Methodological insights in managerial cognition: applied cognitive task analysis

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ABSTRACT

This paper draws upon Naturalistic Decision Making’s (NDM) methodological insights into the nature of ‘working minds’ (Crandall, Klein and Hoffman, 2006). First, an overview of NDM in organizations in the last decade is provided, observing how management decision makers negotiate uncertainty and utilise their expertise in order to make sense of events. Second, the current methodological challenges faced by researchers examining organizational decision making and managerial cognition are outlined. Third, potential methodological advances for accessing managerial cognition are examined focusing upon developments in cognitive task analysis.

Our contribution seeks to focus upon the way in which somewhat disparate areas of research may ‘cross-fertilise’ (McAndrew and Gore, 2006; Hodgkinson and Healey, 2008; Hodgkinson and Sparrow, 2002) in order to make more detailed sense of puzzles in managerial cognition and organizational decision thinking.

Key words:
Naturalistic Decision Making; Applied Cognitive Task Analysis, Managerial cognition
The primary purpose of this paper is to focus upon Naturalistic Decision Making (NDM) and its potential methodological insights for accessing managerial cognition. First, we outline key elements of Naturalistic Decision theory providing a brief synopsis of ideas which have been developed over the past decade. Second, we reflect upon how the methodological features of this line of research inquiry of ‘working minds’ (Crandall, Klein and Hoffman, 2006) may add to the development of the continual emergent research agenda of managerial cognition and organizational decision making. We also suggest a number of challenges and further questions which researchers in these areas may wish to consider as important for the development of our increased understanding of decision making within the complex area of managerial cognition in organizations.

Making detailed sense of decision making within organizations continues to be a highly relevant and important challenge for researchers from a wide range of disciplines and the call for increased dialogue between these disciplines has been requested in several arenas (Hodgkinson and Healey, 2008; Hodgkinson and Sparrow, 2002; McAndrew & Gore, 2006, Tsoukas, 2005; Chia, 2004). Thus, we offer reflection on methodological developments which, we suggest offer a pragmatic way forward.

**NATURALISTIC DECISION THEORY: KEY INSIGHTS**

The development of the NDM framework is now well documented (Schraagen et al 2008, Hoffman, 2007, Lipshitz et al, 2006; Montgomery et al 2004; Lipshitz et al 2001; Salas & Klein, 2001; Zsambok & Klein, 1997; Klein et al 1993), and a generation of researchers and practitioners in a range of domains have been captivated by this pragmatic approach. The NDM framework is regarded as “a loose grouping of non-standard models of individual decision making” (Connolly & Koput, 1997: 285). The NDM models/theories are generally regarded as radical and have evolved from a rejection of subjected expected utility (SEU) theory and decision research which has been primarily based in
laboratory settings. Put simply, NDM theorists suggest that classic decision theory, including SEU has done little to aid our understanding of decision making in real world contexts.

Pliske and Klein (2003) note that NDM inquiry has taken a `second path’ distinct from that taken by (Kahneman, et al., 1982; Tversky and Kahneman, 1974) which has led to the identification of a wide range of heuristics and biases in human decision making. This work has inspired a vast array of suggestions for improving decision thinking; managing heuristics and techniques to avoid decision traps which have become popular within management education and business contexts. The second path, which the NDM movement is following Pliske and Klein suggest, is the close examination of the heuristics and the study of expertise in order to learn more powerful heuristics (2003:579).

NDM has been defined as the study of how people use their experience to make decisions in field settings (Zsambok & Klein, 1997). Notably, the characteristics of NDM research are:

- ill-structured problems
- uncertain, dynamic events
- shifting, ill-defined or competing goals
- action-feedback loops
- time stress
- high stakes
- multiple ‘players’
- organisational goals and norms


Zsambok (1997) identified four criteria which contrast NDM to more traditional types of decision research:

1. the characteristics of the task and setting (context rich)
2. the nature of the research participants (most usually experts)
3. the intention of the research (describing the strategies people use)
4. the point of interest within the decision period (pre-choice processes, e.g. situation awareness).
In the following section of the paper we sketch some of the methodological lines of inquiry developed within NDM and managerial cognition, which our empirical work suggests has strong potential for mapping expert decision thinking.

**Methodological Developments: Accessing Cognition**

Applied Cognitive Task Analysis (ACTA) was developed by Klein and his co-researchers (see Militello, et al, 1997) as part of a project funded by the Navy Personnel Research and Development Centre in the USA. The aim was to design a means of making the process of cognitive mapping more concrete and accessible to practitioners across a range of fields (e.g. technical specialists, HR practitioners) whilst simultaneously maintaining the scientific integrity of conventional methods of task analysis. Militello and Hutton (1998) also provide a useful evaluation of the ACTA technique, reporting its ease of use, flexibility and provision of clear output, making it well suited for purposes of say training need identification or system design.

**Cognitive Mapping**

Attributed to Tolman (1948), cognitive mapping is now more commonly used as an ‘umbrella term’ encompassing methodologies that explore how individuals make sense of their world, thus assisting our understanding of cognition, perception, thinking, problem-solving and decision making. Facilitating cognitive processes which cannot be directly observed is attractive to practitioners, consultants and academics alike. In effect mapping techniques have become intermediate tools, which assist the discussion of areas of ordinarily unexplained behaviour.

Since the seminal works of, for example, Huff (1990), Walsh (1995), Eden and Spender (1998, 1992), cognitive mapping research has made a number of important advances across a range of areas. Significant findings from within the domain of strategic management research focusing upon managerial and organizational cognition (see Neck and Collier, 2002; Huff and Jenkins, 2002), suggests that these advances have resulted in an upsurge in methodological development for the exploration of cognitive maps. The majority of the work in this area has focused upon causal mapping alongside environmental categorization (e.g. Daniels, et al, 1994; Ambrosini & Bowmen, 2001). Techniques have utilized cognitive sculpting and software development to facilitate the analysis of content, and the narrative analysis of stories and metaphor.
The success of the various techniques however, is to date still difficult to assess and moreover methods often appear complex to use both for researchers and for practitioners. Caution has also been called for, and in this regard it is difficult to disagree with the view of Hodgkinson and Maule (2002) that, as yet, there is still little clear scientific evidence concerning the efficacy or reliability of many of the mapping procedures. In addition researchers in the managerial cognition community suggest that cognition is not enough when attempting to understand complex organizational activity; research which explores affect and social interaction is also required (e.g. Huff and Jenkins, 2002). The research community that employs cognitive mapping methods is therefore still seeking to develop and refine appropriate methodological tools to explore managerial cognition.

Jenkins (1998) suggests that in order to overcome this problem research should take issues such as epistemology, validity, reliability and practicability into account. In other words, the theoretical and methodological bases for representing cognition should be considered. The methodology should capture issues which are salient to the participant and as far as possible both the researcher and participant should be free from systematic bias, and finally the research methods used should be efficient and challenging, rather than time consuming and irritating. Jenkins (1998) argues that these are important considerations, especially as they allow management researchers to build the sort of relationships that are needed within the management community more generally. This view is also echoed by Johnson and Johnson (2002: 234) who encourage researchers to ensure the methods they use are ‘fit for purpose’. Hence, mapping should take into account issues such as cognitive theory, context, sources of data and the execution of mapping procedures and the requirements of end users.

**Task Analytical Techniques**

The development of task analytic techniques, which have been crucial to the development of training are also relevant to the development of research focusing upon managerial cognition (Salas & Cannon-Bowers, 2001). Essentially, cognitive task analysis (CTA) methods attempt to identify how individual experts perform a cognitive task. Such methods have received much research attention recently (Annett, 2000; Dubois & Schalin, 2000; Schragen *et al* 2000; Gore, 2003). Historically however, CTA does not have one single and well-accepted definition. In addition, the knowledge
elicitation techniques which are at the heart of these methods, vary greatly. The most frequently used include structured and semi-structured interviews, group interviews, verbal ‘think-aloud’ protocols, retrospective verbal protocols, analysis of previous incidents and observation of task performance. Each of the methods has had some success using realistic problem-solving and decision-making tasks, many experts and many tasks, or many different scenarios revolving around the same task. A key concern here is that CTA methods have been criticised as being difficult to use, very time consuming and sometimes resulting in problematic data analysis (Hoffman et al, 1995, 1998, 2000; Gordon, 1997; Fowlkes et al, 2000).

The ACTA Technique – a potential way forward

Like CTA, the ACTA technique is intended to assist the identification of key cognitive elements required to perform a task proficiently. The cognitive requirements that cognitive task analysis address are: (1) difficult judgments and decisions; (2) attentional demands; (3) identifying critical cues and patterns; (4) problem solving strategies and other related topics. ACTA includes knowledge elicitation and knowledge representation techniques. Knowledge elicitation techniques involve the use of interviews (and sometimes observation), whilst knowledge representation techniques are a means to depict cognitive information (cognitive mapping).

The various ACTA techniques outlined above were developed to compliment each other, each tapping into different aspects of cognition. The first step in the process, the production of the task diagram (usually by means of interview) gives an overview of the task, highlighting cognitive difficulties which are usually explored in greater detail later. This provides the interviewer with a broad overview of the task. The second step, the knowledge audit, reviews the aspects of expertise required for the effective execution of a specific task or sub task. The audit is theoretically grounded in the research literature on expert-novice differences (Chi et al, 1981; Dreyfus and Dreyfus, 1986; Hoffman, 1992; Klein & Hoffman, 1993) and critical decision method studies (Klein et al, 1989; Militello and Lim, 1995). As the aspects of expertise are elicited they are individually probed using a series of generic and domain specific basic and optional probes to elicit for further detail and concrete examples associated with the task are identified and investigated. This technique also encourages the interviewee (usually a subject matter expert) to identify why elements of the task may present a
problem to inexperienced individuals. The knowledge audit has been developed with the aims of capturing key aspects of expertise, and improving and ‘streamlining’ data collection and analysis. The third step, the *simulation interview* or scenario obtains information on the contextualization of the job or task (this is not easy to obtain with the preceding steps). It allows the interviewer to explore and probe issues such as situation assessment, potential errors and biases and how a novice would be likely to respond to the same situation. In the final step, the production of a *cognitive demands table* (CDT) is a means of merging and synthesizing data. The CDT is the deliverable of the ACTA intended for practitioner use and it allows them to focus on the specific outcomes of the analysis that are pertinent to problem solving, decision making and so on in areas such as training, job design, etc.

**ACTA & Training Needs Analysis**

Adopting a training perspective Salas and Cannon-Bowers (2001) also argue that cognitive task analysis is a potentially useful tool but needs more systematic development. Specifically they suggest that a theoretically driven methodology which clearly outlines the steps and stages and how to analyze the data is required. This view from within the training literature therefore complements discussions within the managerial and organizational cognition research community which call for more scientific rigour in order to develop a more robust research methodology. Moreover, Salas and Cannon-Bowers note that whilst much of the rhetoric associated with the theory and practice of training argues that training needs analysis (including methods such as task analysis) is the most important phase in training it remains largely “more art than science”. Determining the training needs of individuals and organizations they argue requires the development of a more systematic and conceptually rigorous methodology. This is especially true with regard to knowledge work and the development of knowledge assets and human capital. The refinement of ACTA for these purposes will provide a significant development in available tools and techniques for the identification of training needs in knowledge-based work and furthermore will provide instructional designers with clearer guidelines when designing training for cognitively demanding tasks.
The Evaluation of the ACTA Process

For the ACTA method to be valid it is essential that the knowledge base is empirically verifiable, hence a significant question in this research is that of how to empirically validate the knowledge base as revealed in the CDT and hence validate its usefulness for practitioners. Militello and Hutton (1998) describe a technique whereby they evaluated both the process (ACTA) and the outcomes (the knowledge base).

The ACTA process was evaluated by trailing its use in an experimental setting with two groups of naïve users. After initial training in CTA the naïve users were separated into two groups. One group (unstructured) used whatever format they felt would be most useful for gathering cognitive information from subject matter experts (SMEs). The second group (ACTA) group was provided with additional training on ACTA and instructed to use this method in their knowledge elicitation exercise with the SMEs. Following further training on the analysis of ACTA-derived data the materials generated by the participants were assessed by SMEs who had not participated in the study. Small group sizes limited the statistical power of the analysis but nevertheless the results of the evaluation revealed that participants (graduate students) were able to elicit important, accurate cognitive information that was easily translatable into training materials.

Taking on board the associated difficulties highlighted by Jenkins (1998), Hodgkinson and Maule (2002) and Johnson and Johnson (2002) in researching managerial cognition, and the concerns expressed by Salas and Cannon-Bowers (2001) with regard to training needs analysis training, our view is that ACTA appears to provide a potential way forward that is theoretically sound and methodologically rigorous and of high potential value to end users. The ACTA techniques are concerned with epistemology, the study of expert knowledge and how it is formed; face validity also seems evident, as does practicability (Hoffman et al 1995). The reliability of the technique however has not been rigorously or fully investigated in general management (having been restricted to a fairly narrow range of technical and specialist tasks). Having a firm theoretical base in decision research the ACTA techniques, their purpose and use are clearly defined and the approach therefore offers a systematic package for practitioners to elicit expertise and map and communicate cognition. However whilst previous exploratory research by Hoffman et al (1995, 1998), McAndrew (2008); Gore and
Riley (2005) and Gore (2003; 2000) suggests that the ACTA methods appear to be useful for knowledge representation and elicitation and have high-face validity amongst participants, there is currently no systematic basis for evaluating ACTA against agreed scientific criteria.

The ACTA techniques are useful in the fact that they hold epistemological assumptions regarding the examination of expert knowledge and its’ formation unlike other qualitative methods. Nevertheless, the ACTA techniques are useful in informing some of the challenges facing the managerial cognition and organizational decision making research communities.

**DIRECTIONS FOR FUTURE RESEARCH**

Given our arguments in favour of cross-fertilising methodological development in NDM with managerial cognition and organizational decision making what is an appropriate research agenda for integration? Whilst this paper has proffered a number of theoretical arguments in favour of adopting a pragmatic approach which values of the use of ACTA in addressing some of the field’s challenges, further empirical examination is still required in a range of areas which involve complex decision making in organisations.
References


International Conference on Naturalistic Decision Making. Monterey, CA.


