

10th International Command and Control Research and Technology Symposium
The Future of C2

How Much Information is Enough?

Decision-making and Cognitive Analysis

Sarah M. Taylor, PhD
Research Engineer, Principal
Lockheed Martin IS&S
Dulles Executive Plaza II
13560 Dulles Technology Drive
Herndon, VA 20171
703-466-3213 or 703-3514440x135 (phone)
703-466-3380 (fax)
sarah.m.taylor@lmco.com

How Much Information is Enough?

Abstract

Today, information overload is a recognized problem. But the strategies people have developed for dealing with it are often focused on simply eliminating material from consideration rather than optimally using as much material as necessary for analysis. Information overload contributes to cognitive overload. These can easily obscure the question of whether sufficient information has been collected to understand an issue or achieve reliable situational awareness. The paper discusses and illustrates some common strategies for dealing with information overload and their pitfalls. It proposes some alternative strategies that can be used; however, most require better support from search and analysis tools than is readily available today. Some areas for additional research and development are noted.

Introduction

Decision-making in military command and control is based on situational awareness, drawing on an intelligence process that gathers data and information from many sources: from human observers and participants to every other kind of INT. Some of this data and information is clearly specific to the situation at hand: it is word of mouth from people on the spot, or data from sensors specifically deployed to support the operation. But beyond that information, there is additional relevant information “out there”, in both open source and classified systems, that is far more diffuse and difficult to locate. Dealing with this extended realm of information, especially on top of the first, more controlled set, can quickly lead to information overload. And yet some of this additional information can mean the difference between a strong decision and a disastrous one.¹

Today, information overload is widely recognized as a significant problem. Much information technology development is focused on resolving it, looking to facilitate human problem solving with a wide variety of automated assistants and smart, more precise search and mining capabilities.² However, this is not just a technology problem. There is a human side to it that also needs to be addressed. The human dimension is not simply that humans need to learn how to use their automated tools better; it is not simply a matter of building automated processes that are easier to use, although these are both important. People need to understand large volumes of information better, and have stronger strategies for dealing with them.

People develop strategies for dealing with information overload that may or may not be effective. Most of these involve heuristics developed over time, and dependent on the personalities and experiences of the person, for ignoring or throwing out data and information, until a manageable volume of data is reached.³ In the case of military command and control, it is imperative that we understand clearly what these strategies are, learn which strategies are more effective, and develop ways to support human thinking so that more and more information can be incorporated effectively into situational assessments. This is critical today, when our tools for handling information remain somewhat crude. It is critical for tomorrow, because information and data

volumes will have increased even more, and situations themselves are likely to be even more complex and fast-changing, as our adversaries increase their capabilities.

Defining the Problem

Information overload can be viewed in two ways:

- Given the pool of information that is available on most topics, there is more material than any one person could be expected to absorb and understand within the time span of many information tasks;
- Given the pool of information available, it is impossible for a person or even a reasonably sized team of people to find within it all the key elements of information necessary to their task.

These views reflect two different ways in which information may be used. In the first instance (Figure 1), information overload is viewed as a problem for understanding, synthesis and fusion. Relevant information must be consolidated into a single coherent understanding, such as achieving situational awareness as the basis for decision-making. Even if the fusion task is divided into segments, and attacked by a team, there may still be too much information available for any single person to completely absorb and confidently say that he has reviewed and understood all the available information relevant to his portion of the task.

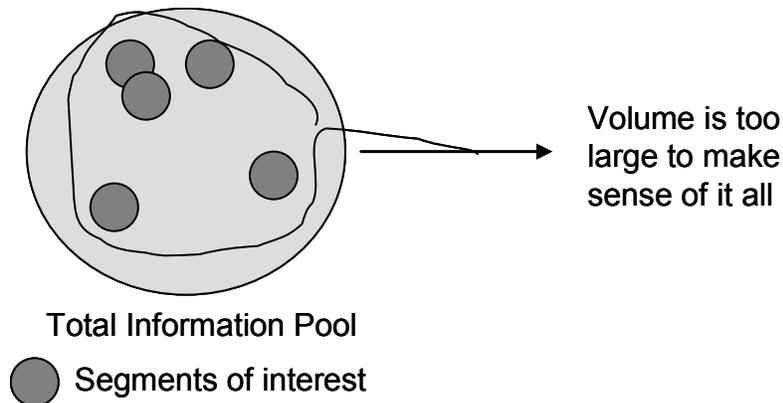


Figure 1

This is the issue represented by the query to Google, for example, “Abu Musab al-Zarqawi”, which returns 326,000 hits. Even if the searcher restricts himself to the first 520 hits that Google will let him easily see, it would take him several days to simply skim them all, let alone determine how the different items of information in the documents he found fit together into a coherent picture.

In the second instance (Figure 2), the problem is considered to be a finding, location or discovery problem. The “connect the dots” issue is such a discovery problem. Of the millions of fine-grained, unknown, pieces of information within a huge information pool, which are significant? Even if discoverable as individual items, their importance may only become apparent if their significant connections are also discovered. But there is simply too much data. Theoretically, even if the task of reviewing the information pool

could be divided up among a large number of analysts, the key connections are likely never to be discovered, because the critical end-points would lie in different sub-pools of data, being reviewed by different people, or even different organizations. And there is no way to frame a query for most systems today to retrieve unusual or significant unknowns, or even to meaningfully subset the data in order to bound a manual search. This is an “I’ll know it when I see it” problem, with no way to be sure you’ll ever “see it.”

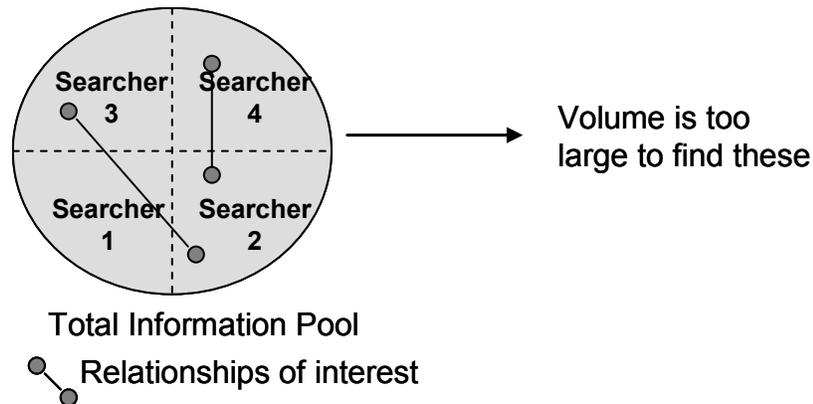


Figure 2

Huge volumes of readily available information cause overload problems in both these aspects of information use. The large volume of information is also a contributor to cognitive overload in information processing tasks. Then, confronted with overlapping information and cognitive overloads, analysts can use strategies that are often at odds with the strategies they should be pursuing to insure information sufficiency. Since information sufficiency is not easily defined, and is difficult to measure, analysts are left to pursue these instinctive, but potentially inadequate, even dangerous strategies.

Information and Cognitive Overload

Information overload and cognitive overload are related. Cognitive overload refers to situations where the task, or a series of tasks, is too complex for the person or persons involved. There are simply too many new decisions that have to be made or issues that have to be resolved within a short period of time, for a person to handle.⁴ Information overload is the situation where there is too much information to absorb and make sense of it. But in fact, absorbing information and making sense of it is a significant cognitive task.⁵ As a researcher works her way through a large pile of material, each new document must be skimmed or more thoroughly understood, and judged for its significance to the topic at hand. Within each document, every information item must be assessed for its likely reliability and for its impact on the model of the situation/ problem that she is addressing. Does this support the current model? Does it support an alternative model that is being considered, and if so, does it raise or lower the likelihood that that is the model that should be current? Does it suggest some other possible model that has not really been defined yet? These speculations and decisions about significance, carried out minute after minute over long periods of time, can be mentally exhausting,

even for someone highly familiar with the information space and the type of situation being addressed.

Information Sufficiency

What is the sufficiency of information to address any particular problem? This question has to be addressed in any consideration of information overload. First, information overload must be tackled without jeopardizing information sufficiency. Clearly, if overload strategies lead to insufficient information, they are impractical. Second, if we understood what constituted information sufficiency, this might help address the information overload issue, particularly for the first type of problem – the fusion, synthesis, situational awareness problem, although it can never be a complete solution to overload (Figure 3):

- Sufficient information may not exist, even in an unmanageably large information pool;
- Sufficient information may still be too large a pool for one person to handle.

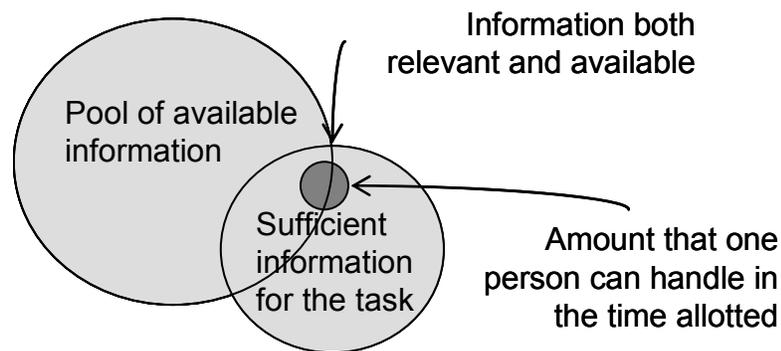


Figure 3

Still, for many problems the pool of sufficient information is enough smaller than the pool of available information, that if it can be accurately identified, the information understanding task becomes manageable.

Scope of Discussion

The remainder of this paper addresses the two questions of information sufficiency:

- What information is required?
- How can it be determined that it has been acquired?

The discussion focuses on the information captured in text, and particularly on open source information. Today⁶, text based information appears to be our least manageable kind of high volume information, and the type of information frequently meant when the phrase “information overload” is used. Additionally, open source provides ample unclassified examples. However, open source is a good example for another reason. It is a source of information over which the decision-maker has no control, and thus poses some of the more difficult problems for understanding its reliability and the completeness of its coverage. Neither the decision-maker nor the analyst can select the subjects that

will be covered by open source writers, or define the ways in which they will cover them (Figure 4). This contrasts to collection established for a particular purpose, over which they have some greater control, and which therefore has a far higher probability of relevance.

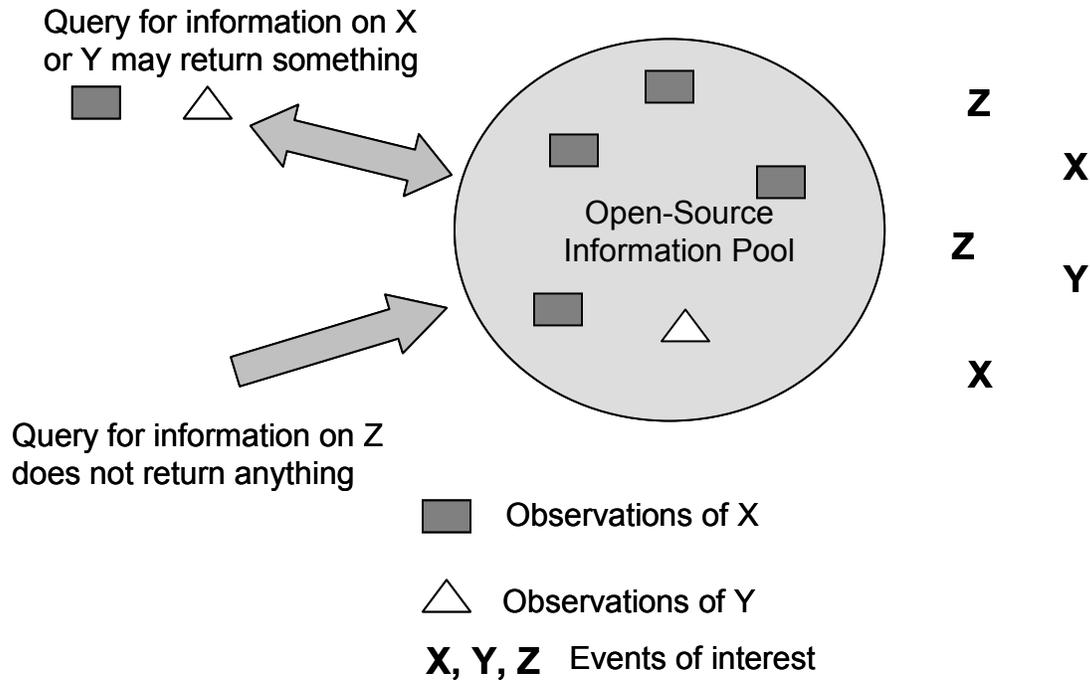


Figure 4

Finally, although I refer frequently to the decision-maker or researcher in the singular, and only rarely mention staffs and teams, clearly the people actually reviewing and assessing detailed information will be staffs and analysis teams supporting and advising decision-makers. Collectively, they are responsible for making determinations of what information is required and whether it has been collected.

What information is required?

This is a difficult if not impossible question to answer definitively for many problems. As a researcher explores any issue, frequently the information she thinks she needs only raises more questions than it resolves. In dynamic situations, the information requirements also can change more rapidly than information can be acquired. But still, she has to start somewhere.⁷

First, the information a decision-maker believes is necessary is highly dependent upon what information she believes exists and can be obtained. This can shape her whole approach to a problem. Think simply of advances in medical knowledge and testing and how that has changed the way both patients and doctors assess what information is necessary before treatment can be determined. Bones were set in the past without X-rays, but that must be a rare occurrence in this country today. Similarly, if precision weapons

are to be used effectively, they have specific information requirements, for which technology exists. Up-to-date, targeted information on public opinion on a myriad of issues did not become a requirement of political campaigns and legislation until it could be acquired.

Second, the decision-maker is guided by his experience and training. Learning the sources of information appropriate for various topics is a major part of schooling. For the Recognition Primed Decision-maker,⁸ part of what he brings to the table is an understanding of the sources of information that were valuable in a previous situation and what information he had then that proved useful and what he, in retrospect, wished he had had. This is the logic behind an information portal; a decision-maker learns from experience what information is valuable to whatever pursuit she is involved with and then can tailor her portal to reflect that information in the format she wants. OLAP tools are an extension of the same concept. The close integration to multiple data bases with live updates on the human interface, and the attractive graphics, are a way to keep at her finger tips a set of information found useful through experience.

Assuming that a decision-maker has been well taught and is reasonably experienced, these two methods for determining what information is required are adequate in two circumstances: a) when the problem or situation being investigated is well understood and has been correctly recognized as being similar to one previously experienced; and b) when the possible sources of information have not changed since the last time a like situation was investigated. Today, given the rapidly changing national security environment and the rapidly changing information environment, neither of these circumstances is likely to hold for very long. The above two methods for determining what information is necessary are thus often going to be inadequate. They can supply a base of information from which to start investigating a situation, but are unlikely to supply the total of the information needed to address any particular situation.

To expand his view of what information is needed from what he has experienced in the past, a decision-maker can use a number of strategies:

- Do an extremely broad based survey of what information is available, and examine as much of this material as possible for new types of useful information;
- Start with a mental exercise to define the problem as completely as possible, breaking it into its constituent parts, at a fine-grained level, and trying to determine what information he would like to have for each part, and then determining if such information is actually available;
- Look for analogous problems or situations, outside his field of endeavor, and learn how those fields define and resolve their information needs, to see if these offer any leads;
- Follow the leads, the links, questions, and openings provided by the information he already has.

Given enough time and resources any of these strategies will lead to a broadened view of the information required to understand a situation. None is infallible, even theoretically, let alone in practice. All are limited by the searcher, and his conceptions of how the

situation or problem is structured, and about how it should be addressed.⁹ All are also, in reality, limited by the time and resources which can be applied. Problems and situations are frequently too complex and the available information too voluminous to use these strategies exhaustively. We are always left with an approximation – the decision-maker’s best estimate of what information is necessary for her decision.

Understandably, when faced with information overload, the strategies that people use to determine what information they need are strategies of reduction, but these may ignore information sufficiency or may heavily skew the information so the situational awareness itself is skewed.

- Information is categorized by source, and sources deemed to be likely of low yield are put on the back-burner, often in the crush of events to be ignored. Determination of probable low-yield could be on the basis of:
 - Previous experience with an apparently similar source, found to be of low yield
 - Sampling – some of the information is skimmed and found uninteresting
 - Unfamiliarity with this type of source
 - It contains no information about known issues (such as known bad-guys)
- Information is put aside because it is too difficult to exploit:
 - May not be readily accessible via digital means
 - May be in a foreign language, encrypted or in a digital format that is not understood, or some form (e.g. unknown signal) that is not even recognized as potentially significant
 - May be believed to be unreliable, so the vetting and thought required to figure out what in it is useful would be too time consuming or perhaps impossible
- Information is put aside because it does not conform to the current model; the fact that it might suggest a different model is ignored.¹⁰

None of these strategies is ideal, even if they are often, in a practical situation, unavoidable. If time is short, information tasks must be prioritized. However, even in the short term, the bias inherent in some of these strategies could be mitigated against. Work, when not in crisis mode, to address new sources, learn their reliability, identify and work with their new formats and languages is all necessary. Both before and after the advent of the World Wide Web, this is a function of FBIS, for example. Additionally, it is important for decision-makers to understand the sources that are being ignored well enough to have some estimate of what they may be missing.

Discarding a source as low-yield is particularly dangerous today, because of the “connect the dots” problem. While useful items of information may be few and far between in an information source, it can still contain links to other information items, in that or different sets, which together make it of significance. Additionally, a source may be assumed to be of low-yield because it has been so in the past or because it is unfamiliar. Use of the World Wide Web for intelligence analysis has perhaps suffered from this problem. Immediate access to foreign newspapers and other publications is obviously a major benefit, and an obvious extension of open source collection in the past. But what about

websites sponsored by groups or individuals of totally unknown origin and funding? And what to do with the often incoherent ramblings of newsgroups, the ignorant ranting of many bloggers, the large amount of material without dates or identified authors, and the endless repetition? In the press of circumstance it can be easy to dismiss these as of low to no value.

Sampling new information to determine its import is risky, unless it can be done systematically. But we don't know what constitutes a reliable sample of a set of documents, for example, in relationship to their information content. Would one need to look at 10%, 20%, 30% of a set of documents to know if they were worth exploiting thoroughly? We have no idea. How to survey documents can depend upon the way the material has been organized initially and for what purpose. Were boxes of captured material packed in the order in which the material was found, packed by media type, packed to distribute the weight evenly, or by some other method? Whatever the case, it is unlikely that opening one or two boxes will give a good sense of what lies in all of them. Even more critically, how well does the analyst understand the effects of the ranking algorithm of the search tools she is using? Google, for example, has been tuned with increasing success to eliminate spam and place material of greater reliability and substance at the top of its return lists.¹¹ These are no doubt useful criteria for the majority of Google users, but the result, on a topic with extensive coverage, is often page after page of blandly similar references. It is easy to get the impression that that is all there is.

Looking only for information that supports a working model or hypothesis is, of course, the ultimate blinder, if also a very efficient way of reducing the information and cognitive overload problem: an information worker targets the information he needs to support his hypothesis, and unless there is no evidence to find, or so little evidence that it is really difficult to find, he can find what he is looking for. And it will be information that he already understands – always easier than finding what is not well understood – and can absorb quickly because its place in the scheme of his situational model is already known. This problem can be made more insidious, because an RPD decision-maker may misrecognize his situation, that is call up a past situation as his basis for action which has similarities to the present, but whose key elements may be different (Figure 5).

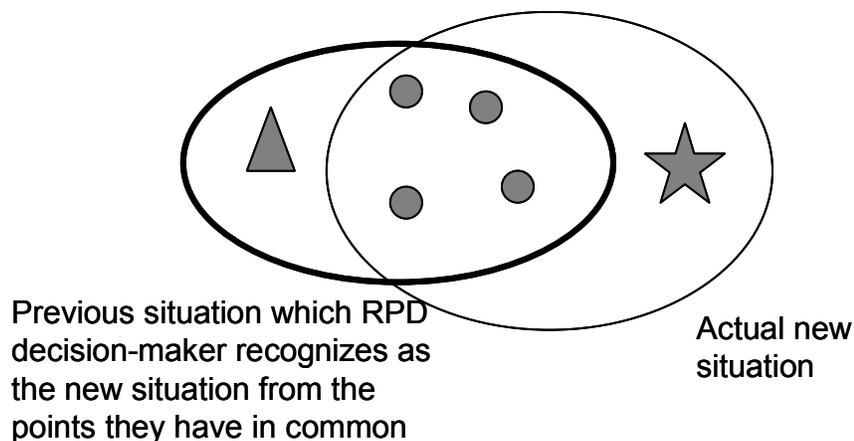


Figure 5

This can be an honest mistake, or be complicated by emotional underpinnings. The data points he looks for or recognizes as significant can be data points which represent a model from the past which was successful or otherwise significant to him. These items, while existent, may not fairly represent the current situation. This is an example of “to a hammer, everything looks like a nail.” A person will see, or recognize, the situations he believes he knows how to resolve, whether the picture is accurate or not. Whatever the cause, since the recognized situation helps guide the search for further situational awareness, that search can be significantly skewed, and corrective information may not be discovered.

How will I know when I have it?

If the decision-maker has in her mind a sufficiently realistic picture of the information she needs to make her decisions, how does she then know when she has actually collected all this information? Given the uncertainties of defining what information is necessary for any particular decision, this question quickly resolves to a practical issue. When can the decision-maker, or her staff, stop looking for more information? Or, put even more realistically, how does she know, when she must make a decision based on insufficient information, what is the extent of the insufficiency? This sense of the degree of insufficiency of the information will be one guide of her estimate of risk for whatever options she may be considering, and thus will influence decisions to perhaps keep multiple options open and to help in her determination of what information to continue to monitor as a situation unfolds.¹²

First, as with determining what information is required, a decision-maker will estimate the sufficiency/insufficiency of his information at least partly based on past experience and training. If he has an estimate in his head of the information he believes necessary for a decision, and a good picture of the information that he currently has, the delta gives him an estimate of the insufficiency of his information. In other words, a decision-maker’s situational awareness includes within it an information situational awareness. Careful investigation of past actions, and the reasons for their failure or success, and how these outcomes relate to the information that was used to make decisions in planning and carrying out the action, build this kind of personal and institutional knowledge concerning the extent and impacts of the insufficiency of information. The pitfalls are the same as for other types of post-mortems: causes and effects can be misconstrued, and it can be hard to see the possible significance of information failures, if the action as a whole has been successful. Additionally, basing sufficiency/insufficiency judgments on past experience will be most effective in situations with a number of precedents. It has the potential to breakdown as the situation diverges from those that are known to the actors.

Some more objective ways to determine what proportion of the information has been gathered include:

- If information requirements are specified at a detailed level– as particular queries to particular data sources – then, the percentage of known sources which have been queried can be tracked. The conclusiveness of the results also should be

tracked. Did the query produce a satisfactory answer, or raise more issues and sources for investigation? How many of those second tier issues have been resolved?

- Queries can be tested for thoroughness on the system being used. Identical queries will not necessarily behave the same way on different systems. One test is to use a fairly broad query describing the area of interest, pick a test document from the returns and select some specific terms of interest from this document. Use these terms as a second query and determine if the test document is retrieved again as it should be, and also if the new set of documents looks substantially different from the original retrieval. If the test document is not retrieved a second time, someone can work with the system to determine the issue, so queries can be better constructed for that system (or a possible bug may have been found). If the second retrieval looks substantially different from the first, then for that system and those sets of documents the second query may not produce a subset of the first (as one might expect), and so a general query is unlikely to be sufficient to retrieve the complete set of documents needed.
- If multiple, differently constructed queries, of both a general and specific nature (all within the same area of interest) produce similar information, then the material has probably been thoroughly covered by the querying.
- Obscure pieces of data can be used to test the coverage of a system and databases. Highly specific and unambiguous queries for items that should be in the database and others that are likely outside the scope of the database can be useful for determining database coverage.

However, given information overload, the greatest problem is that it is easy to believe that a lot of information means that there is sufficient information. The instinctive reaction to very large data returns seems to be that they either tell all it is necessary to know, or they tell all there is to know. It is only when the requirements for information are broken down into specific items to meet specific needs that an estimate of completeness can be made with some objectivity.

Second, any determination of the sufficiency of information must also encompass an estimate of the validity or reliability of the information. For information provided by human sources, whether open source or HUMINT, estimating a level of reliability is difficult and requires extensive experience with the source. Additionally, it is difficult to capture reliability in ways that are meaningful, using either numerical or verbal descriptors.

To a large extent, measures of quality of information are like other characteristics of a situation, something that actors learn from experience to test and recognize. They are an important part of the tacit knowledge that any decision-maker builds over her career, in order to make increasingly successful decisions. As such, any of these either intuitive or explicit measures of quality are subject to the same problems that affect other aspects of decision-making: the tendency to simplify, especially under pressure, and jump to conclusions based on poorly chosen criteria.

This problem has become significantly more difficult in recent years because the amounts of data and information have become so enormous. There are many possible sources of information and each has its own patterns of inaccuracies. One writer may be subject to censorship; another may be out of his normal beat and inaccurate; yet another has great inside sources, but a strong political slant. Editors in their eagerness for a coherent story line can edit out important details. The volumes of information available make it impossible for each piece to be individually checked by the researcher, but that is the type of validation currently available for text based information.

The quality of information is difficult to judge. Key criteria:

- Are multiple information items that appear to be confirming each other really all coming from the same source? For example, the first 20 hits of a recent Google query cited material from 19 different sites of apparently mixed types; however, in actuality, of these 19, 18 used one of two similar AP news stories. The exception used a Reuters story. Two of the 18 cited one additional source besides AP.¹³
- How many hands has it passed through from its point of origin? How does the source claim to know what she says she knows? For example, a specialty news site, found in the previous example, presents a short summary of the BBC coverage (duly cited) of a video shown on al Iraqiya TV.¹⁴ The full BBC story, in turn, cites AP and Reuters reports, but the BBC reporter appears to have no independent knowledge of the original broadcast.¹⁵ The AP and Reuters stories both contain details that imply the reporters had viewed the video themselves, but this is not specifically stated, nor is any credit given to translators, if these were used. The Reuters story contains more of such details. Both the AP and Reuters stories include the information that the contents of the video could not be independently verified, and that the station on which it was aired is US supported.¹⁶ However, it remains unclear exactly who viewed and translated the Arabic video, or what was done to try to track down information about who exactly had made the video and when, or the people interviewed.
- What are the capabilities, biases, and history of the original source and of each of the relay points? For example, in the material just cited, while BBC carries forward, from both Reuters and AP, the information that the details of the video could not be confirmed, that the TV station was US supported, and that the video came at a time when US pressure on Syria was mounting, this qualifying information was dropped in the specialty news site summary. Another news site added material to the Reuters headline to emphasize the possible propaganda nature of the video, but added no material to support this implication.¹⁷
- Are there alternative viewpoints and interpretations? This may require imagining what might be there, and looking for it. Clearly, on many topics foreign websites are a useful source of alternative viewpoints. Al-Jazeera, for example, does not appear (on its English site) to have reported the story of the video confessions at all.¹⁸ Interestingly, a fairly extensive search for alternative views on these video confessions turned up no substantive discussion or investigation of the authenticity of the videos. Many foreign news sources appear to have ignored the story.¹⁹

- What is the internal consistency of the information package; inconsistency may call into question the reliability of the whole, suggesting the possibility of mistranslation of original materials, incomplete or unclear reporting, or bias. A recent report, from a self-proclaimed “activist” site, on February 21 terrorist killings in Colombia’s Antioquia province is internally inconsistent about the number of people killed and timings of the killings. It combines material from two different sources, inconsistent on the number of victims and what bodies were recovered.²⁰
- What is the consistency with other related material about the situation, with common sense, and across different sources? Material from AP on the same February 21 incident is inconsistent with this material. The “activist” site says villagers blamed the Colombian Army’s 11th Brigade; the AP source says the accusation is against the Army’s 17th Brigade. The “activist” material implies the victims were shot and then mutilated. The AP report has them “hacked to death with machetes”. Material from another human rights site presents a much more consistent version of the event, with names, ages, and other apparently realistic circumstantial details. The accusation in this case is against the 11th Brigade.²¹

Answers to these inquiries can rarely be definitive, but collectively they provide a measure of reliability. Unfortunately, under time pressure, only critical pieces of information can likely be checked with thoroughness. Thus it is necessary for the decision-maker to know what is critical and needs to be checked, and to mandate on-going activities to keep up-to-date on the reliability of important information sources.

Role of Technology

There is a role for technology to play in addressing these issues of determining the completeness and quality of information. Unfortunately, today, information systems provide very limited support, and only if the researcher using the system thoroughly understands the inner workings of the tools. Automated techniques and methods already exist which could be usefully applied to these problems, but this has not yet happened with any widespread regularity. In part, this is because the technology and the information overload are still relatively new phenomena. But in part, the people who understand the information space of intelligence are a distinctively different set of people than those who understand the computer technology necessary to navigate it, having dramatically different experiences with using data and information.

Several areas of needed technology development are suggested by this discussion:

- Techniques to systematically sample documents and information
- Techniques to automatically determine conflicting and inconsistent information and viewpoints, as well as techniques to measure redundancy
- Techniques to prioritize and reprioritize document return lists according to different weighting criteria, so documents are mixed differently within the higher rankings
- Better transparency for ranking algorithms
- Techniques for tracking and displaying source reliability

Conclusion

I close with an analogy: the driver of an automobile on the highway is constantly collecting specific data largely visually, but also through touch and sound. He monitors the state of his car – does the engine sound right, are there any funny vibrations, does the steering feel right, are there weird rattles or squeaks, do the instruments read as they should. He monitors the road and traffic conditions, intensively on the road ahead, but also to the side and rear, and possibly even the oncoming traffic to the other side of the middle divide. He fuses this in his mind into a situational awareness: car operating correctly, road dry, traffic up ahead moving slowly, truck coming up a little too fast on my left rear, and so forth. This is what he has been taught to do and learned from past experience is important. It is the equivalent of a known set of information requirements for a known situation. It is unlikely that he consciously thinks to inspect or collect data about additional phenomena around him. But his companion sitting beside him, less focused on the driving task, could suddenly notice “Oh, look, the two people in the car up there are fighting”. It might have no impact, but it might save their lives, as the driver has micro-seconds of warning, and when the car in question starts to veer out of control, he registers the information immediately, knows what is happening, knows there is space on the right to move over, and avoids the accident. This is the information that we don’t want to miss – critical in its effect once in a while, but most often irrelevant, and rarely part of the predefined information requirement because it is unpredictable.

Our information systems and strategies have to focus on getting the first part of this situational awareness correct – know what we absolutely need to know, know our sources and their reliability, and keeping collection up to date. But these systems and strategies also have to be open to the second type of information – we should be sure we are not locking it out of our view, we should in fact troll for it regularly, have a view of the places where it might be found, and have rapid techniques for judging its potential significance and reliability, if something tells us that it could be critical.

¹ David S. Alberts, John J. Garstka, Richard E. Hayes, David A. Signori, *Understanding Information Age Warfare*, CCRP, August 2001, especially pp. 54-56. Another view on information advantage is presented in Jan Kuylentierna, Joacim Rydmark, Tonie Fahraeus, “The Value of Information in War: Some Experimental Findings,” 5th ICCRTS, Canberra, 2000.

² Dennis K. Leedom, “Functional Analysis of the Next Generation Common Operating Picture,” 8th ICCRTS, Washington, DC, 2003; p. 3.

³ Janet Sutton, Keryl A. Cosenzo, Linda G. Pierce, “Influence of Culture and Personality on Determinants of Cognitive Processes Under Conditions of Uncertainty,” 9th ICCRTS, Copenhagen, 2004; Introduction.

⁴ Rosemarie Reynolds, Michael Brannick, University of South Florida, “Thinking About Work/Thinking at Work: Cognitive Task Analysis,” presented at 17th Annual Conference of the Society for Industrial and Organizational Psychology, Toronto, April 2002. Page 4-5 provides a description of cognitive overload which applies extremely well to the task of dealing with too much information.

⁵ Susan G. Hutchins, Peter L. Pirolli, Stuart K. Card, “A New Perspective on Use of the Critical Decision Method with Intelligence Analysts”, 9th ICCRTS, Copenhagen, 2004. This study describes the cognitive

processes of an Intelligence Analyst; many of these tasks are related to searching for and sifting information.

⁶ This will change as the number and kinds of collectors grow and as issues with text-handling are resolved.

⁷ James P. Kahan, D. Robert Worley, Cathleen Stasz, *Understanding Commander's Information Needs*, RAND, Arroyo Center, 1989; p. 3.

⁸ Gary Klein, David Klingler, "Naturalistic Decision Making," Human Systems IAC Gateway, Volume XI: Number 3. Describes Recognition Primed Decision-making in a context of fire-fighting.

⁹ Mark Burnett, Pete Wooding, Paul Prekop, "Sense Making – Underpinning Concepts and Relation to Military Decision-making", 9th ICCRTS, Copenhagen, 2004; p. 7.

¹⁰ Richards J. Heuer, Jr., *Psychology of Intelligence Analysis*, Center for the Study of Intelligence, 1999, discusses this problem as an instance of bias; but it is a bias which becomes a coping strategy with cognitive and information overload.

¹¹ <http://www.google.com/technology/> and

http://sharpnet.typepad.com/search_engine_optimizatio/2004/09/another_major_g.html

¹² John Buchanan, Ned Kock, "Information Overload: A Decision Making Perspective," presented at MCDM2000, Ankara, July 2000. This paper is based on self reporting about information use in overload situations; the article includes recognition of information sufficiency as part of an RPD decision-maker's recognition of the situation he is in.

¹³ The query used was 'Syria Iraq insurgents video confession' to find information about the video confession of a Syrian intelligence officer that was broadcast on Iraqi TV late in February, stating that the Syrian government was supporting training of people to destabilize Iraq. The sources listed in the top twenty were an apparent variety: ABC, MSNBC, several news groups, commentators from the left and the right, and a number of city newspapers.

¹⁴ ShortNews.com, February 23, 2005, 10:26PM; ID46305; "Alleged Iraqi Insurgents Make TV Confession Regarding Syrian Backing".

¹⁵ BBC News, UK edition; February 23, 2005, 20:48 GMT, World. "Iraq 'rebels' claim Syria backing".

¹⁶ Reuters.com; Wednesday February 23, 2005. "Iraq Hits Syria with State TV Video 'Confessions'". ABC 7 News, Wednesday February 23, 2005, "Iraqi TV Airs Tape of Purported Confession," Baghdad, Iraq (AP). Many versions of the AP story were readily available. The Reuters story appears to have only one version available in the material Etaiwannews.com, 2005/02/25, aside from the Reuters archive.

¹⁷ ShortNews.com, February 23, 2005. Etaiwannews.com, 2005/02/25, changed the Reuters headline to read "Iraq hits Syria with video 'confessions': Some Iraqis doubt authenticity of claim." [Added words are underlined.]

¹⁸ On the other hand, two other stories on Al-Jazeera, English, in February (a report on the Amnesty International report concerning the conditions for women in Iraq today, and a report on Pakistani warnings to the US about the risks of selling Patriot missiles to India) follow the Western press (BBC, Washington Post) closely, while (predictably?) omitting a few details that temper the tone of the stories.

¹⁹ The Khaleej Times and the Gulf News, both from Dubai, in English, carried a short version of the Reuters story. Le Monde (France), Hindustan Times (India), The Dawn (Pakistan), Kurdish Media News (Iraq), Syria Times (Teshreen.com) all appear to have ignored the story. Rory Carroll, a reporter for The Manchester Guardian, posted a story from Baghdad with a few additional details, beyond what was available in Reuters and AP. I used three methods to find these additional viewpoints: (1) Searching news sources already known, which might contain alternative views (Le Monde, Hindustan Times, The Dawn); (2) Guessing the possible names of news sources (Syria Times), submitting as a query to Google, and searching the resulting site; (3) Taking the list of person names from the Reuters.com article cited above (Adam Omar, Mohammed al-Tae, Anis, Ahmed Abdel Jabbar; and the place name Latakia, where they were apparently trained), and using each of these in turn as an exact phrase, plus the terms Mosul, or video, and submitting these as additional queries. (The terms Mosul and video were used to specify the incident, as several of these are common personal names),

²⁰ UK Indymedia, "Seven in Peace Community Massacred by Colombian Army," February 27, 2005.

²¹ Associated Press, "Colombia Massacre Raises Rights Issues", March 4, 2005; Colombia Support Network, posted on Global Exchange.