An Introduction to Cognitive Mapping

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EXECUTIVE SUMMARY

1. This paper provides a brief introduction to the technique of Cognitive Mapping. It describes the supporting theories behind the technique, some general principles on the use of the technique and two basic examples of Cognitive Maps. This paper was funded through the Dstl 'Soft Operational Analysis Community of Practice' and seeks to raise awareness across Dstl of Cognitive Mapping as a technique.

2. Cognitive Mapping refers to the process of mapping the view of an issue or event as interpreted by an individual or group. The mapping process captures the individual or group's interpretation of how concepts (ideas and / or actions) in the area of interest are related.

3. Cognitive Mapping is identified as offering a highly flexible approach to capturing and exploring qualitative data. This paper focuses on the use of the technique of Cognitive Mapping to support problem structuring rather than the options and intervention analysis that is provided by using Cognitive Mapping within broader approaches such as 'Strategic Options Development and Analysis' (SODA) or JOURNEY Making.

4. The paper gives some example of where Cognitive Mapping could be usefully applied, including:

a. Structuring intelligence or assumptions about how an adversary or person / group of interest perceive the problem space.

b. Understanding and expressing a Commander's or planner's interpretation of the strategic / operational / tactical environment.

c. Informal use by an analyst or researcher to better understand a problem space, particularly at the scoping phase of a research project.

INTRODUCTION TO COGNITIVE MAPPING

OVERVIEW

5. *C*ognitive Mapping refers to the process of mapping the view of an issue or event as interpreted by an individual or group (Eden & Ackermann, 2001). The mapping process captures the individual or group's interpretation of how concepts (ideas and / or actions) in the area of interest are related. While such maps cannot seek to represent the general *thinking* of a person or group they do provide a tool for the analysis of subjective knowledge and judgement of the area of interest. This then allows the maps to form the basis of problem exploration, decision-making and negotiation (Eden, 1992).

6. Cognitive Mapping is described as a causal method in that it reflects 'cause and effect' linkages between concepts in the area of interest, as interpreted by the individual or group that is the 'subject' of the map. These concepts and their causal linkages are represented visually on a map in a 'word and arrow' format (Bryson et al, 2004). Each concept is represented in the map with a concise piece of text that best reflects the data provided by or indirectly elicited from the subject.

7. Causality in this context can be problematic to define. Cognitive Maps show linkages between concepts where the subject of the Cognitive Mapping interprets there to be causality, influence or implication between the concepts (Montibeller et al, 2008). Each concept is "linked to others through the use of arrows indicating 'may lead to', 'has implications for', or 'supports' moving up the arrow and 'may be explained by', 'is implied by' or 'is supported by' when moving down the arrow" (Eden & Ackermann, 1998, pp.285). Each map may contain from ten to many hundreds of inter-linked concepts. In comparison to using continuous written prose to describe numerous concepts and linkages, mapping offers the benefit of representing the qualitative data in a format that can be easily recorded, accessed, explored and continually revised.

8. Cognitive Mapping is one of a number of mapping techniques, including causal mapping and process mapping. Cognitive Mapping's distinction is that it focuses on the subjective interpretation

of issues or events as opposed to objective causation, or actual / planned processes. The process used for applying Cognitive Mapping is dependent on the context and the wider analytical approach, with some of the key 'rules' for its application described in paragraphs 12, 13.a and 15. In particular, Cognitive Mapping is often used as part of a broader Strategic Options Development and Analysis (SODA) (see Eden & Ackermann, 2001, and Westbury, 2008) or JOURNEY Making (see Eden & Ackermann, 1998) approach. This paper focuses on the technique of Cognitive Mapping outside of these broader approaches.

9. This paper was funded through the Dstl 'Soft Operational Analysis Community of Practice' and seeks to raise awareness of the use of Cognitive Mapping across Dstl. For further sources of information and particularly detailed descriptions of how to use Cognitive Mapping, please see the References section below for recommended reading.

SUPPORTING THEORIES

10. The theoretical underpinnings for Cognitive Mapping are in Kelly's Theory of Personal Constructs (Kelly, 1955). The essence of Kelly's theory is that in making sense of the world we detect repeated themes and use a 'construct system' to interpret them (Eden, 1988). Other elements of this theory that are implicitly reflected in Cognitive Mapping as a technique are that:

a. People interpret events in different ways as a result of their different experiences.

b. Understanding other people's construct systems allows us to communicate with them and take part in a social process.

c. Where there is commonality in experience there may be commonality in constructs, which will support the attainment of consensus and commitment.

11. Further interpretation of Kelly's theory leads to an important assertion that people seek to understand the significance of their world by organising concepts in a hierarchical fashion, with a system of ordination reflecting relative importance and causality (Eden, 1988). This is reflected in the cause and effect linkages used in Cognitive Mapping, as well as the way Cognitive Maps are generally arranged to show chains of linked concepts running from the bottom to the top of the map.

COGNITIVE MAPPING AS A TECHNIQUE

12. Cognitive Mapping is a flexible approach that can be used in a wide variety of contexts and can be tailored in the way it is applied. Maps are developed by interviewing the subject of the mapping or by using data from which the subject's interpretation of the area of interest can be elicited. Maps can also be developed for groups, either with individual maps being combined or with a map being developed based on data provided by a group. Group maps are generally referred to as Cause Maps[1], Group Maps or Strategy Maps to reflect the fact that they don't reflect the thinking of a single individual (Eden & Ackermann, 2001).

13. The development of a map can take place in 'real-time' during an interview or workshop, or can be developed from the notes taken after the data collection process. Once developed, the map acts as a living draft in that it can be discussed with the subject (individual or group) to test understanding and to make further developments. This paper proposes a four stage process through which Cognitive Maps are generally developed:

a. **Collect**. Collect data through one or a combination of the following: interview with the subject, interview with somebody who represents or understands the subject, secondary data (e.g. published sources about the subject) or a facilitated group workshop. The latter may involve the Oval Mapping Technique, which is a workshop based approach to gathering, structuring and exploring data that is provided by a group of workshop participants (see Ackermann & Eden, 2001 and Eden & Ackermann, 1998 for a fuller

[1] Also called Casual Maps.

description of this technique). The data collector will probe for concepts and meaning by asking questions about each concept, such as 'how might that be done?' moving down the network or 'what outcomes would you expect from?' or 'so what?' to ladder up the network (Eden & Ackermann, 1998).

b. **Collate**. Collected data is collated and represented in a map. The map may be developed in software such as Decision Explorer®[2] or CMapTools[3] or in non-specialist software such as PowerPoint. Concepts in the map may be coded to reflect different types of concepts (e.g. actions, ideas, beliefs etc.) and ordered in a hierarchy as appropriate. This hierarchy may reflect the linkages from options through issues or possible strategies up to goals or outcomes (Ackermann & Eden, 2001).

c. **Confirm.** Review the draft map with those who are able to validate content and check clarity.

d. **Consider.** Use the map to share and explore the information with others and as the basis for action planning, i.e. by asking "how will potential actions affect the subject's interpretation of this area of interest?" This process will help to better understand the subject and / or the area of interest, which will support consensus building and an appreciation of how the subject and / or area of interest may be affected by change or actions.

14. Extensive guidance on how to develop cognitive maps in interviews and workshops is given in Eden & Ackermann (1998; Ch P1 and P2) and Ackermann & Eden (2005; Ch 3 and Ch 4). This guidance is specifically for using Cognitive Maps for strategy development and the Strategic Options Development and Analysis (SODA) approach, but provides useful tips for broader uses.

15. The flexibility of Cognitive Mapping is in part because the concepts shown in Cognitive Maps can take a variety of forms:

a. They can describe a variety of issues, including actions, ideas, beliefs, attitudes and status. This allows maps to be used for a variety of purposes, from better understanding the beliefs and attitudes of an individual, through to identifying why an industrial change management scheme is not working.

b. The meaning of a concept may be described by including a contrasting idea within the concept such that it is phrased as X rather than Y, or X as opposed to Y (Eden & Ackermann, 2001). The addition of the contrasting idea is useful where a single statement is not sufficient to provide clarity of the precise meaning of the concept. However, this isn't always required, and rules for expressing concepts can be flexible (see the approaches used by Bryson et al, 2004, as an example).

c. Concepts may be phrased in a certain format (e.g. as a 'call to action' with an action or problem solving orientation, and specifically for the SODA approach; Eden & Ackermann, 2004) or phrased within certain parameters (e.g. using 8-10 words to aid clarity) (Eden & Ackermann, 2001). The use of phrasing should be consistent throughout the map to aid interpretation but the choice of phrasing rules will be dependent on the data collection method and the nature of the problem space covered by the map.

EXAMPLES OF COGNITIVE MAPS

16. Figure 1 gives a simple, dummy example of a Cognitive Map for a hypothetical person who is hoping to get a job in the Civil Service. This shows how the person's interpretation of the problem space (how to get a job in the Civil Service) relates to their goal (starting work in the Civil Service). The map includes some concepts that include the contrasting idea within the concept, as described

[2] A software tool developed by developed by academics at the Universities of Bath and Strathclyde and now licensed by Banxia Software Ltd. See www.banxia.com (accessed 6th November 2008) for further information.
[3] Software provided by IHMC, available at: http://cmap.ihmc.us/ (accessed 6th November 2008)

in paragraph 15.b. For these contrasting ideas, the phrases 'as opposed to' or 'rather than' are denoted by '….', which is common practice for expressing concepts (Eden & Ackermann, 2001). Negative signs are attached to arrows to show that the concept has a negative or opposite impact on the concept that it has a link to. For example, in Figure 1 the negative sign shows that concept 13 is interpreted by the subject as having a negative impact on concept 10, in that the higher the number of applications, the lower the likelihood of their personal success.

17. Figure 2 gives a further dummy example related to hypothetical views of a staff objective-setting and appraisal system (called the 'Personal Development Agreement', PDA). This map shows one cognitive map for a Team Leader (line manager) and one for a Team Member. These maps have been combined reflecting the concepts of each individual, along with two shared concepts. This merging of individual maps creates a Cause / Group map (see paragraph 12) and reflects more than one person's view of the problem space. Such a map could be further developed by identifying further concepts including shared concepts, or by re-phrasing the map to refer to Team Leaders / Team Members rather than the first person 'I'.

18. These two examples have been used to reflect how Cognitive Mapping can be used to focus on attitudes and perceptions of a problem space (Figure 1) as well as on perceptions of a real-world system / process (Figure 2). The coding of concepts has been flexible, with a focus on using 4 – 10 words to aid clarity rather than requiring a "call to action".

POTENTIAL APPLICATIONS FOR DEFENCE

19. The following are potential areas in which Cognitive Mapping could be used to better understand and structure elements of the Defence environment. These suggestions for the use of Cognitive Mapping have not been tested or validated so remain potential areas only.

a. A means of structuring intelligence or assumptions about how an adversary or person / group of interest perceive the problem space. Such Cognitive Maps could be used to:

(1) support situational awareness and action planning (i.e. to explore 'what can we do to alter or influence this interpretation?').

(2) support 'Red Teaming' or gaming, where the Cognitive Map is used to brief the game-player or 'Red Team' on how the subject interprets the problem space.

b. Understanding and expressing a Commander's or planner's interpretation of the strategic / operational / tactical environment. This would be particularly appropriate as part of a broader SODA approach.

c. Understanding the requirements for training, as interpreted by various people who receive or benefit from the training.

d. Understanding different interpretations of organisational structure and change within MoD / Armed Forces organisations.

e. Informal use by an analyst or researcher to better understand a problem space, particularly at the scoping phase of a research project.

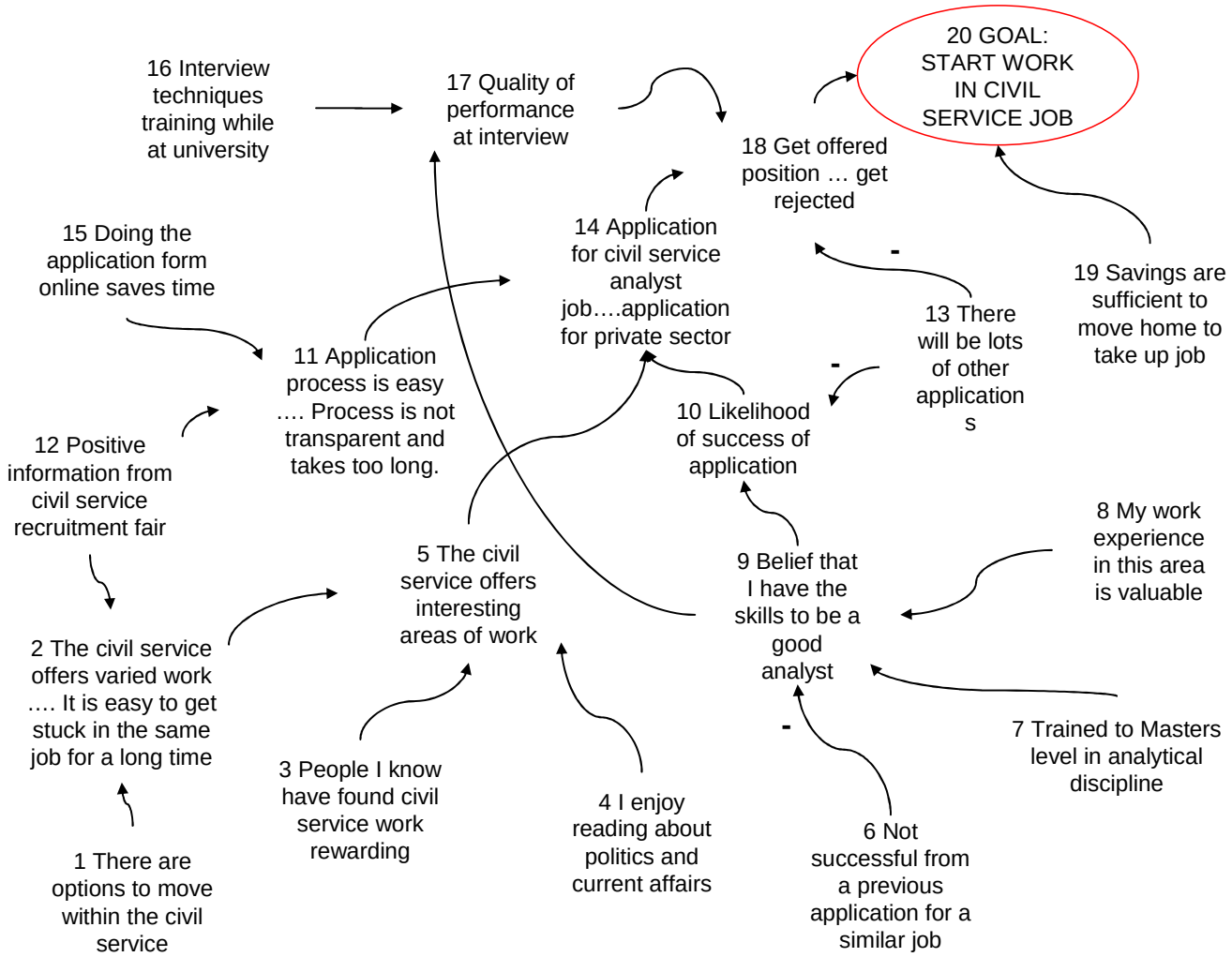

Figure 1 – Basic Cognitive Map using a dummy example of a goal to start work with the Civil Service[4].

[4] Negative signs are attached to arrows to show that the concept has a negative or opposite impact on the concept that it has a link to. '…' denotes the phrases 'as opposed to' or 'rather than'.

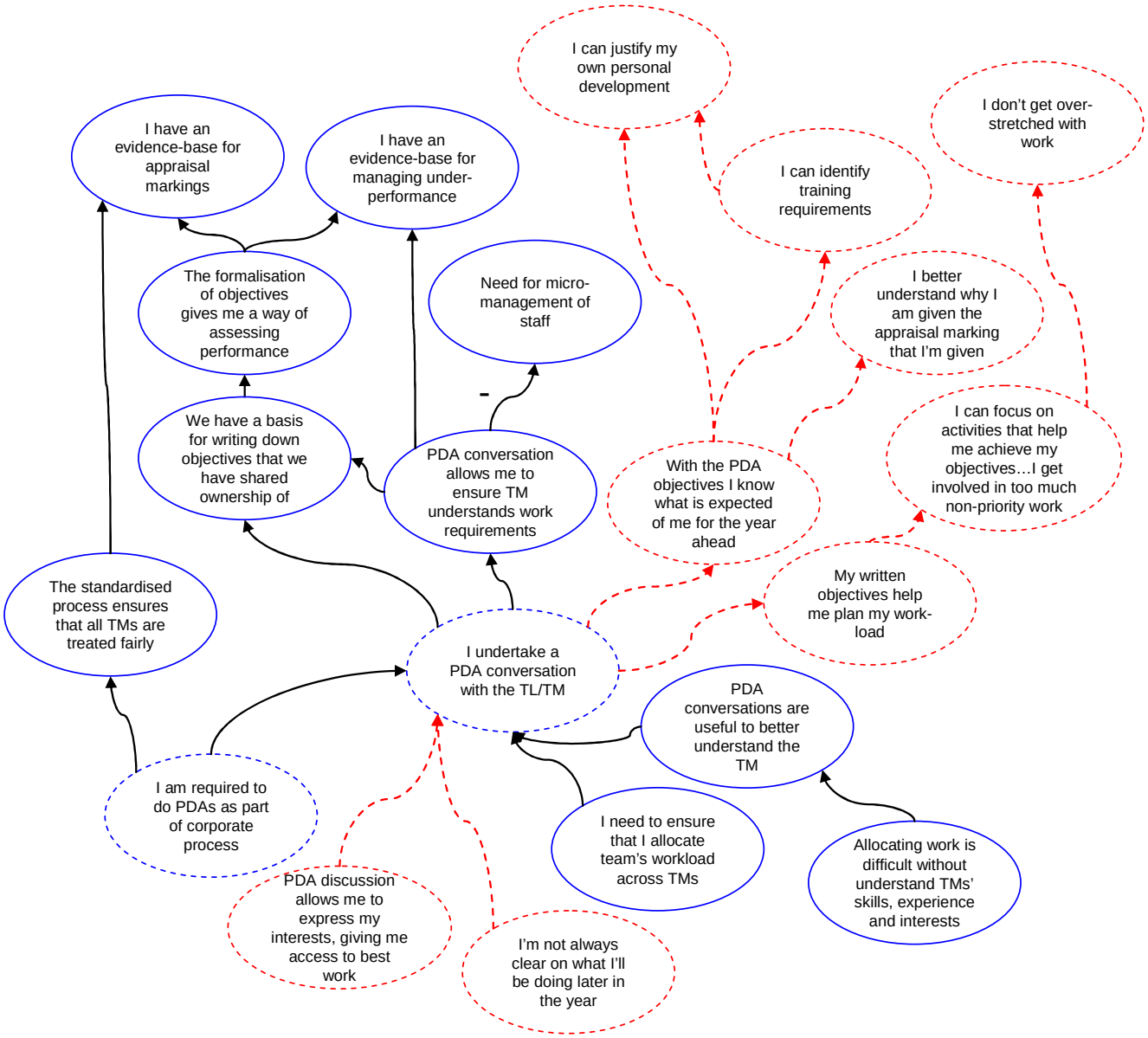

Figure 2 – The merging of two cognitive maps for a dummy example related to a staff appraisal system[5]

[5] Negative signs are attached to arrows to show that the concept has a negative or opposite impact on the concept that it has a link to. '…' denotes the phrases 'as opposed to' or 'rather than'.
Key: Blue solid lines = Concept from Team Leader (line manager); Red dashed lines = Concept from Team Member.; Blue dashed lines= Shared concept from Team Leader and Team Member. PDA = Personal Development Agreement (a system for objective-setting and appraisal); TL = Team Leader (line manager); TM = Team Member.

CONCLUSION

20. Cognitive Mapping is a useful technique for those wishing to better understand how an issue or event is interpreted by other individuals or groups. The flexibility of Cognitive Mapping is a key strength of the technique, allowing the analyst to apply it in a range of contexts and with a range of qualitative data.

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* Key introductory texts.

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