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VALIDATION WORKSHOP OF THE DRDC CONCEPT MAP KNOWLEDGE MODEL: ISSUES IN INTELLIGENCE ANALYSIS

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ABSTRACT

The Thinking, Risk, and Intelligence Group (TRIG), one of three groups of the Adversarial Intent Section at Defence Research and Development Canada (DRDC) Toronto, is unique in Canada given its objective "to support Canada's defence and security community through applied behavioural science aimed at promoting human effectiveness in risk management and intelligence production". The Group Leader of TRIG, Dr. David Mandel, is leading an Applied Research Project (ARP) entitled "Understanding and augmenting human capabilities for intelligence production". Under the auspices of this ARP, the TRIG at DRDC Toronto held a discovery workshop on 5 February, 2010 to explore and discuss the utility of concept map knowledge modelling within the Canadian intelligence analysis community. Several government organizations participated in a half-day workshop that included two sets of interactive, group-oriented, break-out sessions in which teams engaged in discussion activities to address several objectives related to a concept map knowledge model and concept mapping (CMapping) in general. Participants derived several conclusions relating to the organization, design and the potential application of CMapping, in addition to several implementation issues and suggestions for the improvements. This report summarises the impressions of participants pertaining to the concept map tool and process, and key points and outcomes from the workshop.

RÉSUMÉ

French abstract not available.

EXECUTIVE SUMMARY

The Thinking, Risk, and Intelligence Group (TRIG), one of three groups of the Adversarial Intent Section at Defence Research and Development Canada (DRDC) Toronto, is unique in Canada given its objective "To support Canada's defence and security community through applied behavioural science aimed at promoting human effectiveness in risk management and intelligence production". The Group Leader of TRIG, Dr. David Mandel, is leading an Applied Research Project (ARP) entitled "Understanding and augmenting human capabilities for intelligence production". Under the auspices of this ARP, the TRIG at DRDC Toronto held a discovery workshop on 5 February, 2010 to explore and discuss the utility of concept map (CMap) knowledge modelling within the Canadian intelligence analysis community.

Several government organizations participated in a half-day workshop that included two sets of interactive, group-oriented, break-out sessions in which teams engaged in discussion activities to address several objectives related to a CMap knowledge model and concept mapping (CMapping) in general. The workshop's format balanced formal activities with open discussion-based interaction and drew on intelligence analysis expertise. The workshop produced thought-provoking and insightful observations on factors involved in CMapping for the intelligence community in Canada.

Two broad conclusions were shared by the participants at this discovery workshop. Firstly, CMapping has potential utility for organizing analytic thought and structuring the thinking process, and it is useful as an imaginative or visual tool to "see the bigger picture" and explore a topic in depth. As a visual representation of an analysis, a CMap can be used to validate arguments by identifying any gaps in the argument and to communicate ideas and foster discussion about particular topics. Secondly, CMapping was determined to be a difficult process that takes time to learn and may not be amenable to quick tactical problem analysis. In addition, while there are many benefits of using CMaps and executing a CMapping process, this may be of primary benefit to people who are visual thinkers. CMapping may therefore not be a practical process to implement. Participants derived several conclusions relating to the organization, design and the potential application of CMapping, in addition to several implementation issues and suggestions for improvements.

This report summarises the impressions of participants pertaining to the CMap tool and process, and key points and outcomes from the workshop. The third section, Summary of workshop break-out group sessions, describes the process and outcomes of the interactive break-out sessions, including the potential uses, benefits and drawbacks of CMapping. The fourth section, Discussion of workshop results, provides a more detailed discussion of topics related to CMapping including the potential application of CMapping, implementation issues of CMapping and suggestions for improvements.

SOMMAIRE

French executive summary not available.

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ACKNOWLEDGEMENTS

CAE Professional Services would like to acknowledge Dr. David Mandel and Dr. Natalia Derbentseva for their contribution to this report. They provided useful and professional advice.

1 INTRODUCTION

This report, completed under contract for the Thinking, Risk, and Intelligence Group (TRIG), one of three groups of the Adversarial Intent Section at Defence Research and Development Canada (DRDC) Toronto, is documentation of the proceedings of a workshop entitled, "Concept Map Knowledge Model Workshop". Specifically, this report documents the feedback from the Subject Matter Experts (SMEs) in the intelligence community and the outcomes arising from break-out group sessions during the validation workshop. This report will help guide the potential application of concept mapping (CMapping) to intelligence activities, including analysis, training, communication, and resource planning.

1.1 Background

The Group Leader of TRIG, Dr. David Mandel, is leading an Applied Research Project (ARP) entitled "Understanding and augmenting human capabilities for intelligence production". This ARP is conducted for Captain (N) Barber, Director of Intelligence Capabilities at Chief of Defence Intelligence (CDI) and is funded through the Intelligence Thrust of the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Partner Group. The objective of TRIG is to support Canada's defence and security community through applied behavioural science aimed at promoting human effectiveness in risk management and intelligence production.

Under the auspices of this ARP, Dr. Mandel and Dr. Natalia Derbentseva, also from TRIG, have developed a concept map (CMap) knowledge model[1] of intelligence analysis (hereafter CMKMIA). CMapping is a knowledge-visualization and modeling technique which has been used by DRDC Toronto to visualize the domain of intelligence analysis. The CMKMIA, created in CmapTools (Novak & Cañas, 2008), consists of a collection of interlinked CMaps supplemented with links to academic literature, technical reports, and images. The interlinked CMaps address many different facets of the intelligence analysis process, including products, challenges, people, organizations, cognitive processes, training, and purposes. The purpose of CMKMIA was to demonstrate the potential applications, both as process and product, of CMapping to an audience with limited familiarity with the specific approach, and to generate their feedback on the tool and on CMKMIA itself.

1.2 CMapping Overview

CMaps are "graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts. Figure 1-1 shows an

[1] A Concept Map Knowledge Model is distinct from a Concept Map. A Concept Map is a single map, probably presented in one view, while a Knowledge Model is a set of interlinked maps. Both may contain linked document, etc. references.

example of a concept map that describes the structure of concept maps and illustrates the above characteristics" (Novak & Cañas, 2008, p. 1).

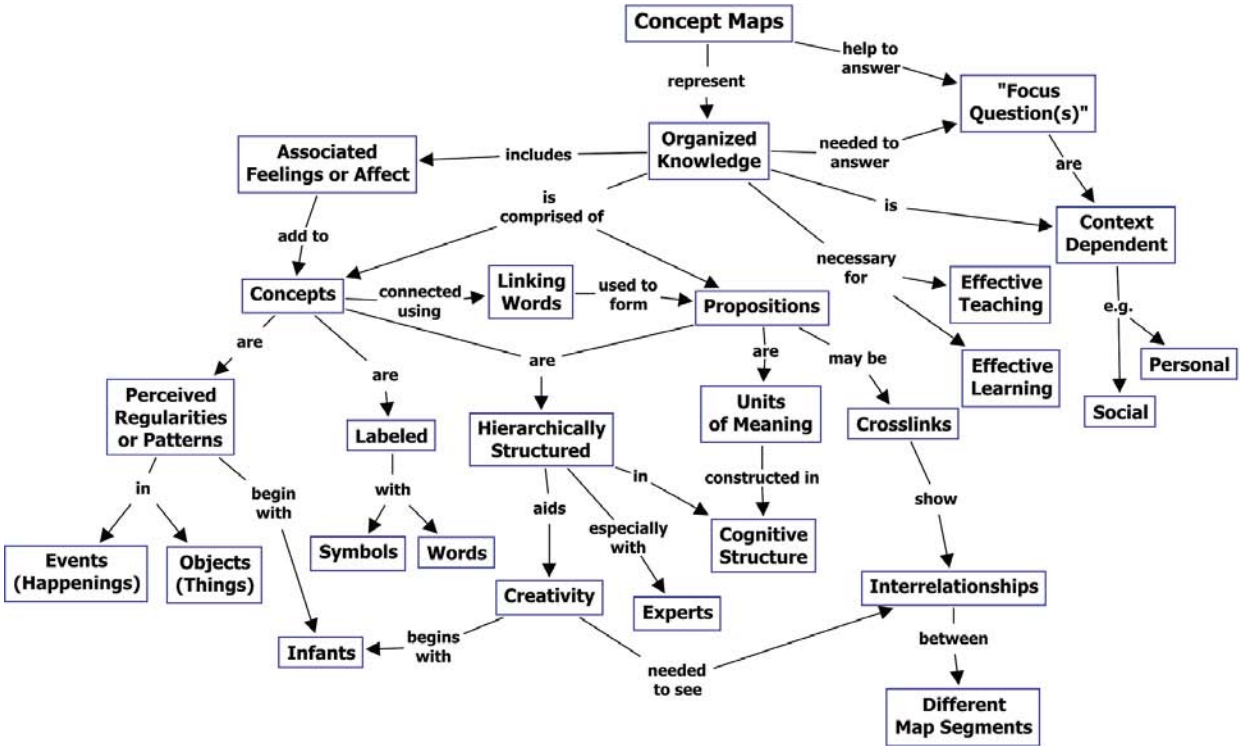

Figure 1-1: A CMap Showing the Key Features of CMaps (Novak & Cañas, 2008)

Main characteristics of CMaps are:

- *Concepts.* Novak & Cañas (2008, p.1) define a "concept as a perceived regularity in events or objects, or records of events or objects, designated by a label". A word or several words are used as a label for most concepts although symbols such as + or % are also sometimes used.
- *Propositions.* Propositions are defined by Novak & Cañas (2008, p. 1) as "statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement.
- *Hierarchical arrangement*. "Concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. Concept maps tend to be read progressing from the top downward" (Novak & Cañas, 2008, p. 1-2).
- *Cross-links.* "These are relationships or links between concepts in different segments or domains of the concept map" (Novak & Cañas, 2008, p. 2).

CMKMIA was developed based on the CMapping methodology described in Novak and Cañas (2008). The DRDC model is briefly described below.

1.3 CMap Knowledge Model of Intelligence Analysis (CMKMIA)

CMKMIA was developed as a comprehensive resource on the topic of intelligence analysis. It depicts interdependencies among various issues involved in intelligence analysis and also serves as a "knowledge hub," which provides easy access to attached academic and practitioner literature on specific topics. The model, created in CmapTools, consists of a collection of interlinked CMaps supplemented with links to academic literature, technical reports, and images. See Figure 1-2 for the top level map of the CMKMIA.

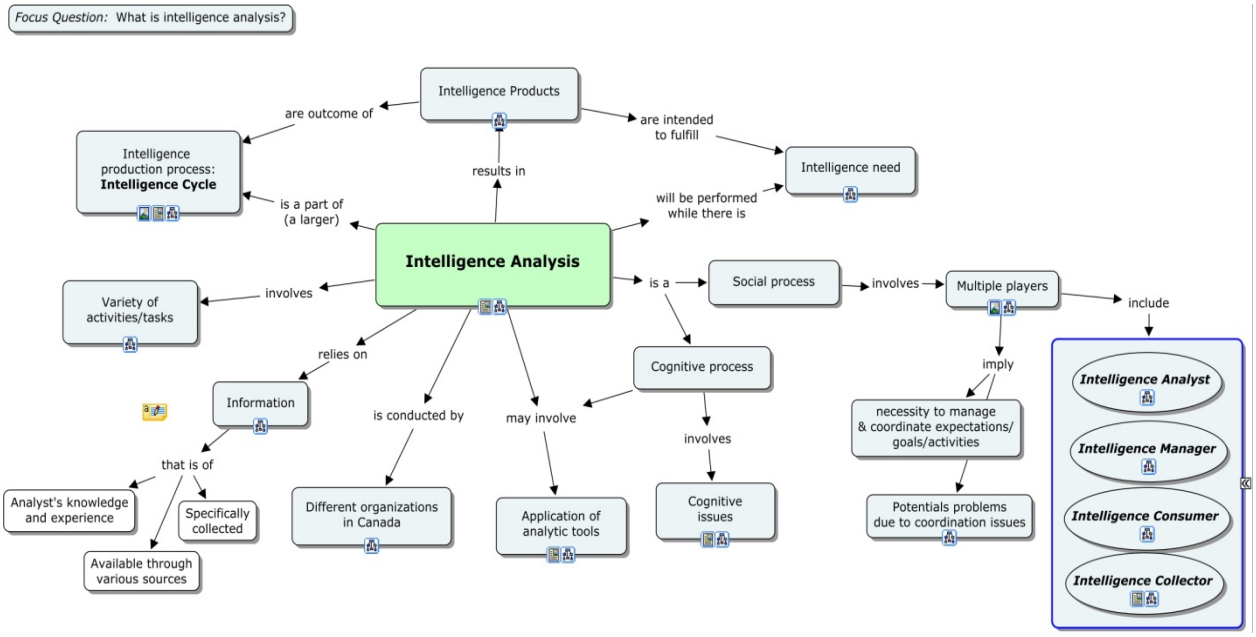

Figure 1-2: Top level map of CMKMIA

1.4 CmapTools Software Toolkit

The CmapTools software toolkit was used to create CMKMIA. The CmapTools software was developed at the Institute for Human and Machine Cognition. It has been made available for free to promote the sharing of knowledge. The software enables users to construct and modify CMaps much as one might use a word processor, and it enables users to collaborate at a distance in the construction of their maps, and to publish their CMaps on the Internet. The software also allows incorporating resources (photos, images, graphs, videos, charts, tables, texts, internet pages or other CMaps) that can be associated with concepts or linking words in a CMap. Links to these resources are displayed as icons underneath the concepts (see Figure 1-2).

CmapTools provides extensive support for collaborative work during CMap construction. The high degree of explicitness of CMaps makes them an ideal vehicle for the exchange of ideas or for the collaborative construction of new knowledge.

2 STRUCTURE OF THE WORKSHOP

This section describes the workshop participants and organizers, the agenda, and the structure of the workshop.

2.1 Introduction

To investigate the potential utility of CMap knowledge models and CMapping for intelligence analysts, DRDC Toronto hosted a half-day workshop to generate feedback from intelligence community SMEs. The feedback concerned the organization, design and the potential application of CMapping, and any implementation issues and/or suggestions for improvements. The results of the workshop will help guide potential application of CMapping to intelligence activities, as well as analyst training.

2.2 Workshop Organizers

The workshop was organized by members of TRIG from DRDC Toronto and CAE PS (see Table 2-1).

Table 2-1: Workshop Organizers

Name	Position
David Mandel	Senior Defence Scientist, Group Leader of TRIG, and Workshop Organiser, DRDC Toronto
Natalia Derbentseva	Natural Sciences and Engineering Council of Canada Visiting Fellow and Workshop Organiser, DRDC Toronto
Tab Lamoureux	Senior Consultant, CAE PS
Michelle Gauthier	Consultant, CAE PS

2.3 Participating Organizations

Ten intelligence SMEs from several government departments and one industrial partner attended the workshop (see Table 2-2).

Table 2-2: List of Participating Organizations

Organization	Organization
Campbell Intel Services Inc.	CDI

Organization	Organization
Canadian Border Services Agency (CBSA)	Library of Parliament
Canadian Forces School of Military Intelligence (CFSMI)	International Assessment Staff – Privy Council Office (IAS-PCO)

2.4 Agenda

The workshop followed the agenda presented in Table 2-3.

Table 2-3: Workshop Agenda

Time	Title
13:00 – 13:15	Registration
13:15 – 13:45	Introduction to CMapping and CMap knowledge model demonstration
13:45 – 14:40	Breakout group discussion session 1
14:40 – 14:50	Group reports
14:50 – 15:10	Break
15:10 – 16:05	Breakout group discussion session 2
16:05 – 16:15	Group reports
16:15 – 16:30	Conclusions and Wrap Up

2.5 Workshop structure

The following subsections provide details regarding the review of CMKMIA, break-out sessions, and discussion activities.

2.5.1 Introduction to CMapping and CMKMIA

The workshop began with welcoming and introductory remarks by Dr. David Mandel followed by an introduction to CMapping and an overview of CMap properties by Dr. Natalia Derbentseva. The CMKMIA was presented next to facilitate the consideration of CMapping as an effective means of organizing information and managing resources.

The utility of CMap knowledge modelling methodology for information management and education purposes, and as a venue for discussion and collaboration, was demonstrated. The potential breadth (i.e. showing the variety of topics) and depth (i.e. show the level of detail of a specific map) of the model were also considered.

2.5.2 Break-out Discussion Sessions

Two sets of interactive, group-oriented, break-out sessions were carried out. The break-out groups were organized into three concurrent 50-minute sessions in which teams pursued two discussion activities to address several objectives related to CMapping. Each group was pre-assigned two workshop participants to fill the roles of the rapporteur and facilitator. One of the workshop organizers was assigned to each of the groups as an observer and note taker. The break-out sessions provided participants with an opportunity to share their thoughts, perspectives, and reflections on CMapping, and to discuss future applications.

2.5.3 Group Assignment

Participants were assigned to one of three groups. The groups were organized to establish equal composition of operationally focused, international/domestic, training, and academic perspectives (see Table 2-4).

Table 2-4: List of Group Assignments

Group 1	Group 2	Group 3
IAS	CDI	CBSA
CDI	Campbell Intel Services Inc.	Library of Parliament
DRDC (D. Mandel)	IAS – PCO	CDI
CFSMI	*CAE PS Canada (note taker)*	CDI
CAE PS Canada (note taker)		*DRDC (note taker)*

2.5.4 Break-out Session Questions

Several activities and questions related to CMapping were addressed and discussed during the break-out sessions. The following section outlines the discussion activities and related questions addressed during the break-out sessions.

2.5.4.1 Discussion Activity #1

Objective 1

- What do you see as the potential uses of a CMap knowledge model or CMapping in general within the intelligence community?
- Prioritize the potential uses listed from 1 (most important) onward.

Objective 2

- Given your responses to Objective 1, what benefits, if a*ny,* does CMapping offer over what you or those you supervise (or have supervised) currently do?
- What drawbacks, if any, would you anticipate if CMaps were to be used?
- If possible, specify the benefits and drawbacks in relation to the potential uses you described in your answer to Objective 1.

2.5.4.1 Discussion Activity #2

Objective

- Start building a CMap to address the focus question:
  "*What is analytic integrity?*"
- First, generate a list of the most relevant concepts that would help answer the question. We suggest you list between 6-12 concepts.
- Next, start connecting the concepts with specific linking phrases to form a CMap.
- Reflect on the experience of collaborative CMap construction that you just engaged in and note any pertinent observations.
- What parts, if any, were particularly challenging and/or revealing?

2.5.5 Group Reports

Following each break-out discussion session, the main points of the discussion were presented to all workshop participants by the pre-assigned rapporteur from each group.

2.5.6 Conclusions and Wrap-up

At the end of the workshop, participants were encouraged to share their thoughts, perspectives, and reflections on CMapping, and to discuss its future applications.

3 SUMMARY OF WORKSHOP BREAK-OUT GROUP SESSIONS

This section details the results of the team discussion activities which addressed the objectives described in Section 2.5.4 and is organized by the discussion activity, the objective and the discussion results for each team.

3.1 Discussion Activity #1

3.1.1 Objective 1 – Potential Uses of CMaps

3.1.1.1 Group 1

Below is a list of potential applications that were identified and discussed by Group 1.

- Management; understanding and making adjustments to organize information (e.g. tagging info): CMapping was seen as useful for taking different types of information and tagging that information to relevant concepts that could be tracked over time.
- Collection planning; CMapping may be useful for spreading out the argument or analysis in a tree branching way rather than using a checklist. The advantage of this approach is that it allows the analyst to better match the analysis to the end requirement.
- Quality control: All participants in the group saw CMapping as a potentially effective way to validate an argument and organize corroborative evidence. The ability of a CMap to support the identification of gaps and anomalies in the argument (i.e. sanity check), or lack thereof, can help qualify the strength of an argument. It allows the analyst to represent what would normally be a paragraph in visual form which can be used to more easily verify that all the information and concepts are included in the argument. A benefit of this approach is that it can be used at a tactical level to test the logic of people's arguments which would satisfy the burden of proof that lawyers need before they give the go-ahead to further research a specific target.
- Imagination (structured analytical methodology): Some participants proposed that CMaps can be used as an "imaginative tool" for validating an argument in a graphical form.
- Collaboration tool. A benefit of CMapping is its ability to schematically lay out an argument. This allows an argument to become transparent and be shared with others. This facilitates the use of CMapping as a collaborative tool. For instance, a map could be kept on a server where people could add comments to the map and share information. A potential application of the tool would be with the IACC (Intelligence Assessment Coordination Committee) where different parts of the intelligence community could come together and collaborate and use the different parts of a CMap knowledge model as areas of discussion. As a collaboration tool, it can also be used to foster discussion among analysts. During

these discussions, there was some dissonance regarding the practical application of CMapping as a collaboration tool.

- Teaching tool: Since CMapping can be used for collaboration, it could potentially be useful as a teaching tool, and as a means of working through an argument within a group environment. This approach could teach students to use a structured approach to analysis. One participant meanwhile suggested that intelligence analyst training could be used as a test bed to validate the effectiveness of the CmapTools and the CMapping process.

Following the discussion, the group agreed on the following potential uses of CMapping which were presented during the group report:

- Management; understanding and making adjustments to organize information (e.g. tagging info);
- Collection planning;
- Quality control;
- Teaching tool;
- Imagination (structured analytical methodology); and
- Collaboration tool.

It was agreed by all participants in the group that they could not prioritize the potential uses identified because their use depends on the context in which CMapping is applied. The group did reach a consensus however, whereby quality control, an imagination tool and collaboration were likely to be equally useful.

3.1.1.2 Group 2

Below is a list of potential applications that were identified and discussed by Group 2.

- Explore a topic in depth: Because the approach relies on a systematic drill down into concepts and all potential relationships, it is possible to quickly reach a deep level of understanding about a topic very quickly.
- Structure the intelligence problem: CMapping can be used as an aid to structure the intelligence problem.
- Strategic tool to discipline the thinking process: This approach objectifies and externalizes the analytical process which can be useful for disciplining the thinking process. Participants recognized that structuring and framing the analysis is a benefit for this approach. It was noted that it takes time to create a CMap and may therefore not be appropriate for addressing certain issues that require a quick assessment of the problem scope. The benefits of CMaps must therefore be weighed against the drawbacks when evaluating the added value of using CMaps.

- Managing analysts: CMapping can help identify assumptions which can be used to manage analysts' analytical process.
- Validation mechanism: The externalization of the process increases the transparency of the results which can be used for verification purposes to assess the completeness of the analysis that is performed.
- Audit and defensibility: The representation of the process followed by the analyst, including their thinking, allows for downstream audit of the analysis to ensure the quality of the analyses performed by the intelligence organization. The clear representation of both the analysis and the thinking the analyst brought to the analysis permits the decisions made by the intelligence organization to be defended at a later date, should they be challenged by an oversight review or commission of inquiry.
- Collaboration Tool: The greater transparency of CMaps also allows individuals to query the ideas and assumptions held by others. This dialogical approach can provoke discussion which can promote a shared understanding by rendering ideas and assumptions of individuals transparent, and allowing others to query and understand them.
- Securing additional resources: The CMap can demonstrate to the consumer the breadth of analysis that has led to a conclusion. It can also help decision makers understand what resources (in terms of knowledge and experience) are involved in an analysis. This can then be used to persuasively argue for additional resources to overcome deficiencies in time or potential decreases in quality. A disadvantage of this approach is that the specific deficiencies cannot be weighted using the CmapTools.
- Visual tool: CMapping provides a visualization of the relationship between ideas which is quicker than reading lots of pages. This allows the analyst to have an overview (top down approach) of the problem scope. A graphic representation of the problem space can be useful for some decision makers who have limited time available to 'read in' to a problem and who, anecdotally, tend to share a visual approach to rapid comprehension. The ability to arrange words spatially and linking them in a visual form can provide a higher intensity stimulus that can be used for presentation purposes. This presentation can be adapted for the recipient, such as the analyst creating the map, the approver of an analysis, or the consumer.
- Training tool to accelerate learning: CMapping was seen to be a good training tool to convey a higher level of abstraction regarding a particular intelligence issue. A CMap created by an expert desk analyst may be used as a training aid for a novice analyst taking over the desk, which may accelerate his or her learning. The expert's CMap may be adapted and augmented over time. The benefit of this approach in training is that it is creative and seen to be suited for the new generation of students.

Following the discussion activity, the group listed out four potential uses of CMapping and prioritized them in descending order. These were presented to the workshop participants during the group report session.

1. Structure the intelligence problem;

2. Act as a training tool/model;

3. Discipline the analysis process; and

4. As a tool for securing additional resources.

3.1.1.3 Group 3

Below is a list of potential applications that were identified and discussed by Group 3.

- Foster group discussion: CMapping was seen as useful at the beginning of an analysis to foster discussion among analysts by identifying possible concepts and sub-concepts involved in an argument. It can also be used at the end of the analysis as a means to verify that everyone has a common understanding of the problem space.
- An analytical tool to structure an analysis and to analyse the organization structure: Participants recognized that the tool would be useful to structure the analytical process as it allows an analyst to decompose the process into discrete steps, and to break down a problem into concepts and sub-concepts. The benefit of this approach is that it visually captures very complex thinking and, for instance, will quickly show illogical arguments. The ability of CMapping to break down a problem into concepts and sub-concepts allows an interested party to analyze the organizational structure of that analysis and identify leverage points within a system (one of the participants referred to this process as a "system of systems analysis").
- Visualization (visual tool): All participants agreed that CMapping provided a visual representation of the analysis and externalized one's logical thinking. This externalization allows an analyst (or, more likely, another analyst) to identify what is missing in the argument or certain gaps in logic. It was recognized, however, that this method may only be appropriate for "visual thinkers". For these types of people, gaps in logic may be harder to find in prose rather than in a visual map.
- Validation: All participants in the group saw CMapping as an effective way to validate an argument by looking back on one's own work and identifying what is missing, what gaps there are, and what should be explored further.
- Prioritization of collection management: One participant suggested that CMapping could be used to identify what information has already been acquired and what is already known about a particular topic. Once identified, analysts could then identify and collect information that is missing or unknown.
- Resource forecasting. One participant suggested that CMapping could be used to identify a range of probabilities which could be developed into a decision tree. This would be useful for resource forecasting exercises and also for expanding the minds of decision makers.

Following the discussion activity, the group selected four potential uses of CMapping and prioritized them in descending order. These were presented to the workshop participants during the group report session.

1. Prompts discussion: process of putting together CMap and process of CMapping;

2. Structure and analysis: process of structuring the analysis, decomposing;

3. Visualization: having done analysis, can look at it, ability to show smart work; and,

4. Validation: looking back on your work: what is missing, what gaps are there, where should we explore further?

3.1.2 Objective 2 – Benefits and drawbacks of CMaps

3.1.2.1 Group 1

Below is a list of potential benefits and drawbacks that were discussed by Group 1. Some of these were discussed in relation to the potential uses of CMapping (see Section 3.1.1.1 above).

Benefits

- CMapping can address the "systems question" (the big picture) to visualize the inter-relationships between concepts and see how the bits and pieces of intelligence analysis fit together. CMapping allows more focus on the issue as it would allow the analyst to reason through their thought process, to focus their research and in problem solving. In this way, CMapping would be useful as an analytical and validation tool.
- CMaps can support the identification of gaps and anomalies in the argument which is useful for validating arguments. CMapping allows the thought process to be clearly articulated by schematically laying out an argument. A reviewer of a CMap can follow the logic of an author's arguments. In this way, a CMap would be useful as a collaboration and validation tool.
- CMapping is a simple process (only some participants saw this benefit).
- CMapping is a good methodology for analysts with a 'visual' style of thinking.
- CMapping can make a person think by creating dissonance.
- CMapping can offer the analyst lots of options and answers. For instance, CMapping can be used as a flowchart to identify data that goes into the argument. Options can then be abstracted from the data.
- CMapping can be a time saver (without wasting time writing it on paper first). The process of CMapping was recognized by some participants to be a time saver during the process of intelligence analysis as it enables a person to brainstorm their ideas and form them into a complete argument prior to putting their ideas into paragraph form.
- CMaps have the ability to link propositions in an explicit manner. CMapping is linked to language in the sense that it is propositional, but it is not constrained by the linear formation of sentences.
- CMaps can allow the analyst to better match the analysis to the end requirement.

- CMaps are good to foster discussion and can be useful as a collaboration tool. For instance, CmapTools allows people to share information over a server or over the internet.

Drawbacks

- CMapping is not good for discrete questions, targeting specific events.
- An analyst with a 'linear' style of thinking will get lost in the lines of a CMap. It is not appropriate for all cognitive styles. That is, it was noted by some participants that this approach may only be a good methodology for people who are non-linear, visual, creative thinkers. One participant suggested that linear kinds of thinkers would get bogged down in the model and lose track of the relationships between concepts.
- The answer is not readily clear in a CMap. In this way, it may be difficult to use as an analytical tool.
- It takes time to learn the method of CMapping and CmapTools. Analysts may therefore spend their energy on learning the tool rather than on the specific issue at hand (only one participant argued this).
- CMapping is not practical in the field (only one participant argued this). He argued that the complex and time-consuming process of CMapping would not be practical in light of the day-to-day pressure of producing analytic work against time constraints.
- CMapping and CmapTools need validation as they are still in the experimental stage. CMapping could be tested during the training curriculum to demonstrate how it might actually be used in the field. It should be noted that one participant argued that not all new processes and tools can be tested prior to use.
- CMapping is a complicated process (only one participant expressed this drawback).
- CmapTools is yet another tool (similar to, for example, i2).
- CmapTools is not a presenting tool. Although it may be a good method to restructure and present ideas, the CMap would need to be restructured to outline the major discussion points in order to present it to others.
- A CMap is not self explanatory. It is difficult to find the entry point and the answer and may therefore not be practical in all types of analyses.

Following the discussion related to Objective 2, the following benefits and drawbacks of CMapping were reported by the rapporteur from Group 1 during the group report activity.

Benefits

- Can address the "systems question" (the big picture).
- Good for analysts with a 'visual' style of thinking.
- Gives lots of options/answers.

- Can be a time saver (without wasting time writing it on paper first).

Drawbacks

- Not good for discrete questions.
- Linear analyst will get lost in the lines.
- Answer is not readily clear.
- Takes time to learn the method and the tool.
- Needs validation as it is still in the experimental stage.
- Yet another tool (e.g. i2).

3.1.2.2 Group 2

Below is a list of potential benefits and drawbacks that were discussed by Group 2. Some of these were discussed in relation to the potential uses of CMapping (see Section 3.1.1.2 above).

Benefits

- The graphical approach of a CMap acts as a visual checklist of concepts. This benefit would make a CMap useful for structuring the analysis, training and to request additional resources.
- CMapping and CMaps allow for a deeper understanding of a topic by looking at all potential relationships and would therefore be useful to explore a topic at depth.
- The graphical approach of a CMap allows a quick assessment of the whole problem space. It is quicker than reading lots of pages (top down approach).
- CMapping objectifies, makes explicit and externalizes the analysis process which would be useful to discipline the thinking process. CMapping as a result makes the process of analysis transparent.
- A CMap identifies the completeness of an argument by identifying what is known and what is unknown and would therefore be useful as a validation tool.
- A CMap provokes conversation and may promote a shared understanding.
- A CMap can also help decision makers understand what resources (in terms of knowledge and experience) are involved in an analysis. A CMap could be useful as a tool to request additional resources.
- CMapping allows for a higher level of abstraction for problem solving.
- A CMap can be adapted for the recipient, such as the analyst creating the map, the approver of an analysis and the consumer.

- CMapping is an unconstrained process. Since problems are not linear, but fluid and dynamic, CMapping may be better suited than traditional linear problem solving to deal with the nature of complex intelligence.

Drawbacks

- CMapping is not for non-visual thinkers.
- The greater the complexity of the problem, the more complex the CMap will be. A linear method may be more appropriate for highly complex problems.
- The focus question, if not formed well, can be a constraint on how well the CMap represents a problem and how well it facilitates the group's ability to explore a problem.
- There is no weighting factor in CmapTools. It is not possible to show the relative importance of certain concepts.
- The answer is not readily available in a CMap and it does not necessarily help resolve complex problems. While the CMaps help to tease out the elements of the problem space, it does not necessarily provide the "so what?" or the conclusion.
- There is no guarantee that the process of CMapping will lead to a better understanding or better outcome. There is no measurement of how close the CMap is to the reality of the problem. It is therefore unclear where the value of CMapping would provide a better outcome over other approaches.
- The process of CMapping is time consuming.
- There are not a lot of drawbacks in the training context, except that some people may see it as overly 'arty'.

Following the discussion related to Objective 2, the following benefits and drawbacks of CMapping were reported by the rapporteur from Group 2 during the group report activity.

Benefits

- Visual (quicker).
- Checklist: review quickly.
- Appreciation of problem space.
- Consideration of complex problems (instead of linear problems).
- Links words with spatial representation – how far concepts are related / non-related.
- Educational – audience and students.

Drawbacks

- Focus question itself if not phrased well.
- Strategically not tactical (where need quick turnaround).
- It is part of a toolbox (not a panacea).
- Measure relative quality of outcome.
- Lack of weighting.
- Not guarantee of better outcome (inputs, propositions, may be delusional).

3.1.2.3 Group 3

Below is a list of potential benefits and drawbacks that were discussed by Group 3. Some of these were discussed in relation to the potential uses of CMapping (see Section 3.1.1.3 above).

Benefits

- CMaps can identify capabilities within a system (i.e. system of systems analysis) by decomposing the process into discrete steps and breaking down a problem into concepts and sub-concepts. This makes them useful for analyzing the organizational structure for any analytic challenge.
- CMapping can capture visually very complex thinking (if an argument is not logical, then this will quickly be shown in a CMap). In this way, a CMap is a powerful tool for identifying what is missing and/or gaps in logic.
- CMapping externalizes thinking and identifies strength of arguments. This makes CMaps useful for identifying how the analysis should be further explored.
- CMaps help analysts and the audience get the full picture.
- CMaps can help communicate ideas.
- CMapping is good for visual people. For these people, a CMap may make it easier to manage an analysis than when it is in a textual form.
- A CMap can identify a range of probabilities which would be useful in forecasting exercises. A decision tree can be created from a CMap and used to support the thinking of the decision makers and open up a greater range of possibilities.
- CMapping answers conceptual or systemic questions. For example, tangible systemic questions such as “What is the nature of (Hamid) Karzai’s (President of Afghanistan) power?” is well-suited to CMapping.
- CMaps link concepts. CMapping’s ability to identify concepts that connect to one another is additional powerful methodology that could be added to the existing repertoire of tools.

CMaps are therefore useful for visualizing propositional relationships. The use of verbs as descriptions within propositions was seen as the real benefit with CMapping.

Drawbacks

- CMaps are not easy to manage for people who are not visual thinkers. CMapping may not be appropriate for people who are not visual thinkers.
- The CMap needs to be well crafted in order to represent thinking well.
- It is not as intuitive to create a map of "what can be".
- One participant recognized that there are other similar tools that are already being used by the intelligence community (e.g. i2) and that CMaps may not offer anything over what these other tools already do.
- One can answer only a narrow range of questions with a CMap. CMapping would be less useful to answer less tangible or discrete questions like "What would be the impact of Karzai's death?"

Following the discussion related to Objective 2, the following benefits and drawbacks of CMapping were reported by the rapporteur from Group 3 during the group report activity.

Benefit

- Verb use (can use any verb as description within the proposition).

Drawbacks

- Narrow range of questions that can be answered.
  - Cannot answer the following question: "What would the impact of Karzai's death be?"

3.2 Discussion Activity #2

3.2.1 Objective – CMap Construction

Participants were given a limited amount of time to construct a CMap of their own and to form impressions about the process of building a CMap and its possible utility to intelligence analysis. During the workshop groups generated their maps on paper flip charts. These maps were later transferred into an electronic format using CmapTools. The CMap outputs generated by each group are presented in the following sections.

3.2.1.1 Group 1 – CMap of Analytic Integrity

Below is Group 1's CMap of analytic integrity following the group's discussion activity (see Figure 3-1). The CMap in Figure 3-1 was created with CmapTools by the author following the workshop. The original CMap drawn by Group 1 can be seen in Annex A, Figure A-1.

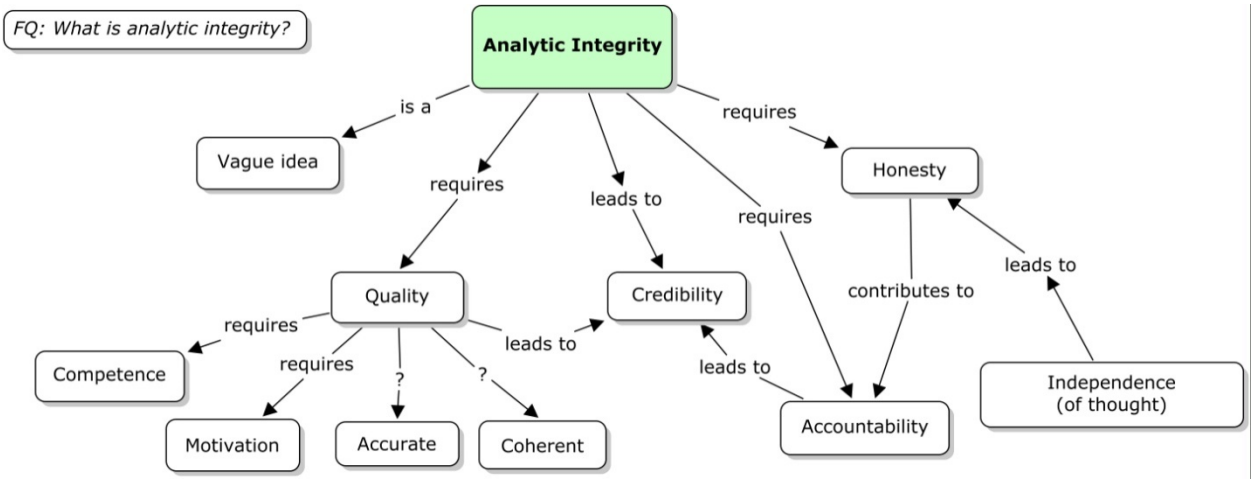

Figure 3-1: Group 1 – CMap of analytic integrity

3.2.1.1.1 Group 1 – Identification of the challenging and/or revealing parts of CMapping

The following issues were identified by Group 1 as particularly challenging or revealing with respect to CMapping:

- It is difficult to decompose a vague idea;
- CMapping is a difficult process;
- CMapping can be an effective tool for exploration and education beyond that of current methods; and
- The tool does not have ability to weight the propositions. There is a need for a tool that blends this capability.

3.2.1.2 Group 2 – CMap of analytic integrity

Below is Group 2's CMap of analytic integrity following the group's discussion activity (see Figure 3-2). Note that some concepts were not linked given the limited time available to perform the task. The CMap in Figure 3-2was created with CmapTools by the author following the workshop. The original CMap drawn by Group 2 can be seen in Annex A, Figure A-2, Figure A-3, and Figure A-4.

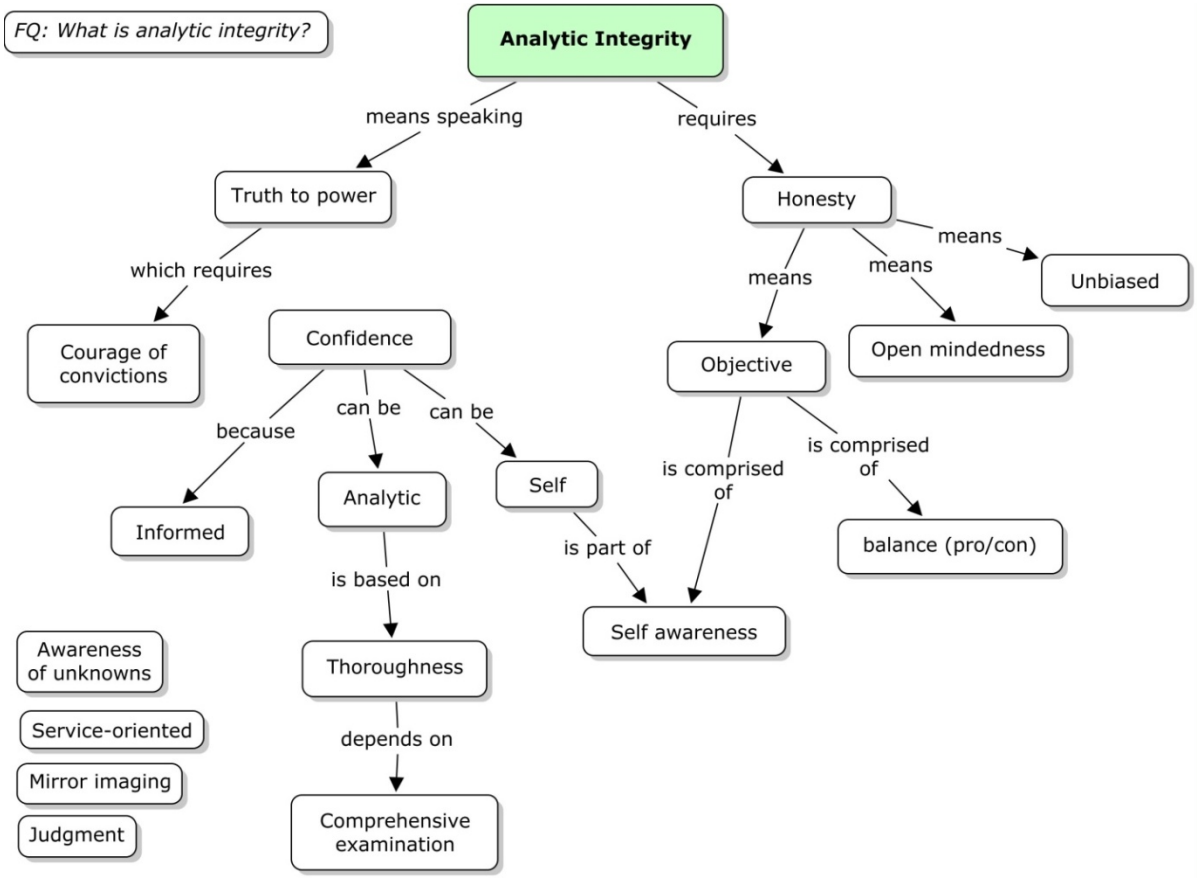

Figure 3-2: Group 2 – CMap of analytic integrity

3.2.1.2.1 Group 2 – Identification of the Challenging and/or Revealing Parts of CMapping

The following difficulties were identified by Group 2 in terms of CMapping:

- Definition of terms;
- Coming up with linking terms;
- Developing effective concepts; and
- Overlap/redundancy.

3.2.1.3 Group 3 – CMap of Analytic Integrity

Below is Group 3's CMap knowledge model of analytic integrity following the group's discussion activity (see Figure 3-3). Note that some concepts were not linked given the limited time

available to perform the task. The CMap in Figure 3-3 was created with CmapTools by the author following the workshop. The original CMap drawn by Group 3 can be seen in Annex A, Figure A-5.

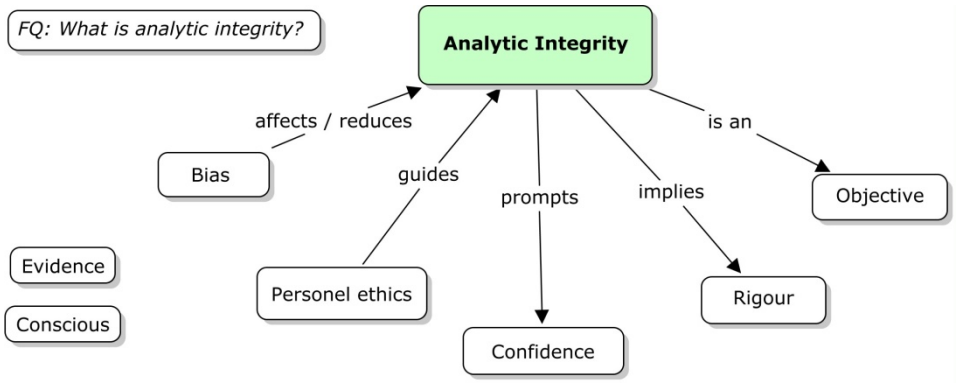

Figure 3-3: Group 3 – CMap of analytic integrity

3.2.1.3.1 Group 3 – Identification of the Challenging and/or Revealing Parts of CMapping

The following difficulties were identified by Group 3 in terms of CMapping:

- How to use active and passive voice;
- Uni-directional arrows (use of multi-directional arrows would have helped); and
- CMapping is very difficult: first have to define the term because it is vague.

4 DISCUSSION OF WORKSHOP RESULTS

This section details observations made during the group discussion sessions. The first subsection is organized in accordance with the group and the discussion session. The subsequent subsections reflect a logical grouping of outcomes from the workshop: potential application and benefits of CMapping, implementation issues of CMapping and suggestions for improvements.

4.1 Observations during discussion activity sessions

The discussion activities elicited a lot of comments and suggestions from the participants. Overall, participants were positive about the potential use of CMapping for the intelligence community. Participants could readily see many potential uses of CMapping in general and identified some benefits and drawbacks in terms of these uses. The following sub-sections detail the observations that were captured during discussion activity #1 and the construction of the CMaps.

4.1.1 Observations captured during the discussion activity #1

4.1.1.1 Group 1

There was some dissonance among participants in Group 1 regarding the practical application of CMapping in general and the tools needed to create CMap knowledge models in everyday analysis tasks. In particular, one participant saw CMapping as a time consuming and complex process that would not be practical in the field. Other participants in the group, however, saw value in CMapping's ability to structure and frame the analysis, particularly its ability to visualize the relationship between concepts. This dissonance led to discussions centred on the practical applications of CMapping within the intelligence community and the benefits and drawbacks of these applications.

4.1.1.2 Group 2

Group 2 tended to focus on characteristics of the CMapping approach rather than on the application itself. There was also an absence of disagreement between the participants, making it difficult to decide whether the views expressed by participants were consensual or whether they merely decided not to express disagreement. Nevertheless, a number of potentially useful aspects and applications were identified.

4.1.1.3 Group 3

Much of the discussion during this breakout session surrounded the question of "*What does CMapping offer over what you do now (different)?"* Some participants saw the process of CMapping as very similar to other processes that use other tools, e.g. i2, Mind Manager, to perform intelligence analysis. One participant was familiar with Mind Mapping as he had used it frequently to brainstorm about particular topics and to validate his arguments. This participant recognized how CMapping differed from current processes in that it allows the use of verbs to describe the propositions. Mind Mapping, for instance, is only a hierarchical representation of an argument with no qualified relationships between concepts. Another participant argued that i2 does develop relationships, and even puts a weight on the relationships. It was argued, however, that CMapping explains a concept, it is a visual representation of the "what" – which, to the participant, seemed different from a power relationship (that i2 offers for instance).

4.1.2 Observations captured during the discussion activity #2

4.1.2.1 Group 1

During the group's efforts to identify the various core concepts that compose analytic integrity, it was quickly recognized by all participants that CMapping was a difficult process. The group began to build a list of the most relevant core concepts that constitute analytic integrity.

During the activity, participants acknowledged that the resulting CMap can be used as a way to show consumers how their conclusions were derived. It also occurred to the group that the process of identifying concepts and relationships enabled them to derive conclusions that would not have been as readily apparent if the concepts were shown on a Microsoft PowerPoint slide as bullet points. For instance, it was concluded that the group's CMap of analytic integrity demonstrated that integrity and quality were the core components anchoring all of the other components in the model. In identifying the propositional relationships between the concepts; the group came to realize that quality and integrity is fundamentally the same thing. This was evidence to the group that CMapping was indeed a "thinking tool".

Most interestingly, one participant who had previously argued against the practicality of CMapping for analytic tasks came to believe following this exercise that "the structured brainstorming of CMapping and of decomposing the component parts may be the first step of intelligence analysis".

4.1.2.2 Group 2

The following observations were made by the member of the organising group who participated in this session. They are therefore opinion-based.

The construction of the CMap was popular and enjoyable with the participants because it was a participative learning process, rather than simply using Microsoft PowerPoint. The group had

difficulty with the definition of the terms used, but only once they began to try and create linking phrases between concepts. Prior to this there was probably an assumption that everyone shared an understanding about the terms. There was a great deal of overlap and redundancy among the terms.

The group had great difficulty coming up with linking terms and changing their perspective to accommodate the directional nature of relationships. A member of another group noted problems with grammar, and a more standard approach to the grammar of the linking term (e.g. use only active tense) would certainly have addressed this. A related issue is that the group had difficulty reading the resulting CMap, and would often misread the relationship. Often, this was a product of the 'directionality' of the relationship; the group needed some training and experience to immediately see the causality that is built into the CMap representation.

The group had difficulty developing effective concepts for the map, as was evidenced by the redundancy. Again, this may have been due to their unconscious biases, and may also have been due to a quickly adopted focus on personality traits, rather than trying to reduce focus and increase the orthogonality of the concepts.

Overall, it is not surprising that this group of experts had difficulty with the task. The process of decomposing an expert process is very difficult for experts because they have internalised the skills and knowledge required to do the job and thus have difficulty verbalising this information. This group probably needed a facilitator with training and experience.

4.1.2.3 Group 3

The group initially broke down analytic integrity into two component parts "Analysis" and "Integrity" and a number of concepts comprising analytic integrity were derived. During the decomposition process, the group defined the term 'analytical integrity' in order to help them more clearly identify the concepts of analytic integrity. While participants were trying to define analytic integrity, they came to realize that the very process of brainstorming its concepts was in itself providing them with the definition. The following concepts were derived by the group: ethics, rigor, bias, assumptions, training, directives (mission), policy, intelligence problem, and political command pressures.

The group then began to focus on connecting the various concepts with specific linking phrases to form a CMap. It was during the process of creating propositions that the group ran into difficulties in constructing the map.

- The group had difficulty creating propositions without a more precise definition of analytic integrity. The following definition was proposed: "it is a conscious decision to not ignore or change evidence or to change conclusions because of external pressures". This more concrete definition provided a context in which participants could work out the relationships among the concepts.
- There was some difficulty among the group participants in determining if an active or a passive voice should be used to word the propositions. Participants concluded that a

passive voice shows the relationship in the opposite direction of the visual arrow (they are uni-directional). Participants interpreted the direction of the arrow in a CMap to imply the direction of causality in the relationship, which caused a great difficulty in accepting the possibility of linking phrases in a passive voice. Therefore, it was concluded that active wording should be used for the propositions.

- Participants did not realize that the arrows could be directed upwards as well as downwards. This led to some confusion as to how to structure the CMap.

Due to these difficulties the group did not advanced as much in linking concepts in their CMap as the other two groups. Interestingly, the resulting map following the activity contained almost none of the original concepts that were generated at the beginning of the exercise. The group concluded that constructing a CMap is a challenging task. The passive wording of the propositions made the task particularly difficult. One participant made a final comment that one would need training to effectively do CMapping.

4.2 Potential applications and benefits of CMapping

4.2.1 Potential applications of CMapping

The potential uses that were derived during the break-out session discussions for all three groups are tabulated into Table 4-1 below. As can be seen in the table, there is much overlap between the groups in regards to the potential applications of a CMap knowledge model or CMapping in general for the intelligence community. This is an interesting finding because all three groups arrived at these conclusions separately during the break-out sessions. It is also an interesting outcome because each group was composed of different organizations within DND and other government departments.

Table 4-1: List of potential uses for CMapping derived by the groups

Group 1	Group 2	Group 3
“Imaginative tool” for validating an argument in a graphical form	Visual tool to see all concepts at a glance; visual approach to thinking	Visualization / visual tool
Thinking tool to structure the thinking process	Strategic tool to discipline the thinking process	An analytical tool to structure an analysis/ analyze the organizational structure of an analysis:
Collaborative tool to foster discussion	A collaboration tool to provoke discussions and to query ideas and assumptions;	Foster group discussion
Quality control (decompose and show logic in argument)	Verify/Assess completeness of the intelligence analysis	Validate an argument
Collection planning		Prioritization of collection

Group 1	Group 2	Group 3
		management
Teaching tool	Training tool; accelerate learning	
	Tool to argue for resource requirements	Resource forecasting
	Process to manage analysts	
	Explore topic in depth; good to identify relationship between concepts while exploring topic	
	Structure the intelligence problem	
	Audit and defensibility of the analysis	
Management of information		

Table 4-1 demonstrates the following four potential uses that all three groups identified:

- *Visualization:* CMapping is an "imaginative tool" useful for providing a visual approach to thinking.
- *Analytic tool:* CMapping can be considered an analytical tool that models the process of analysis and the cognition of analysts. This capability of CMapping can be useful for disciplining and organizing analytic thought and structure the thinking process.
- *Collaboration tool to facilitate discussion:* CMapping is a useful collaborative tool that can facilitate discussions among analysts and to query ideas and assumptions.
- *Validation:* CMapping can be used as quality control to validate arguments by verifying the completeness of an analysis and identifying any gaps in the argument.

Despite the overlap between the different groups, some groups identified other potential uses of CMaps or CMapping in general. Groups 1 and 3, for instance, identified CMapping as a way to prioritize collection planning. Groups 2 and 3 meanwhile both identified CMapping as potentially useful to forecast the resources needed for a particular intelligence project. Groups 1 and 2 also identified that the representation of the "map" associated with a topic area can also be useful in training and teaching of intelligence analysis. This "product" approach to considering the CMap was given little attention by any of the three groups.

As a product, a CMap can be used to communicate ideas quickly and effectively. For instance, if a particular person of interest has a broad web of associates from which the intelligence community can draw clues, a CMap is an efficient means of showing these relationships and identifying who of these associates is worthy of significant allocation of resources. As a product, the CMap can also provide continuity to intelligence files. It may be the case that intelligence officers are rotated to new responsibilities as their knowledge of a particular area reaches a critical mass. This critical mass may be the point where they are able to extrapolate from the facts to the likely future. A detailed CMap for a particular intelligence area of interest may more effectively transfer the sum total of the outgoing intelligence officer's knowledge about a topic to

the incoming intelligence officer. The graphical representation makes it more likely that the incoming officer will use the information, because it is very accessible with minimal study.

The idea of continuity also extends to training. By having acceptable models of intelligence analysis, like the model (CMKMIA) constructed by DRDC Toronto, intelligence training agencies can foster a greater degree of consistency between analysts. These models can serve to represent and externalize expert's mental models. While consistency may not be desirable from the perspective of diversity of opinion, it is desirable to have all analysts following the same process and proceeding from the same basic level of knowledge. Training, especially of skilled pursuits, can be highly variable in its quality due to the teacher, the student, and the learning opportunities offered. CMapping can help to standardise some of this.

In the case of training, significant effort would need to be expended at the outset, in order to develop a comprehensive model and then for it to be reviewed and accepted by stakeholders. Teaching of intelligence would then follow the curriculum laid out by the CMap. At once, the student would 'see' the whole of the expert's mental model of intelligence analysis, but they would only be responsible for knowing (or learning) a manageable chunk of that model. Practically, this means that the student learns the content being presented, but is not fooled by the pedagogical approach into creating a mental model that will need to be deconstructed and reformed at a later date as new information, relationships, and nuances about the model are added. This is a common observation in learning of skilled occupations: opportunities to learn through case studies or simulation are degraded as students first 'unlearn' then learn again mental models that are sufficient to understand the situation and act appropriately.

There is a further advantage of providing an expert mental model from the outset of training. Students' retention is better when the framework being developed is accurate. A CMap is constructed of concepts, related by linking phrases. This representation allows a reader to quickly identify the most critical concepts: those with the most incoming and outgoing links. These concepts form the backbone of a training curriculum. With this framework in place, new knowledge is more easily 'located' in the framework and has a higher strength of relationship, leading to greater probability of quick and accurate recall, long-term retention, and, ultimately, job success.

4.2.2 Benefits of CMapping

The benefits of CMapping that were identified during the break-out session discussions for all three groups are tabulated in Table 4-2 below. In common with the list of potential uses shown in the previous section, there is much overlap between the groups in regards to the benefits a CMap knowledge model or CMapping in general for the intelligence community.

Table 4-2: List of Benefits Related to CMapping Derived by the Groups

Group 1	Group 2	Group 3
It allows the visualization of relationships between concepts	Allows for deeper understanding of problem space by looking at all	A graphical approach to links concepts

Group 1	Group 2	Group 3
	potential relationships	
Good to foster discussion	Promotes conversation and shared understanding	Communicate ideas
Ability to link propositions in an explicit manner	Explicit/Externalizes process and makes the process transparent; objectifies the process	Explicit use of verbs and the ability to link concepts
Identify gaps and anomalies in the argument.	Identify completeness of an argument	Allows you to see what is missing/gaps in logic
Good for visual analyst		Good for visual people
Can see the bigger picture		Get the full picture
	It is an unconstrained process which can be considered for complex problems	Capture visually very complex thinking; identify capabilities within a system (i.e. system of systems analysis) and allows the breakdown of a problem into concepts and sub-concepts
Makes a person think by creating dissonance		
Gives lots of options/answers		
Can be a time saver (without wasting time writing it on paper first)		
It is a simple process (only some participants saw this benefit)		
Allows the analyst to better match the analysis to the end requirement		
	The graphical approach allows a quick assessment of the whole problem space	
	The graphical approach acts as a visual checklist of concepts	
	Ability to identify resources involved in an analysis.	
	Can be adapted for the recipient	
	Higher level of abstraction	
		Externalized thinking.
		Identify range of probabilities
		Create decision tree; expand

Group 1	Group 2	Group 3
		the mind of the decision makers.
		Good for conceptual or systemic questions

Table 4-2 indicates that all three groups identified the following four benefits:

- *Visualization of relationships between concepts.* CMaps enable the visualization of relationships between concepts. This helps analysts to gain a deeper understanding of the problem space by linking concepts and looking at all potential relationships.
- *Fosters discussion/communication.* CMap is a medium in which analysts can communicate their ideas to each other and foster discussion about particular topics. This is particularly useful when using CMapping as a collaboration tool and to ensure a shared understanding about a topic or problem.
- *Externalizes the problem scope.* CMapping objectifies and externalizes the analytical process. CMaps allow an analyst to link propositions in an explicit manner using actionable verbs which can be useful for disciplining the thinking process.
- *Identify gaps and anomalies.* CMapping enables an analyst to systematically identify what is missing in their argument or gaps in their logic. Such a validation tool for verifying the completeness of an analysis and identifying any gaps in the argument would be extremely beneficial.

Despite the overlap between the different groups, some groups identified other potential benefits of a CMap knowledge model or CMapping in general. Two other overlapping benefits were identified by Group 1 and Group 3. Both noted that CMapping may benefit people who are visual. Both groups also recognized that CMapping would be beneficial for an analyst to gain a full picture of the problem scope. Finally, Groups 2 and 3 both recognized that CMaps would be beneficial to visually capture complex problems and thinking.

4.3 Implementation issues of CMapping

During the first and second break-out sessions, several drawbacks and difficulties with CMapping were identified. The drawbacks and difficulties that were derived during the break-out session discussions for all three groups are tabulated in Table 4-3 below.

Table 4-3: List of Drawbacks Related to CMapping Derived by the Groups

Group 1	Group 2	Group 3
CMapping is a difficult, complex process	CMapping is very difficult	Difficult process
Not good for linear analysts	Not for non-visual thinkers	Not for non-visual thinkers

Group 1	Group 2	Group 3
Yet another tool (e.g. i2)	Added value unclear	Other similar tools
Difficult to decompose a vague idea	Difficult to link terms	Difficult to define terms and link propositions
Cannot weight the propositions	No weighting factor	
Tool needs validation	No guarantee of better understanding	
Not self explanatory/ Answer not readily clear	Answer is not readily available	
Not good for discrete questions		Can answer only a narrow range of questions. Not intuitive how to map things of "what can be".
	May be seen as overly 'artsy' in the training context	
	Linear method may be more appropriate for highly complex problems.	
	Measure relative quality of outcome	
	Need good focus question	
	Constrained by focus question	
	Time consuming / strategic and not tactical for quick turnaround	
		The CMap needs to be well crafted
		Can have a lot of overlap/redundancy
		Not sure how to use active and passive voice
Will spend energy on process rather than issue		
Not practical in the field		
Takes time to learn		
It is not a presenting tool		

Table 4-3 clearly demonstrates four overlapping drawbacks that were identified by all three groups. Firstly, it was quickly determined following the second discussion activity that all three groups found the process of CMapping difficult. Indeed, as was mentioned in Section 4.1.2.2 the process of decomposing an intelligence problem is difficult for analysts because they have internalised the skills and knowledge required performing intelligence analysis and thus they have difficulty verbalising this information. Secondly, all three groups also recognized that while there are many benefits of using CMaps and executing a CMapping process, this may only benefit people that are visual thinkers. All three groups recognized that the added value of

CMapping and CmapTools is not readily clear as there are other similar tools (e.g. i2) available for the intelligence community. Finally, all three groups had difficulty in defining terms and in linking propositions.

There was much overlap between Groups 1 and 2. Groups 1 and 2 both identified that a drawback of CMapping is the fact that there is no guarantee that CMapping will provide a greater understanding than current methods being used. Indeed, Group 1 recognized that the tool still needs to be validated as it is still in the experimental stage. These groups also realized that the tool lacks the ability to weight a concept or a relationship and that the answer is not readily clear from the CMap.

These drawbacks and difficulties could impact the implementation of CMapping for the intelligence community. Below are the potential implementation issues related to the potential uses of CMapping for the intelligence community?

- *May take time to learn the process and the CmapTools.* As can be seen in Table 4-3 and in Section 4.1, all three groups had difficulty constructing a CMap. Indeed, all three groups admitted that CMapping is a difficult process. While CMapping is not a complex process (in and of itself notwithstanding the comments of Group 1 that CMapping was quick and intuitive), some assumptions are not obvious and need to be taught. For instance, Group 2 and Group 3 were unclear how to phrase the linking phrases within the propositions. There was some confusion over the need to use the active or passive voice. In addition, Group 3 did not realize that the arrows within the propositions could be multi-directional (i.e. outgoing and incoming). Meanwhile, while not explored during the break-out sessions, CmapTools itself would require some basic training in order to learn how to use the tool effectively. These issues imply that a short period of 'formal' instruction would be needed to learn the process and CmapTools in order to develop effective and useful CMaps. The training time required may impact the intelligence community's willingness to implement CMapping to perform everyday analytic tasks. A separate issue, but also related to time, was that CMapping was seen by several participants as not amenable to quick tactical problem analysis and may therefore not be seen as a practical process to implement.
- *CMapping may only be useful for visual thinkers.* All groups agreed that CMapping is a useful "imaginative tool" to visualise an analyst's argument or concept. It has been noted however that it may not be useful for non-creative, non-visual, linear thinkers. Indeed, it was proposed that linear analysts may get lost in the lines. Therefore, it is unclear at this time if CMapping is appropriate for everyone. The unconstrained, visual and non-linear process of CMapping may not be readily adopted by non-creative, non-visual, linear thinkers and may pose an issue for implementation within the intelligence community. However, the visual representation may be particularly well-suited to senior decision makers who, anecdotally, often exhibit a preference for visual representations of issues, problems, and plans.
- *CmapTools does not have the ability to weight the propositions.* CmapTools lacks the ability to weight a concept or a relationship in terms of its overall importance. It was not evident to participants how conditionals could be represented in the map because the links between concepts could not be prioritized. Participants felt there was a need for a tool that could blend this capability. For instance, the intelligence analysis application i2 has this capability.

The lack of the weighting capability of CmapTools may deter some people from the intelligence community from adopting CMapping.

- *Unclear how CMapping is better than other current processes.* Some participants saw CmapTools as yet another tool. Indeed, the intelligence community is already using other similar processes with tools like Mind Manager and i2. In addition, participants could not see how CMapping could guarantee a better outcome than current processes. It is conceivable that this perception was partly the result of a lack of training in CMapping. Perhaps a better understanding of the CMapping process and CmapTools may impact this perception.
- *Developing an 'accepted' CMap would be a significant undertaking.* Given the potential extent of such a model for intelligence analysis, the process by which such a model would be developed would necessarily take a long time to construct, and even longer to validate with stakeholders. This time would compromise the time to orient an audience to a model, and then time to allow the audience to comment, then time to incorporate (and deconflict) the audience's input. To this end, the DRDC Toronto contribution is a valuable and effective start. Unfortunately, during this workshop, there was not enough time to validate CMKMIA. Participants were encouraged to review the map at their own pace and provide any feedback directly to the project SA.

4.4 Suggestions for improvements

Several suggestions for improvements were identified during the workshop. These are listed below:

- *Implement the capability within CmapTools to weight concepts:* As was mentioned in the previous section, CmapTools does not have the ability to weight the propositions. Participants suggested that there is a need to implement this capability within CmapTools. This ability would not only allow propositions to be weighed, it would allow an analyst to show confidence in their level of knowledge and identify what is missing from their argument.
- *Implement the ability to insert 3D linkages between CMaps*: It was suggested that it would be useful to have the ability to create linkages between maps. This ability could be useful for showing relationships between CMaps as opposed to simply having a sub-map. It was also suggested that tracking those linkages would be useful.
- *Implement basic training prior to introducing CMapping*. As was mentioned in the previous section, participants found CMapping a difficult process that takes time to learn. To avoid confusion and erroneous assumptions, it is recommended that basic, brief training sessions in CMapping and CmapTools be given prior to implementing CMapping to the intelligence community.

5 CONCLUSIONS

The discovery workshop brought together SMEs from the intelligence community to generate feedback regarding the organization, design and the potential application of CMapping (as implemented currently in CmapTools), and any implementation issues and/or suggestions for improvements. The results of the workshop will help guide the potential utility of CMapping for the intelligence community, as well as analyst training.

Overall, participants were positive about the potential use of CMapping for the intelligence community. The discussion activities were engaging and were successful in eliciting valuable participant feedback. Participants could readily see many potential uses of CMapping in general and identified some benefits and drawbacks in terms of these uses.

Despite the limited knowledge and experience with the CMapping approach, it is interesting to note that there was much overlap among the three groups in recognizing the potential uses of CMaps and CMapping for the intelligence community and in identifying benefits and drawbacks. The second discussion activity was a powerful demonstration of how difficult it actually is to create a CMap. It was evident that a lack of knowledge and expertise in CMapping influenced the groups' ability in constructing a CMap. Despite the difficulties encountered by the groups during the second discussion activity, by the end of the activity all participants saw the value of CMapping as a means of structuring the brainstorming process.

In terms of the potential uses of CMaps for the intelligence community, all groups recognized that CMaps could be used for visualising the thinking process, as an analytical tool, as a collaboration tool, and for validating arguments. Workshop participants identified several benefits that make CMaps particularly useful including the ability to visualize relationships between concepts, the ability for analysts to develop a deep understanding of an issue, to foster discussion among analysts and to identify gaps and anomalies. While there are many benefits of using CMaps and executing a CMapping process, this may only benefit people who are visual thinkers. Meanwhile, CMapping was found to be a difficult process that takes time to learn and may not be amenable to quick tactical problem analysis. Consequently, the added value of CMapping is not readily clear as there are other similar tools (e.g. i2) already available in the intelligence community.

CMapping is new to the Canadian intelligence community and the workshop hosted by DRDC Toronto was one of the first introductions of CMaps and CmapTools to the community. The workshop was successful in identifying potential areas of application and areas for further development and investigation. As was identified during the workshop, CMapping is still at an early stage in its introduction to the Canadian intelligence community and needs to be validated. Indeed, a needs analysis of the intelligence analysis task needs to be performed and matched to the capabilities of CMaps and CmapTools. Comparative evaluation of CmapTools with other tools currently used in the community may help identify its unique added value. The results of the workshop will guide the development of DRDC's research program.

6 LIST OF ABBREVIATIONS

CAE PS	CAE Professional Services
CBSA	Canadian Border Services Agency
CDI	Chief of Defence Intelligence
CFSMI	Canadian Forces School of Military Intelligence
CMap	Concept Map
CMapping	Concept Mapping
CMKMIA	Concept Map Knowledge Model of Intelligence Analysis
DRDC	Defence R&D Canada
IAS	International Assessment Staff – Privy Council Office
IACC	Intelligence Assessment Coordination Committee
SME	Subject Matter Expert
TRIG	Thinking, Risk, and Intelligence Group

7 FURTHER READING

Krizan, L. (1999). Intelligence Essentials for Everyone: Occasional Paper Number Six. Joint Military College: Washington, DC.

Novak, J. D. & Cañas, A. J. (2008). The *Theory Underlying Concept Maps and How to Construct and Use Them (*Technical Report IHMC CmapTools 2006-01 Rev 01-2008). Florida Institute for Human and Machine Cognition. Retrieved February 12, 2010 at http://CMap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf

ANNEX A CMAPS

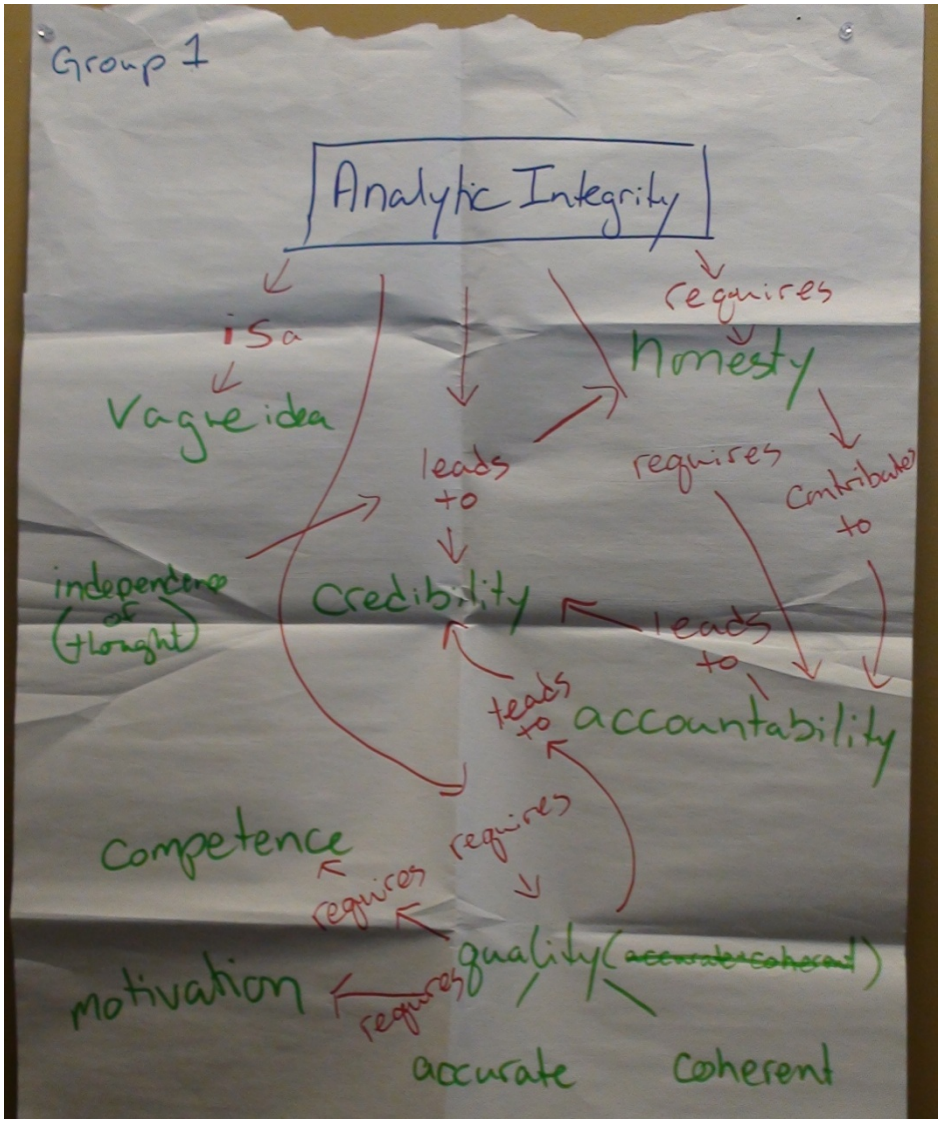

Figure A-1: Group 1's CMap of analytic integrity drawn during discussion activity #2

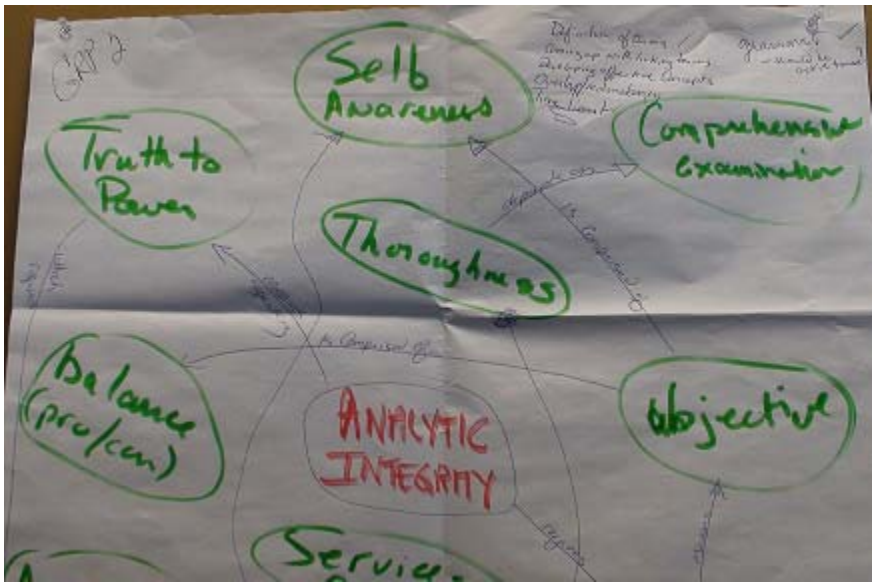

Figure A-2: Group 2's CMap of analytic integrity drawn during discussion activity #2 (Top-Section)

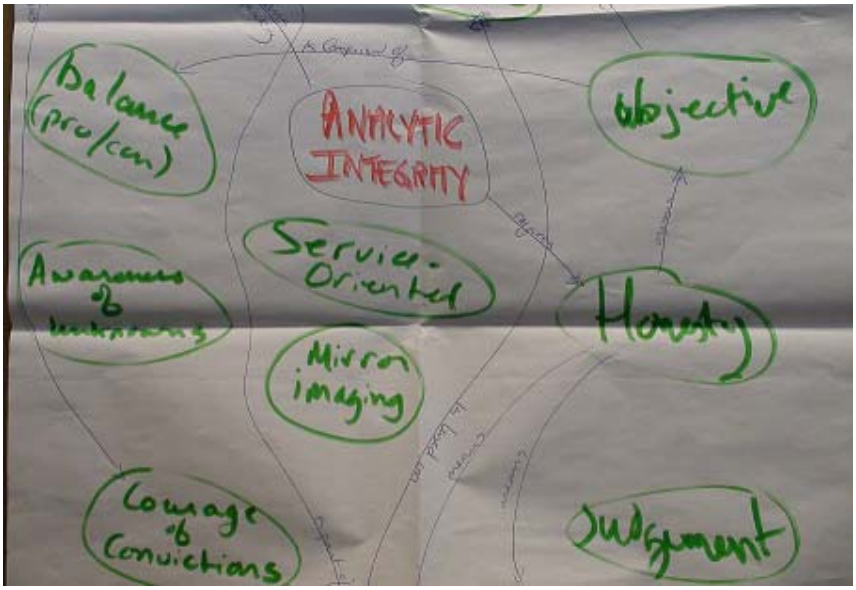

Figure A-3: Group 2's CMap of analytic integrity drawn during discussion activity #2 (Mid-Section

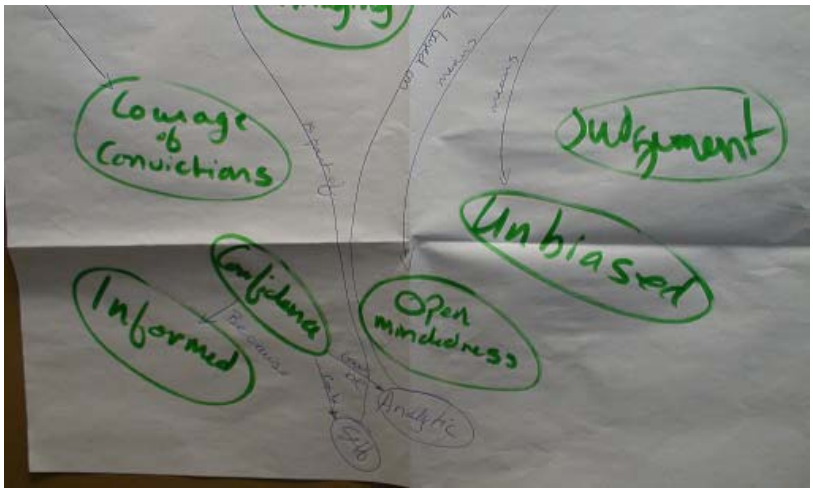

Figure A-4: Group 2's CMap of analytic integrity drawn during discussion activity #2 (Lower-Section)

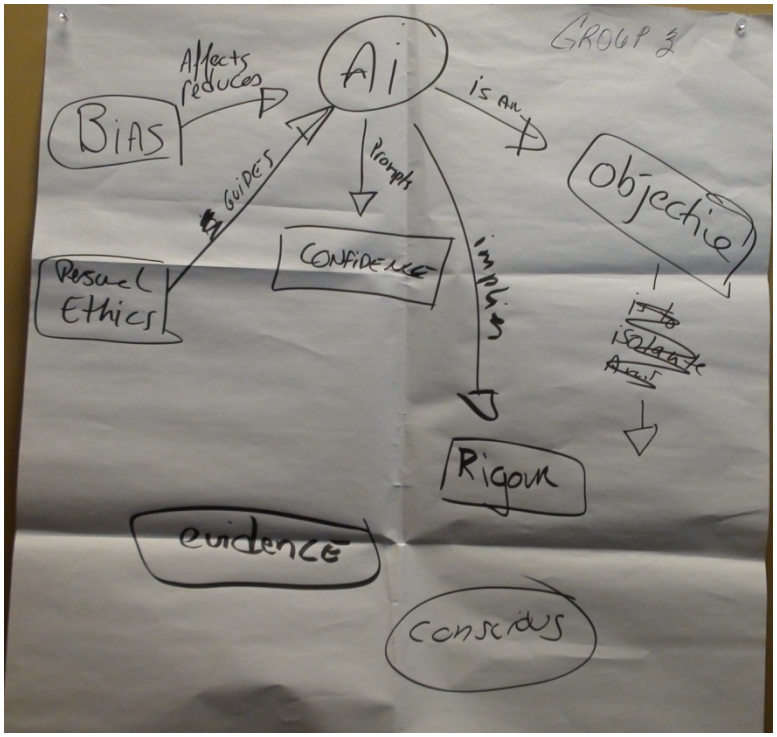

Figure A-5: Group 3's CMap of analytic integrity drawn during discussion activity #2

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(U) The Thinking, Risk, and Intelligence Group (TRIG), one of three groups of the Adversarial Intent Section at Defence Research and Development Canada (DRDC) Toronto, is unique in Canada given its objective “to support Canada’s defence and security community through applied behavioural science aimed at promoting human effectiveness in risk management and intelligence production”. The Group Leader of TRIG, Dr. David Mandel, is leading an Applied Research Project (ARP) entitled “Understanding and augmenting human capabilities for intelligence production”. Under the auspices of this ARP, the TRIG at DRDC Toronto held a discovery workshop on 5 February, 2010 to explore and discuss the utility of concept map knowledge modelling within the Canadian intelligence analysis community. Several government organizations participated in a half−day workshop that included two sets of interactive, group−oriented, break−out sessions in which teams engaged in discussion activities to address several objectives related to a concept map knowledge model and concept mapping (CMapping) in general. Participants derived several conclusions relating to the organization, design and the potential application of CMapping, in addition to several implementation issues and suggestions for the improvements. This report summarises the impressions of participants pertaining to the concept map tool and process, and key points and outcomes from the workshop.

(U)

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(U) Concept mapping; intelligence analysis; visualization; structured analytic techniques; collaboration tools