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Original citation:
Okoli, J, Weller, G, Watt, J & Wong, BLW 2013, Decision making strategies used by experts and the potential for training intuitive skills: A preliminary study. in H Chaudet, L Pellegrin & N Bonnardel (eds), *Proceedings of the 11th International Conference on Naturalistic Decision Making (NDM 2013).* Association pour la Recherche en Psychologie Ergonomique et Ergonomie, Marseille, France, pp. 227-232.
http://arpege-recherche.org/ndm-13

Publisher: ARPEGE SCIENCE PUBLISHING

Decision making strategies used by experts and the potential for training intuitive skills: A preliminary study

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ABSTRACT

Experts do better than novices- not only because they possess more perceptual and cognitive skills but also because they are able to organize and apply those skills better than their counterparts. However, experts find it difficult to express what they know. This is mainly because their knowledge is highly resistant to surface articulation, even by the experts themselves. Thus, it is evident experts need help telling what they know and do. In this study, expert firefighters were interviewed using the critical decision method (CDM) procedure. Results from the investigation revealed certain tacit (procedural) knowledge and cognitive skills they used in performing complex tasks in time pressured environments. It is hoped that systematically organizing this knowledge and skill into a framework will enhance the design of a well informed instructional curriculum for training less experienced officers.

KEYWORDS

Decision Making; education and training; expertise; critical decision method; tacit knowledge; intuitive skills.

INTRODUCTION

During any crisis, civilians whose lives and properties are at stake usually expect a lot from incident command teams. Hence, responding to more dangerous and un-predictable crises will definitely call for the skills of more experienced personnel (Zsambok, 1997). Managing real-world crises poses numerous challenges to professionals because they operate under time pressure, uncertainty, dynamic and changing conditions, ill-defined goals, high stakes etc. (Lipshitz, Klein, Orasanu & Salas, 2001). The goodnews however, is that experienced decision makers still carry on despite these challenges, and they perform reasonably (and sometimes exceptionally) well under these conditions (Orasanu & Connolly, 1993).

Nevertheless, there is compelling evidence to suggest that experts are not fully aware of about 70% of their own decisions and mental analysis of tasks (Clark, Feldon, van Merrienboer, Yates & Early, 2006). In other words, they sometimes find it challenging to fully explain how they arrive at their judgement especially when such information is required to support the design of training, assessment or decision aids (Hannabuss, 2000; Dane & Pratt, 2009).

The objectives of this research therefore are: (1) to investigate how real experts make critical decisions in performing complex tasks (2) to develop a well structured instructional curriculum (educational framework) using the information generated from objective 1 above. This framework will facilitate the learning process and the transfer of relevant knowledge, skills and competence (KSC) to novices.

This current paper presents a preliminary result on some key insights generated from the pilot study, which is part of the ongoing research process. This result will subsequently inform part of the design of a training curriculum using the four component instructional design (4C/ID) framework.

EXPERTS, DECISION MAKING AND THE NATURALISTIC ENVIRONNMENT

Shanteau (1992) defined experts as “those who have been recognized within their profession as having the necessary skills and abilities to perform at the highest level”. The school of thought that favours experts’ cognitive competence has generally been referred to as naturalistic decision making (NDM); where complex and challenging tasks are performed in naturalistic (real-life) settings (Gore, Banks, Millward & Kyriakidou, 2006; Lipshitz, Klein, Orasanu & Salas, 2001). In contrast to the normative model which prescribes how decisions should be made, NDM describes how people actually make decisions using their experience (Zsambok, 1997; Shanteau, 1992). This way, NDM researchers make prescriptions based on descriptive models of expert performance. As Kahneman and Klein (2009) puts it:

H. Chaudet, L. Pellegrin & N. Bonnardel (Eds.). *Proceedings of the 11th International Conference on Naturalistic Decision Making (NDM 2013), Marseille, France, 21-24 May 2013*. Paris, France: Arpege Science Publishing. ISBN 979-10-92329-00-1

"A central goal of NDM is to demystify intuition by identifying the cues that experts use to make their judgments, even if those cues involve tacit knowledge and are difficult for the expert to articulate. In this way, NDM researchers try to learn from expert professionals".

There is growing evidence from the literature to suggest that decision making within the naturalistic setting involves more than one reasoning strategy (cf Gigerenzer & Gaissmaier, 2011).Within the field of cognitive science, two main modes of thinking have been suggested: the intuitive and analytical strategies (Klein, 2003:64), elsewhere known as system 1- effortless, intuitive and automatic, and system 2 - effortful, analytical and deliberate (Kahneman, 2011). However, the intuitive strategy (tacit system) is usually the "default" operational procedure, and the deliberate (analytical) system is only invoked when the former cannot solve the problem at hand or when there is need to make a conscious decision- such as planning what to do next.

Unfortunately, despite arguments that individuals may benefit from switching between intuitive and analytical approaches, little research agreement has emerged concerning the preferred sequence by which individuals should employ these approaches e.g. should people take stock of their intuition first and then engage in analysis? Or, should they expect intuition to play a key role after engaging in an analytical decision-making process? It is therefore not entirely clear whether intuitive and deliberative thinking actually represents two different modes of thinking or whether they are end points of the same dimension.

METHODOLOGY

Critical Decision Method

The critical decision method (CDM), which is a semi-structured interview process, was specifically used to elicit expert knowledge (cognitive strategies and mental models) in this study. Critical decision method is a retrospective interview strategy that applies a set of cognitive probes to actual non-routine incidents that required expert judgment or decision making (Klein, Calderwood & MacGregor, 1989)

This method was preferred to others within the cognitive task analysis family for two reasons: First, the CDM has a strong theoretical basis and it is highly instrumental in defining the emerging field of Naturalistic Decision Making (Hoffman, Crandall, & Shadbolt, 1998). Second, it has been widely used in different ways to elicit expert knowledge across different domains, hence, the validity and reliability of this method has been proven (Wong, 2000). CDM (being a semi-structured protocol with cognitive probe) has also been successfully used to overcome the effects of memory limitations- which has proved to be a major concern regarding retrospective verbal reports in the knowledge elicitation process (Clark et al., 2006)

Participants

30 experienced fire-fighters (n=30) selected across various fire stations in the UK and Nigeria makes up the sample size for the wider study. Currently, six experienced firefighters (n=6) in the UK have been interviewed as part of the piloting process. The participants were carefully chosen based on their rank/position as well as through peer nomination- as a proof of their expertise. This is to ensure that expertise is verified and not assumed. All participants had personally been involved in managing real-life fire incidents in which they made critical decisions, and have at least operated as an incident commander.

Procedure

Participants were first asked to recall and 'walk-through' a memorable fire incident that tasked their cognitive skills. Thereafter a timeline was constructed jointly with the participants, and decision points were identified. This was then followed by probing the decision points using some set of cognitive probes- at this point, we are interested in unmasking the tacit knowledge and decision making strategies behind experts' performance. Each interview lasted between 1hr-2hr and was recorded with the consent of each participant.

RESULTS AND DISCUSSION

Data from the CDM procedure were carefully transcribed. A total of 19 decision points were identified from the six interviews, and these decision points formed the basic unit of analysis (Figure 1). Data analysis was conducted using both the critical decision analysis and the emergent themes analysis (ETA) processes (Wong, 2004).

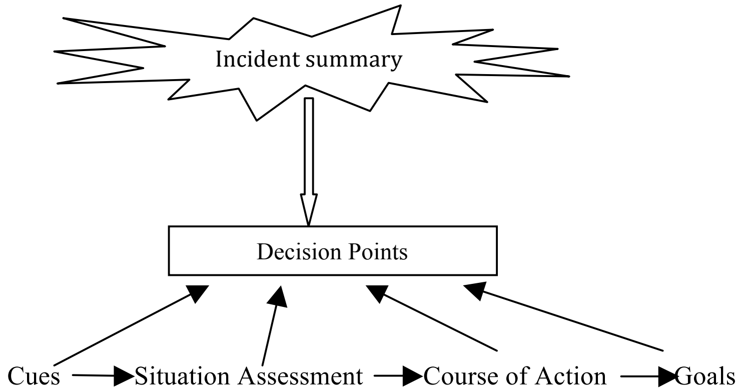

Figure 1. CDM data analysis process

Specific themes from the CDM data analysis were then collated across the six different incidents in order to identify commonalities. Five main themes emerged from this preliminary study and are briefly discussed below:

Complex Tasks

For a task to be judged as complex they must be performed using both automated and explicit knowledge, and will in addition usually extend over many hours or days (Clark et al., 2006). To demonstrate this, interviewees reported certain difficulties they encountered when managing the various incidents which they narrated. These difficulties include: working over a long duration of hours usually without breaks or refreshments, the need to manage and coordinate resources effectively (crew members, fire engines and appliances), the need to continuously monitor the situation and develop plans based on changing conditions, and the possibility of encountering novel situations etc. Interviewees explained some complexities associated with their job tasks:

> *"This incident was very challenging for me because we were working against very difficult atmospheric conditions- very dry, severe drought and windy conditions in a densely populated area- with houses all over" (participant 6)*

> *"It was very unusual for me because the woman involved was psychiatric and threatened to burn down the building (Arson) if we left. So the incident turned out to be a welfare issue" (participant 2)*

If we therefore aim to achieve a more efficient process of transferring intuitive skills from experienced officers to novices, it then becomes necessary to understand and capture how these experts perform such complex tasks (van Merrienboer, Clark & de Croock, 2002)

Cue Identification

Interviewees reported relying heavily on their senses- eyes, ears, and nose- as useful aids in formulating their decisions. In other words, they made decisions based on identified cues, such as the colour, intensity and smell of smoke. Generally, the level of risk that expert firefighters are willing to take depends largely on whether or not the environment presents favourable cues (Kahneman & Klein, 2009). When asked about the cues they looked for, interviewees responded thus:

> *"I used information I gathered from people around, I used my eyes, my ears, and a bit of common sense"* (Participant 5)

> *"I think seeing is believing; so I will take all I can see as my basis of information"* (participant1).

Situation Assessment

Interviewees reported that they always conduct a 360^0size up, also known as situation assessment immediately they arrive at the scene of an incident. They also reported that past experiences, in addition to their existing knowledge were crucial factors in maintaining accurate situation assessment.

> *"The only way I can describe it is that those incidents contribute to a template. You may only have 5 or 6 templates perhaps, but most of the incidents you go to will fit into one of those templates"* (participant 3)

However, interviewees explained that the task begins to place more cognitive demand on them when the current situation fails to match any of the pre-stored patterns in their memory. This is the point where they normally shift from rule-based to a more creative decision making strategy, which sometimes might contradict the SOPs (Klein, 2003)

> *''Yes we don't normally get people down through a ladder because it is risky, but I had to take that risk and it turned out that I was right''* (Participant 1)

Table 1. Analysis of oil storage fire incident showing shifts in Situation Assessments

Situation assessment 1	
Cues	Very large fire involving oil storage; collapsed roof; site of incident very close to residential houses
Expectations	Very intense fire with high potential to spread further
Goals	Get access to the building; get enough water to attack the fire; contain the fire
Decision-Point 1	Ask for reinforcement (Requested 15 additional pumps)
Decision-Point 2	Exterior attack- it is too dangerous to commit crew
Situation assessment 2	
Cues	Fire growing bigger; arrival of 15 additional pumps
Expectations	Presence of additional workforce will result into better control
Goals	Get access to the seat of the fire; resort to another option since the initial option of water attack is not working; safety of crew members
Decision-Point 3	Get specialist appliance to climb higher in order to see the actual seat of the fire
Situation Assessment 3	
Cues	Fire still burning due to involvement of petrol at the seat of the fire; water unable to put out the fire; pollution of water courses.
Expectancies	Fire may remain uncontained and burn out itself unless a more rigorous strategy is employed
Goals	Reduce environmental pollution from the flames as much as possible; clear the road for road users to get to work as soon as possible.
Decision-Point 4	Decision to request specialist appliance (foam attack)

Decision Making Strategy

Interviewees agreed that they employ both intuitive and analytical strategies in making most of their decisions. However, they stated that many of such decisions have to be intuitive. Even the analytical decisions still have to be made as quick as possible. According to them, time is a critical factor which is never sufficient when managing fires- thereby limiting the possibilities of conducting any thorough analysis. The breakdown of the 19 decision points based on decision making strategies and the estimated decision time is shown on table 2:

Table 2. Analysis of the decision making strategies from the six incidents

Decision making strategy	Estimated decision time by participants	No of Decision points
Intuitive	≤ 1minute	10
Analytical	>10 minutes	2
Intuitive + Analytical	≤ 10 minutes	7
		Total =19 decision points

Previous research has shown that professionals could actually draw on the repertoire of patterns that they had compiled during more than a decade of both real and virtual experience to identify a plausible option, which they considered first (cf Klein, 2003). This is what the recognition primed decision (RPD) model developed by Klein and his colleagues illustrate (Klein et al., 1989). According to the RPD model, the patterns stored in the memory of the decision maker highlights the most relevant cues, provide expectancies, identify plausible goals, and then suggest appropriate types of reactions (i.e. using recognized patterns to solve current problems).

Table 3. Analysis of the problem solving strategies from the six incidents

Problem solving strategy	Description	No of Decision points/Percentage
Standard	Generally agreed by all officers as the most appropriate option	5 (26.3%)
Typical	Modifications to the standard operating procedures to meet the requirements of the situation	9 (47.4%)
Creative/constructed	No standard solution exist; typically requires creative problem solving	5 (26.3%)
		19 (100%)

It can therefore be suggested that, depending on the complexity of the problem at hand and the ease of recall to memory, officers usually confront challenges using any of the 'standard', 'typical' or 'creative' problem solving strategies (see Table 3). To validate this, interviewees were asked if the situation they narrated and their subsequent decisions fit into the scenario they were generally trained for. They reported thus:

> "*Normally you have a set of options that you pick, and they will be right- one way or another. You might start up with option A, and a subtle change to option B will be successful. You adapt the procedures for the job to do something unusual*" (Participant 3)

> "*It was an unusual incident, but something inside you takes over- where you go into a mode of professionalism- and it comes because you have been doing it for that long*" (Participant 5)

Training Requirements for Less Experienced Officers

Interviewees ascribed their decision making ability to both the quality and quantity of the training they have undergone over their years of practice. They were able to identify some of the training they have but which their non-expert counterparts did not have (or which they have at just a basic level). These include: command and control training, breathing apparatus training, human resource management training, training involving acetylene cylinders and asbestos, training on how to use hydraulic platforms, first aid trainings etc. They however explained that this training could be merely theoretical if officers do not have the opportunity to apply them in real life incidents.

> *"Most firefighters are taught to do the techniques that extinguish fire. But an incident manager needs to be trained to manage the incident, needs to be trained to command, and that is quite a long and extensive period of training"* (participant 3)

> *"As a manager as well, you have management training; how to deal with incidents, how to deal with people, and how to deal with staff"* (participant 2)

Thus, to be able to attain automaticity and expertise, novices must be given opportunity to practice their job procedures deliberately and continuously until processing becomes more effective and efficient (Ericcson, Prietula & Cokely, 2007).

CONCLUSION AND FURTHER WORK

One of the ways of improving the overall level of human performance in a task is by understanding how proficient individuals actually perform the task. This preliminary study, using the critical decision method (CDM) has begun to reveal some of the skills, knowledge and competencies inherent in expert firefighters we interviewed.

However, at the advanced data collection stage of this overall study we hope that data from subsequent CDM process will be analyzed further to provide detailed and in-depth information about the skills, cognitive strategies, sequence, action scripts, mental models, prerequisite knowledge, and rules required for complex skill learning. This learning process will then be coherently organized for ease of teaching through the four component/instructional design (4C/ID) model.

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