improvement). Likewise, in projecting to the future one might be able to make some specific near-term predictions (e.g. the watch will be discarded or its parts recycled), but as one reaches further out, it becomes less clear what the repercussions might be (that watch would have been Jimmy's gift to his dad). At different regions along the left and right 'bow ties', one has to look for *different kinds* of evidence concerning different kinds of causation.

Human activity is perhaps the most significant realm of indeterminate causation. Herein is a major source of difficulty. Over the past two decades, the field of Expertise Studies has revealed a significant difference between two kinds of domains. In Type 1 domains the primary tasks are fixed and relatively stable, and it is relatively easy to define

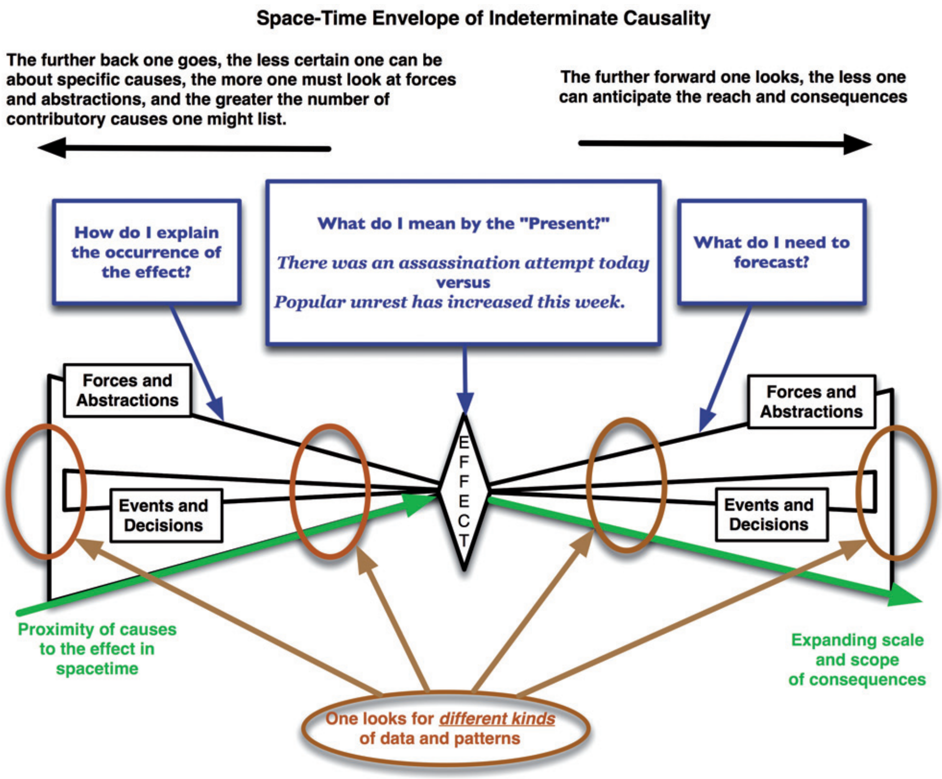

Figure 1. A visualisation of how indeterminate multiple causation generates challenges for cognition.

expertise, relatively easy to find genuine experts, relatively easy to measure their performance and compare performance to baseline data. Examples are sports, musical performance, medicine and weather forecasting. In Type 2 domains, it is not easy to define expertise or measure performance. Examples are jurisprudence, economics and psychotherapy. Type 2 domains are the ones in which the principal task goals involve predicting individual or aggregate human activity (Shanteau 1992). The fact that there are bounds on the possibility of anticipating aggregate or individual human activity means that there is also a bound on the ability to accurately predict secondary or cascading effects (or rather, too much can be predicted).

An adversary's activity does not always make sense, especially if they are culturally different from the sensemaker (sometimes even bounding and identifying the adversary is extremely difficult). An adversary's activities are moderated in significant ways by attitudes, beliefs and emotions, and of course these are sometimes unknowable and often difficult to discern. And it must be kept in mind that people's activities do not always make sense to them either.

Understanding an adversary's actions and decision-making is crucial to successful adaptation. This is not just a matter of canvassing the range of possible actions for a given situation, but rather, a matter of exploring the reasoning of the decision maker to understand how he perceives, how he strategises, and how he makes sense of the world. These cognitive dimensions are deeply interactive with cultural knowledge and influences.

The complexity of both individual and cultural characteristics implies that specific activities-in-context cannot be predicted, even with the benefit of a seemingly exhaustive cultural taxonomy or knowledge of the actor's culture. Rather, knowledge of the actor's culture and beliefs allows one to appreciate how the actor makes sense of the world, and thus formulate situation dependent tendencies in reasoning and judgment.

Academic theory and research on causal reasoning has generally focused on causal reasoning about physical events (determinate causality), and most analyses are in terms of chains of cause and effect. Causal reasoning about human activity and affairs involves complexities and subtleties rarely acknowledged in the academic or scientific literatures of psychology, philosophy or sociology. For all the studies and discourses on causal reasoning generated over the centuries, this is still an open area for cognitive research and discoveries about analytical reasoning.

Theorists may tend to assume that 'causal reasoning' is a isolable process. But causal reasoning does not always have clear-cut beginnings and endings: some key event happens and leads to a cause, and in retrospectively understanding this, the decision maker has to apprehend the effect and the cause and feel satisfied that the effect has been plausibly explained. Sometimes the 'trigger' does not perk the decision maker's curiosity at all, and causal reasoning is not engaged when it should be (Klein and Hoffman 2009). Furthermore, reasoning about causation often does not always resolve or have a clear-cut terminus. Indeed, it can be very extended over time and have no clear-cut conclusion, resolution or point of satisfaction.

Events that occur over time are difficult to link causally if only because they always involve multiple interactive causation (Mill 1882). We have found about a dozen repeating patterns of causal reasoning, and the simple cause-effect chain is one of the least frequent of them (Klein and Hoffman 2009). Other patterns involve complex causation. For example, 'swarms' are multiple converging causes; 'onions' are when causes are unpacked into other cause-effect relations; 'spirals' are when one effect feeds-back to increase the power of some other effect. A pattern called 'clockwork' is when there are multiple causes that influence one another. Additionally, these patterns show some interesting domain dependencies. For example, explanation by 'clockwork' seems common in discussions of the causes of events in economies. Explanation by 'dramatic reversible' is common in analyses of the outcomes of sporting events. There are many patterns to causality and although these can sometimes be known, causality can remain difficult to resolve.

Unfortunately, the word 'prediction' has become identified with the act of forecasting specific adversary courses of action over some specific time period with associated specific probabilities (a feature of structured analysis approaches). Analytical activity might escape this mind-set by referring instead to *anticipation of ranges* of activities or 'course of action envelopes'.

Given these kinds of difficulties to critical thinking, what are the possibilities for helping analysts cope with them?

4. Structured analysis versus sensemaking approaches

The strategy of systematically laying out the pros and cons of alternative solutions is one that has been advised by many (Heuer cites Benjamin Franklin, one might also cite Arthur Conan Doyle), and is a strategy always discussed in books on problem solving. The strategy is also advocated for intelligence analysis. According to Heuer (1999, see also

Heuer and Pherson 2010) the following activities can be structured and thereby insure the soundness of critical thinking.

- Recognising and clearly delineating assumptions and chains of inference,
- Determining and specifying uncertainty,
- Determining and specifying the diagnosticity of evidence,
- Disconfirmatory reasoning, pitting competing hypotheses against the evidence,
- Considering alternative interpretations and (re)consideration of evidence that might be ignored on the basis of mind-set,
- Analysis of multiple alternative and competing hypotheses,
- Enhancing analysts' metacognitive awareness and understanding of their own thinking,
- 'What-if' reasoning.

Some evidence suggests that formal analytical procedures are utilised on only a small percentage of cases (Pascual and Henderson 1997). While there is certainly value and utility to systematically laying out problems, say in the form of a matrix and associated likelihoods, one might be wary of going from this to a system that forces a reasoner to become a probability-juggler.

Humans have a remarkable ability to learn to perceive meaningful patterns, and this can be disrupted and inhibited by the application of reductive approaches. The attempts to impose quantification of complex variables and patterns – typically seen as the only method for enhancing rigor – often end in a frustrating exercise of 'jury-rig-oring', where final numerical answers are nothing more than the aggregation of make-shift calculations that mask other judgments and caveats. Under some circumstances, forcing a multi-attribute utility analysis on the decision maker can degrade performance. Heuer recognises that there are times when multi-attribute utility analysis can be useful. But in doing so, he points to cases that are 'important, difficult, or that involve controversial judgments' (Heuer 1999, p. 90). One wonders if, in such cases, a systematic utility analysis might be more valuable in post-hoc justification for reporting than it is in the actual analysis.

If any single factor comes to mind when navigating the morass of difficulty factors (Figure 1), it is complexity. Cognition adapts to complexity, through processes such as problem detection and sensemaking (Klein *et al.* 2003, 2006a,b,c). The sensemaking approach to critical thinking and intelligence analysis leverages our methods of cognitive field research and our understanding of expertise (Moore 2011). It can be thought of as complementary to the structured analysis approach, which focuses on helping less experienced analysts overcome reasoning traps and biases. This complementarity is described in Table 1.

5. Prospects

Some of the sources of difficulty might be overcome, some may be inevitable. Shifting from the 'blame game' that is associated with structured analysis to a sensemaking approach might help analysts and organisations cope with difficulty, though no approach, however fresh, could make the inherent difficulty of the cognitive work go away. Changes to organisational cultures (policies, procedures and disincentives) certainly have great potential for eliminating some unnecessary difficulties (e.g. the burdens of reporting). But they could not possibly eliminate the difficulties inherent in problems created by a complex and dynamic world. Changing the thrust of technology development from creating tools to

Table 1. Structured analysis versus sensemaking approaches.

Approach	Structured analysis	Sensemaking
Disciplinary origins	Cognitive psychology of the 1970–1980s.	Expertise studies of the 1980s–2000s.
General intent	Cautionary tales about biases, aimed primarily at novice, apprentice and junior journeyman analysts.	Help the analytical community escape the 'blame game'. Provide tools that are useful to analysts at all levels of proficiency.
Empirical base	Experiences of senior analysts.	Empirical studies of proficient reasoning and critical thinking, including studies of analytical performance, reasoning styles and strategies.
Theoretical foundation	Heuristics and biases.	Data-frame theory of sensemaking.
Scope	The individual analytical problem.	The analyst and the problem in context.
Application	Individual problem solvers	Problem solving at the individual, team and organisational levels.
Methods	Utility analysis, listing and evaluation of alternative hypotheses, probability estimation and probability juggling.	Simple, flexible tools to allow analysts to express and evaluate their reasoning.
Intent of methods	Mitigate bias.	Balance the drive to mitigate bias with the need to be creative and adaptive.
Implicit message	All human reasoning is necessarily flawed and limited.	Humans are capable of solving tough problems, adapting to uncertainty, and achieving expertise.

mitigate bias to tools that support perceptual learning and the achievement of expertise would almost certainly lead to improvements in performance and increases in morale.

Although we have pointed to an empirical base of understanding about the cognition of intelligence analysts and the sources of difficulty, there is a concern within the intelligence community that there remain gaps in our empirical understanding, gaps that pertain to the adoption of a sensemaking approach and the continuing 'evolution of tradecraft' (Swenson *et al*. 2005, p. 4).

> [It] is not to say that an intelligence literature does not exist but rather that the literature that does exist has been focused to a greater extent on case studies than on the actual process of intelligence analysis ... The problem is that most of the internal research has concentrated on historical case studies and the development of technological innovations. What is missing is focused study of human performance within the analytic components of the Intelligence Community. Questions about the psychology and basic cognitive aptitude of intelligence analysts, the effectiveness of any analytic method, the effectiveness of training interventions, group processes versus individual processes, environmental conditions, and cultural-organizational effects need to be addressed (Johnston 2005, p.111).

The missing empirical base includes a number of questions all of which converge on cognitive difficulty, and has implications concerning analytical work methods and decision-aiding by software tools and intelligent systems. For example, evidence on the frequency of occurrence and magnitude of biases in professional analytical reasoning is largely anecdotal. Some studies of experts in various domains have raised questions concerning the occurrence and extent of bias 'in the real world' (Hoffman and Militello 2008, Chap 5). Following the occurrence of several 'errors' and the uncovering of systematic 'flaws' in intelligence analysis processes (e.g. McGroddy and Lin 2004), the US intelligence community believes it must seek fundamental, systematic change (WMD Commission 2005). The same holds in the United Kingdom (Butler 2004). Closely related to the metaphors (e.g. 'connecting the dots') are characterisations of analytic work that seemingly rest on empirical findings but are not accompanied by evidence of their veracity. These catch phrases hint at aspects of analysis – particularly at challenging aspects – but by themselves seem to beg the question of their own importance. Thus, the literature is littered with calls to help analysts 'flip the bathtub curve of time spent researching, analysing and producing' analytic products, help analysts 'overcome biases', and help analysts find 'novel intelligence in massive data'. Rarely is a corresponding description of the actual challenges that are faced by intelligence analysts offered. We suggest that it is the reliance on common assumptions about cognitive work – as opposed to a reliance on empirical research of how analysts *actually do work* – that is the primary cause for the limited success of the recommendations offered to the intelligence community.

In effect, the tools are instances of the trap of designer-centred design. This trap is hard to avoid – smart and well-intentioned people develop their own theory of the work to be supported, come to believe they can 'fill the shoes' of the target users, and then build a tool that is, in effect, an hypothesis of how the work will change once the tool is introduced. Generally, the hypothesis is that work will be improved, but there are almost always certain kinds of unanticipated consequences. Users have to fight the technology and are prevented from being fully engaged in the problem. As a result, they often end-up creating workarounds or kluges such that they can progress their work in spite of the technology (Koopman and Hoffman 2003, Moon and Hoffman 2005, Laplante *et al*. 2007).

When a support tool is presented for consideration, one must ask these kinds of questions: Was any form of cognitive task analysis undertaken to understand the user's current work methods, challenges and bottlenecks? What model of work does the tool support? How involved were analysts in the tool development process? Is there convincing empirical evidence that the tool is useful and understandable? Once a new tool is in place, is the changed work observable such that performance and tool effectiveness and impact can be studied?

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About the authors

Robert Hoffman is Senior Research Scientist at the Institute for Human and Machine Cognition in Pensacola, Florida. Among his many interests are the psycholinguistics of figurative language, the psychology and history of science, the cognition of experts (especially weather forecasters), human centred computing, and geological field research in planetary science. His major current projects are the development of a general theory of macro cognitive work systems, and theories of complexity and measurement in systems analysis.

Simon Henderson is a Principal Consultant in QinetiQ's Human Influence Team and has over 20 years experience in leading research to enhance all aspects of team-working and decision making across a wide variety of domains. In addition to leading a broad range of projects for Ministry of

Defence in the areas of command, intelligence and information operations, he has increasingly been involved in transferring capability to work with other safety critical non-military organisations, including the NHS, energy companies, the European Space Agency, and the Police.

Brian Moon is Chief Technology Officer at Perigean Technologies LLC in Fredericksburg, Virginia. His experience includes Applied Concept Mapping for government and commercial organizations, supporting the development of a structured brainstorming application and measuring the impact of information technologies for the U.S. intelligence community, and the redesign of a the White House Situation Room.

David T. Moore is a senior intelligence professional and educator. He teaches critical thinking and structured techniques for intelligence sensemaking and his research focuses on developing validated multidisciplinary approaches to facilitate intelligence sensemaking. His most recent posting was to the School of Leadership and Professional Development at the National Geospatial-Intelligence Agency. Formerly he served as a technical director at the National Security Agency where he advocated and mentored best practices in intelligence sensemaking.

Jordan A. Litman is a visiting research scientist at the University of South Florida, Psychology Department. His primary interest is the study of state and trait curiosity and information seeking behavior. His work on curiosity incorporates theory and research on memory, metacognition, emotion, and individual differences in personality.