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A Comparison of the Decision Ladder Template and the Recognition-Primed Decision Model

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ABSTRACT

The decision ladder template, one of the tools of Cognitive Work Analysis, attracts attention as a point of comparison for models of naturalistic decision making, such as the recognition-primed decision model. This report compares the decision ladder template and the recognition-primed decision model in terms of five main factors. These factors are origins, concepts, knowledge elicitation, knowledge representation, and implications for the design of decision support systems. The report concludes that while there are several similarities between the decision ladder template and the recognition-primed decision model, there are a number of significant differences as well.

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Executive Summary

Decision support systems for complex sociotechnical systems must support workers effectively, not only during stable, routine conditions, but also during situations that have not been foreseen by designers or that are not familiar to experienced workers. Two approaches that may be employed for the design of decision support systems are the decision ladder template and the recognition-primed decision model. The decision ladder template, which belongs to the framework of Cognitive Work Analysis, is a tool for analysing what needs to be done in a system, independently of how it is done or by whom. The recognition-primed decision model is a description of a strategy that experts use for decision making in natural settings.

In this report, the decision ladder template and the recognition-primed decision model are compared in terms of five main factors. These factors are: origins, concepts, knowledge elicitation, knowledge representation, and implications for the design of decision support systems. The comparison highlights that while there are several similarities between the decision ladder template and the recognition-primed decision model, there are a number of significant differences as well.

The similarities between the decision ladder template and the recognition-primed decision model occur mainly because they were both motivated by observations of expert decision making in natural settings. These observations highlighted that experts rarely use analytical strategies for decision making when performing familiar tasks. Instead, experts are able to recognise and respond to situations on the basis of their prior experience.

The differences between the decision ladder template and the recognition-primed decision model arise, principally, due to two reasons. First, the decision ladder template is concerned with representing what must be done in a work domain, independently of how it is done or by whom, whereas the recognition-primed decision model does not make these distinctions. Second, whereas the recognition-primed decision model focuses on expert decision making in familiar situations, the decision ladder template is also concerned with behaviours that can occur under different conditions, for instance, when experts are confronted with unfamiliar situations or when novices are engaged in performing various tasks.

The differences between the decision ladder template and the recognition-primed decision model are reflected in their implications for the design of decision support systems. The recognition-primed decision model focuses on supporting situation assessment by using strategies like feature-mapping and story-building. In addition, the recognition-primed decision model focuses on supporting option evaluation and development by using strategies like mental simulation. The decision ladder template is concerned with

supporting activities like situation analysis, option evaluation and goal selection, and planning, scheduling, and executing action. In addition, the decision ladder reflects a concern with supporting skill-, rule-, and knowledge-based behaviour. These differences do not mean that the decision ladder template and the recognition-primed decision model offer contradictory approaches for the design of decision support systems. Instead, these differences mean that the two approaches are complementary. Both approaches may be useful for the design of decision support systems for complex sociotechnical systems.

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Neelam Naikar is the lead scientist at the Centre for Cognitive Work and Safety Analysis. She joined the Defence Science and Technology Organisation as a Research Scientist in 1996 and was promoted to Senior Research Scientist in 1999. Some of Neelam's major projects have involved the extension of Cognitive Work Analysis to support the acquisition of complex, military systems, such as Airborne Early Warning and Control and F/A-18, and the application of AcciMap Analysis and the Critical Decision Method to enhance safety in complex, military systems, such as the F-111. Her current research interests include the development of theories and methods for analysing cognitive work and safety in complex systems. Neelam obtained a BSc (Hons) in Psychology from the University of New South Wales, Australia, in 1993 and a PhD in Psychology from the University of Auckland, New Zealand, in 1996. Neelam is a member of the Board of Editors for the International Journal of Aviation Psychology.

Contents

1. Introduction

At the last NATO Advanced Study Institute Workshop on Intelligent Decision Support in Process Environments, Rasmussen (1986) argued for the importance of designing decision support systems that are not only effective during stable, routine conditions but also during situations that have not been foreseen by designers or that are not familiar to professional, trained workers (Naikar, 2006). He made the case that, in order to develop such systems, designs cannot be based on detailed, quantitative, or normative prescriptions of task processes or sequences. Instead, design should be based on a model or framework that defines the boundaries of an envelope within which workers can generate ad hoc practices that not only suit their subjective preferences but also the particular demands of the situations or contingencies at hand. His paper focused on describing such a framework; a framework that is now known as cognitive work analysis (CWA).

In the last two decades, CWA has received considerable attention both in terms of research and application. Another significant development during this period has been the emergence of models of naturalistic decision making (Beach, 1990; Klein, 1989, 1998; Noble, 1993; Pennington & Hastie, 1988), which also have major implications for the analysis of decision making and the design of decision support systems. This raises the question of how CWA compares to recent models of naturalistic decision making.

The CWA framework consists of several phases of analysis, each associated with particular modelling tools or templates (Rasmussen, Pejtersen & Goodstein, 1994; Vicente, 1999). A full comparison of the entire CWA framework to a range of models of naturalistic decision making is beyond the scope of this report. Instead, this report compares one of the modelling tools of CWA, the decision ladder, with a well-established model of naturalistic decision making, the recognition-primed decision (RPD) model (Klein, 1989, 1998).

An issue that should be addressed first is whether it is appropriate to compare the decision ladder with the RPD model. The decision ladder is a template for the second phase of CWA, control task analysis, which focuses on identifying *what needs to be done* in a work domain, independently of how it is done or by whom. In contrast, the RPD model is a description of a *strategy* that experts use for decision making in natural settings. It might, therefore, be argued that it would be more appropriate to compare the RPD model with strategies analysis, the third phase of CWA, which is concerned with identifying the set of strategies by which particular work demands can be met. Alternatively, it might be argued that it would be more appropriate to compare the RPD model with the skills, rules, and knowledge taxonomy. This taxonomy, which is associated predominantly with worker competencies analysis, the fifth phase of CWA, has been described as a model of naturalistic decision making (Zsambok, Beach, & Klein, 1992). The decision ladder, however, tends to attract attention as a point of comparison for models of naturalistic decision making. Most likely, this is because the name of the tool implies a concern with decision making and the decision ladder can be seen as a normative, rational model of decision making. These aspects of the decision ladder lead to the question of how it compares to models of naturalistic decision making.
In what follows, this report first provides summaries of the decision ladder template and the RPD model. The report then compares the decision ladder template and the RPD model in

terms of five main factors: origins, concepts, knowledge elicitation, knowledge representation, and implications for the design of decision support systems. The report concludes by providing an overall assessment of the similarities and differences between the decision ladder template and the RPD model.

2. The Decision Ladder Template

The decision ladder is a template for representing the generic categories of activity that are necessary in a system in terms that are suitable for design (Rasmussen, 1974, 1976; Vicente, 1999). Figure 1 shows that the decision ladder is comprised of links between boxes and ovals. The boxes represent information-processing activities whereas the ovals represent states of knowledge that are the results or outputs of those activities. The left leg of the decision ladder is concerned with situation analysis, the top part of the decision ladder is concerned with option evaluation and goal selection, and the right leg of the decision ladder is concerned with planning, scheduling, and executing action.

The basic structure of the decision ladder is defined by a series of states of knowledge and information processes arranged in a sequence that characterises rational, knowledge-based behaviour (indicated by the broken arrows that 'frame' the decision ladder in Figure 1). This sequence of activities is mainly adopted by workers when heuristic or rule-based shortcuts are unavailable, for instance, when experts are confronted with unfamiliar tasks or when novices are engaged in performing certain tasks. Alternatively, rule-based behaviour is exploited by experienced workers when they are performing familiar tasks. This type of behaviour is revealed on the decision ladder as shortcuts from one part of the template to another (exemplified by the solid arrows in the centre of the template in Figure 1). Experienced workers rarely follow the decision ladder in a linear sequence. Instead, large parts of the decision ladder are bypassed. Experienced workers can also 'enter' the decision ladder at different points on the template, and they can move through the decision ladder from right to left rather than only from left to right. Finally, the decision ladder also depicts skill-based behaviour as direct connections between the activation and execution boxes of the template (indicated by the dotted arrow at the bottom of the decision ladder in Figure 1). This type of behaviour is characterised by highly automated and integrated patterns of action, such as sensorimotor behaviour. The variety of 'movements' that are possible through the decision ladder reflects the view that expertise is a constructive process that involves generating a contextually-tailored sequence of cognitive activities that is appropriate for the current situation (Vicente, 1999).

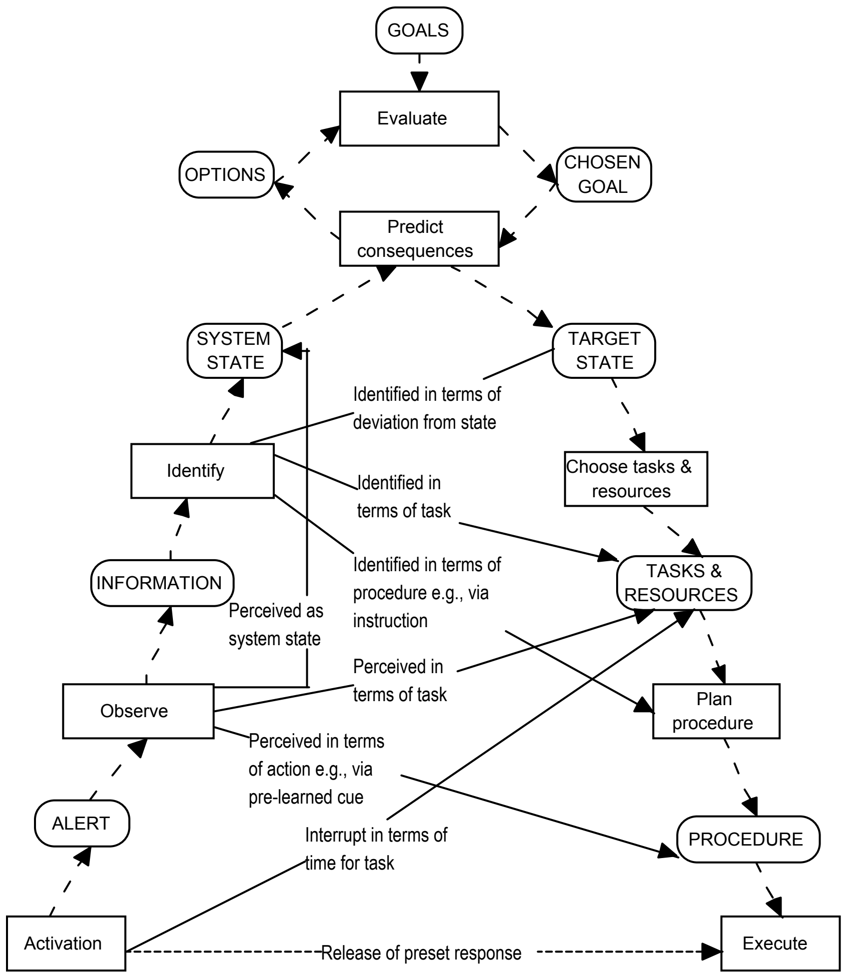

Figure 1 The decision ladder template. Adapted from Rasmussen, J. (1976), Outlines of a hybrid model of the process plant operator, In T. B. Sheridan & G. Johannsen (Eds.), Monitoring Behaviour and Supervisory Control (pp. 371-383), New York: Plenum, with permission, and from Rasmussen, J., Pejtersen, A. M., & Goodstein, L. P. (1994), Cognitive Systems Engineering, New York: Wiley, with permission.

3. The RPD Model

The RPD model describes a strategy that experts use for decision making during familiar situations in natural settings (Klein, 1989, 1998). This model, which is presented graphically in Figure 2, has four major features: the recognition of cases as typical, situational understanding, serial evaluation, and mental simulation. To elaborate, first, the RPD model proposes that on the basis of their experience with a variety of cases, experts can recognise whether a situation is typical or familiar. Second, the RPD model proposes that in recognising a situation as familiar, the decision maker can draw on prior experience for guidance on how to proceed with respect to four different types of information: (1) plausible goals, that is, what is possible to accomplish in the situation; (2) critical cues and causal factors, that is, what cues to attend to and what their causal implications are; (3) expectancies, that is, what is likely to happen and when; and (4) typical actions, that is, what responses are typical in the situation. Third, the RPD model proposes that experienced decision makers engage in serial evaluation of options whereby they assess options one at a time until a satisfactory one is found (as opposed to concurrent evaluation of options whereby a set of options is generated and evaluated comparatively). Moreover, the first option selected by experienced decision makers is the most typical option and, therefore, has a high likelihood of being effective. Fourth, the RPD model proposes that experienced decision makers evaluate one option at a time by the use of mental simulation or, in other words, by imagining how an action or option will be carried out within the specific setting. Mental simulation allows the decision maker to forecast the adequacy of an action.

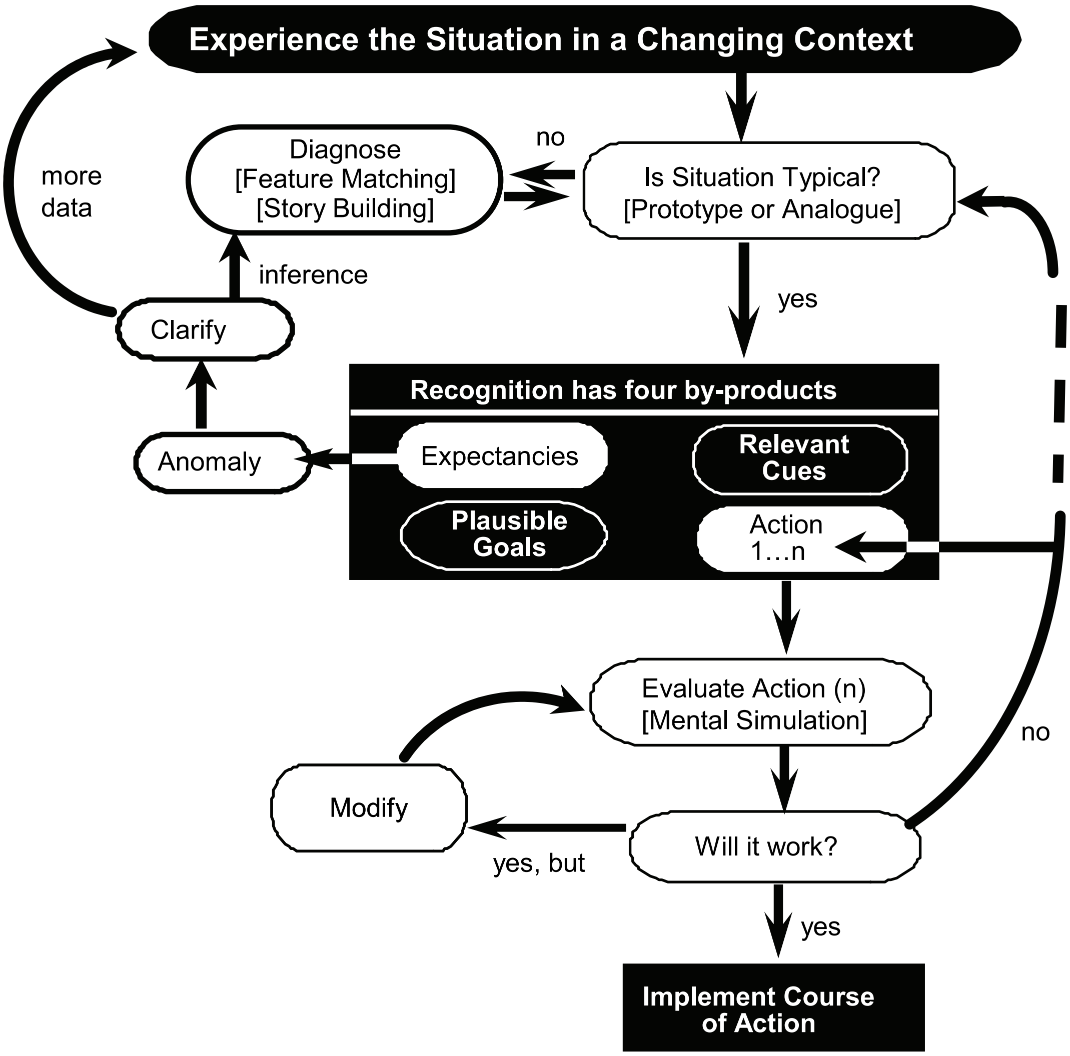

Figure 2 *The RPD model. Reproduced from Gary Klein, Sources of Power: How People Make Decisions, Cambridge, MA: The MIT Press, © MIT 1998, figure 3.2, with permission.*

4. Comparison of the Decision Ladder and the RPD Model

4.1 Origin

Rasmussen (1974, 1976) developed the decision ladder template following several studies in which he used verbal protocols to study the decision making processes of experienced workers in thermal power stations. He found that workers' verbal protocols generally provided very little data about the information processes that were involved in performing various tasks. Instead, workers' verbal protocols seemed to be comprised of various sequences of statements or questions about their "states of knowledge" regarding, for instance, the plant, their tasks, and actions. Furthermore, Rasmussen observed that very little planning and consideration of alternatives was mentioned by workers. In fact, workers seemed to "know" (Rasmussen, 1976, p. 3) spontaneously what was going on, and where to focus their attention, as a result of associations formed on the basis of their experience. However, when workers were faced with unfamiliar tasks, more detailed data about their information processes was evident in their verbal protocols. These data suggested that workers use different mechanisms, such as rational problem solving and intuitive and associative reasoning, for dealing with task demands. This set of observations could not be accounted for solely by traditional models of human information-processing.

Klein (1989, 1998) developed the RPD model following a number of studies of expert decision making in situations that were characterised by high time pressure, changing goals, and personal responsibility. He and his colleagues conducted over 150 interviews with experienced decision makers, including fire ground commanders, tank platoon leaders, and design engineers, about how they made critical decisions under these conditions (e.g., Klein, Calderwood & Clinton-Cirocco, 1986; Taynor, Klein & Thordsen, 1987). They found that very few decisions were made using analytical processes, such as specifying a variety of response options and contrasting their strengths and weaknesses. Instead, experienced decision makers relied on their abilities to recognise and appropriately classify a situation. Once they had recognised a situation as a type, they usually also knew of a typical way of responding to it. Furthermore, mental simulation might be used to evaluate an option's feasibility before implementing it. If problems were envisaged, then the option might be modified or rejected. However, because the first option that was considered was usually the most typical one, it had a high likelihood of being effective. These findings were contrary to those obtained in laboratory studies in which naïve subjects, usually college students, were asked to perform context-limited and unfamiliar tasks.

The decision ladder and the RPD model have similar origins in two senses. First, both the decision ladder and the RPD model were developed on the basis of studies of expert decision making in natural settings. These studies showed that experts rarely use analytical strategies for decision making when performing familiar tasks. Instead, experts are able to recognise and respond to situations on the basis of their prior experience. Second, both the decision ladder and the RPD model were motivated by the inability of traditional theories or models to explain the observations that were being obtained in real settings.

4.2 Concepts

A fundamental difference between the decision ladder and the RPD model is that the former is a template that represents the generic categories of activity involved in decision making whereas the latter is a description of a recognitional strategy that experts use for decision making in natural settings. One question that might be asked is whether the decision ladder is capable of accommodating Klein's (1989) observations of expert decision making in natural settings. This section maps the recognitional strategy described by Klein onto the decision ladder in order to answer this question and to examine the nature of the overlap or discrepancies between the decision ladder and the RPD model.

Figure 3 shows the three variations of the recognitional strategy that make up the integrated RPD model that was presented in Figure 2. Klein (1998) discusses that the first variation depicts the situation where decision makers recognise a situation as familiar, which includes recognising what types of goals make sense, which cues are important, what to expect next, and typical ways of responding to the situation. By recognising a situation as typical, they also recognise a course of action that is likely to succeed, which is then implemented. Figure 4 illustrates that this strategy is revealed on the decision ladder as the observation of a situation leading directly to an understanding of the current system state, including a course of action that is likely to succeed, which is then executed.

According to Klein (1998, p. 26), the second variation depicts the situation:

> when the decision maker may have to devote more attention to *diagnosing* the situation, since the information may not clearly match a typical case or may map onto more than one typical case. The decision maker may need to gather more information in order to make a diagnosis. Another complication is that the decision maker may have misinterpreted the situation but does not realise it until some *expectancies* have been violated. At these times, decision makers will respond to the anomaly or ambiguity by checking which interpretation best matches the features of the situation. They may try to build a story to account for some of the inconsistencies.

Figure 5 depicts how this strategy is revealed on the decision ladder. Specifically, if the observation of a situation leads directly to an understanding of the current system state, including a course of action that is likely to succeed, then this course of action is executed (this is the same as variation 1). However, if the observation of a situation leads to ambiguity about the current system state (because the information does not match a typical case, maps onto more than one typical case, or violates the expectancies of the decision maker) then the decision maker may need to observe more information to make a diagnosis about the situation. Once the situation is identified or diagnosed as being of a particular type, then a course of action that is likely to succeed is recognised and executed.

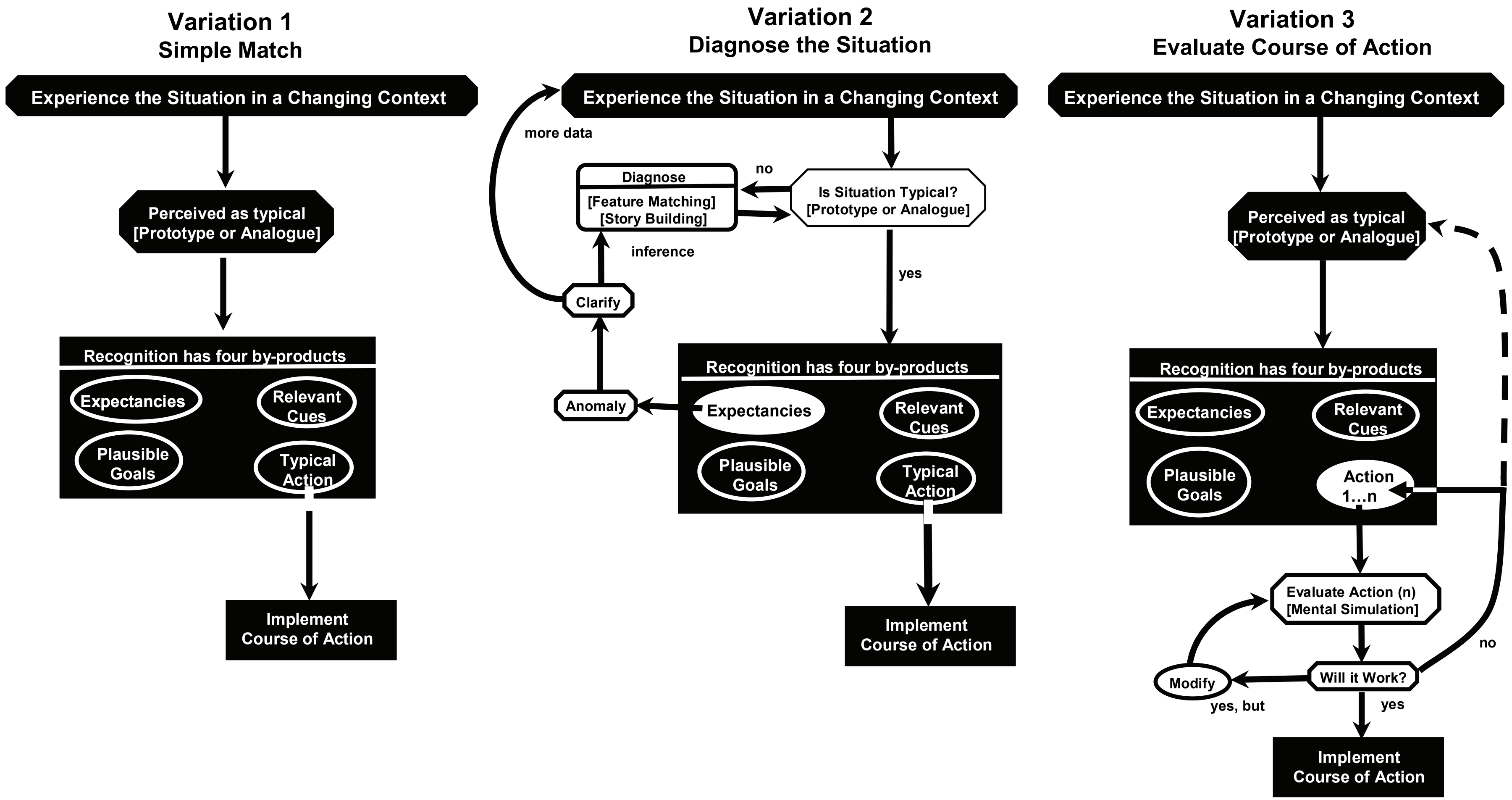

Figure 3 *Three variations of the recognitional strategy that constitute the integrated RPD model in Figure 2. Reproduced from Gary Klein, Sources of Power: How People Make Decisions, Cambridge, MA: The MIT Press, © MIT 1998, figure 3.1, with permission.*

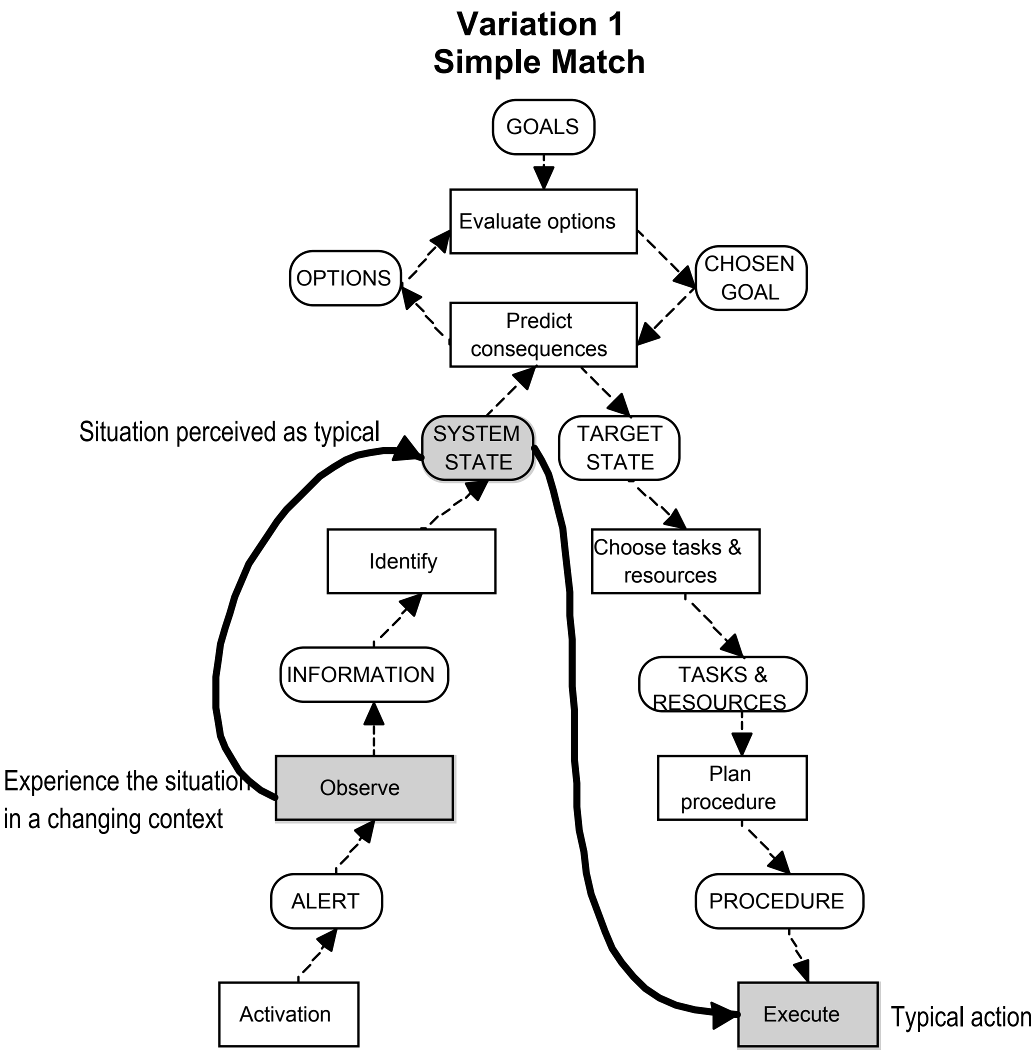

Figure 4   Mapping of variation 1 of the recognitional strategy onto the decision ladder

The third variation "… explains how decision makers evaluate single options by imagining how the course of action will play out. A decision maker who anticipates difficulties may need to *adjust* the course of action, or maybe *reject* it and look for another option." (Klein, 1998, p. 26). Figure 6 shows how this strategy is revealed on the decision ladder. The observation of a situation leads directly to an understanding of the current system state, including a course of action that is likely to succeed. The decision maker evaluates this course of action by imagining the tasks and resources that will be required or the sequence in which the course of action will be carried out. If the decision maker judges that the course of action is feasible and likely to be effective then the course of action will be executed. If the decision maker anticipates some difficulties, the course of action may be adjusted, either by modifying the tasks and resources required or the sequence in which it will be implemented. Alternatively, the course of action may be rejected and another option considered.

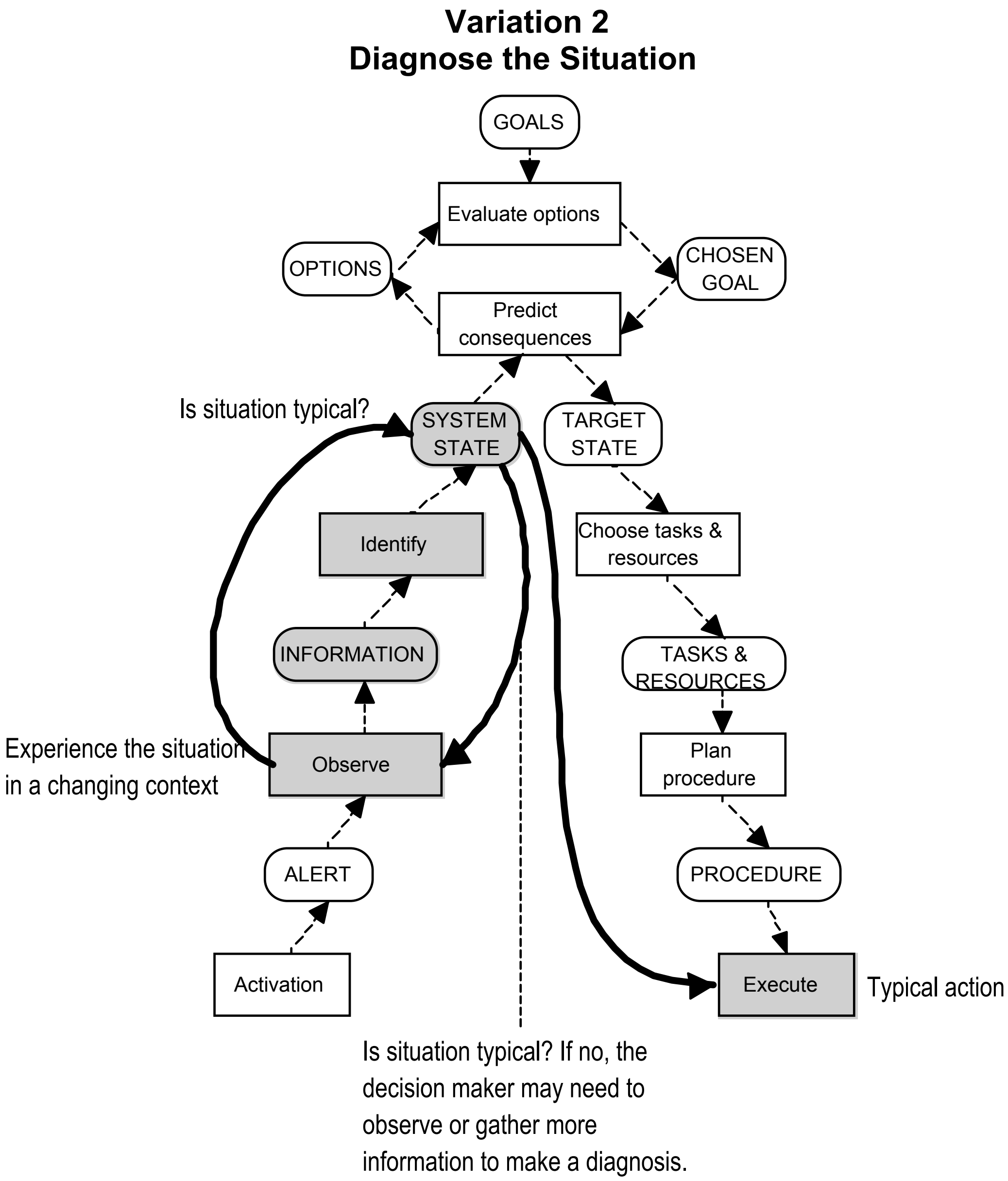

Figure 5 Mapping of variation 2 of the recognitional strategy onto the decision ladder

The preceding discussion illustrates that, to a large extent, the decision ladder is capable of accommodating the RPD model of expert decision making in natural settings. More specifically, the decision ladder is capable of distinguishing between the three variations that make up the integrated RPD model. Variation 1 is revealed on the decision ladder purely as a set of rule-based shortcuts from one state of knowledge to another. Variations 2 and 3 also involve a set of rule-based shortcuts from one state of knowledge to another but these variations are characterised by some additional activities as well. In variation 2, the additional activities are related to gathering information and diagnosing the situation. In variation 3, the additional activities are related to evaluating tasks, resources, and sequences of action.

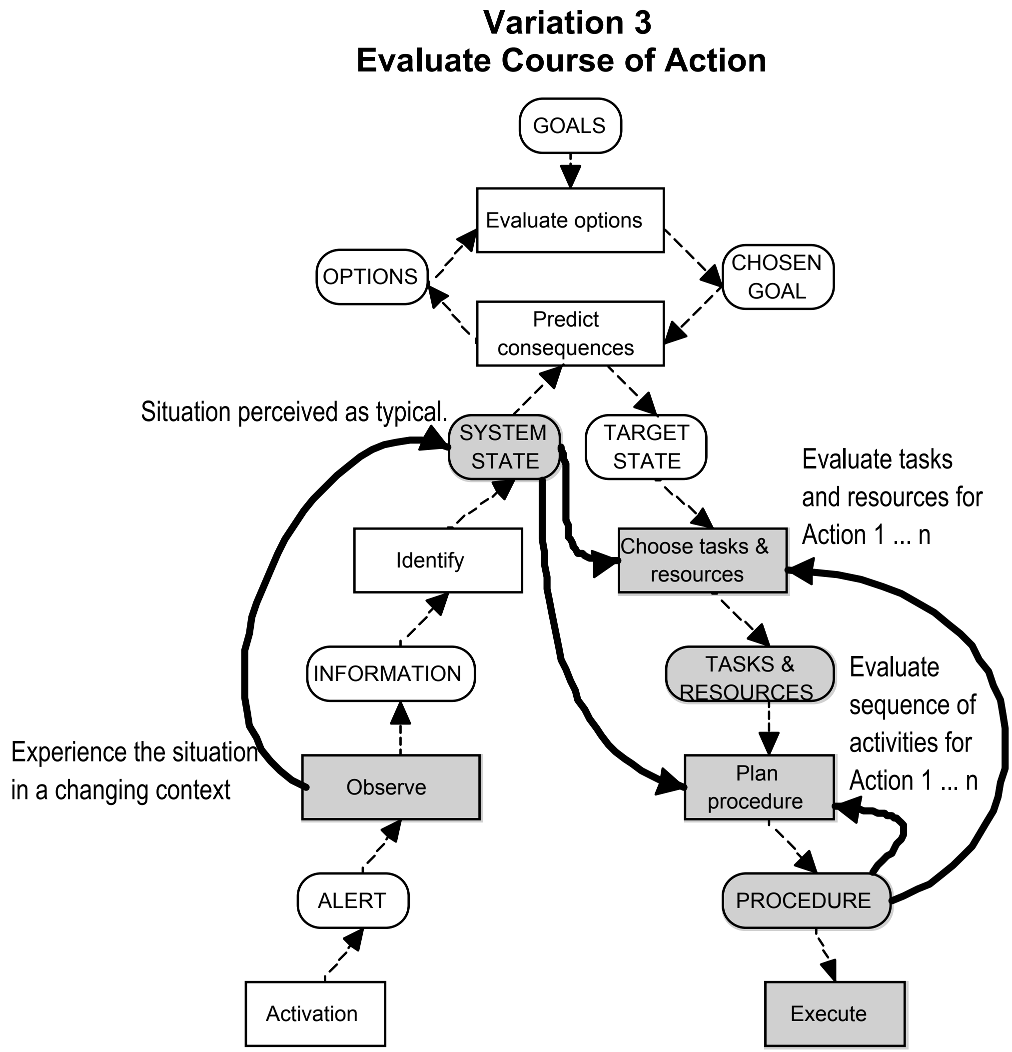

Figure 6 Mapping of variation 3 of the recognitional strategy onto the decision ladder

The decision ladder does not, however, capture the types of strategies that the RPD model suggests that experts use for decision making. First, the decision ladder does not identify that decision makers can use pattern-recognition strategies, including the use of prototypes or analogues, for identifying a situation as typical (variation 1). Second, the decision ladder does not identify that the recognition of a situation has four by-products, that is, expectancies, relevant cues, plausible goals, and typical actions, which lead to the recognition of a course of action that is likely to succeed (variations 1, 2, and 3). Third, the decision ladder does not identify that decision makers can use feature-matching or story-building strategies for diagnosing a situation (variation 2). Finally, the decision ladder does not identify that decision makers can use mental simulation for evaluating a course of action (variation 3).

The fact that the decision ladder does not capture certain aspects of the RPD model does not mean that these aspects of decision making are considered unimportant within the CWA framework. Instead, these aspects of decision making are deliberately analysed separately in other phases of CWA. As mentioned earlier, the decision ladder is a modelling tool for control task analysis, the second phase of CWA. The aim of control task analysis is to identify what needs to be done independently of how it can be done or by whom it can be done.

CWA decouples what needs to be done from how it can be done because it offers a leverage point for design. To explain, CWA recognises that there are many possible strategies for performing a single activity and workers will often switch between multiple strategies while performing an activity in order to deal with changing work demands. For example, if a situation is suddenly recognised as atypical or unfamiliar, workers may switch from using mental simulation for evaluating a single course of action to an analytical strategy that involves a comparative evaluation of multiple options. As a result, it is important to identify the range of strategies that are possible for each activity, and this can only be achieved effectively by first isolating what needs to be done. Then, by identifying the range of potential strategies for each activity, it becomes possible to design systems that support workers in achieving their task demands "…in a flexible manner by using whatever strategy they prefer, and by seamlessly switching between strategies as necessary" (Vicente, 1999, p.222). This is the aim of strategies analysis, the third phase of CWA. The recognitional strategy described by Klein (1989, 1998) could be one of the strategies identified in this phase of analysis, depending on the nature of the system.

CWA also decouples what needs to be done from by whom it can be done because this too offers a leverage point for design. Specifically, CWA recognises that it is important to identify the range of strategies that is possible as opposed to the range of strategies that is used by workers. Workers may not use certain strategies because they are resource intensive but, as a result, they may not be using some very effective strategies. By identifying the range of strategies that is possible, irrespective of by whom they are performed, it becomes possible to design effective support for these strategies, so that workers will be able to adopt strategies that they otherwise might not use. Decisions about the combinations of workers and devices that will be effective for performing the set of strategies that are identified are considered during Social Organisation and Cooperation Analysis, the fourth phase of CWA.

Finally, another difference between the RPD model and the decision ladder is that the former is characterised primarily by rule-based behaviour (Zsambok et al., 1992) whereas the latter also accommodates knowledge- and skill-based behaviour. This difference arises because the RPD model focuses on expert behaviour in familiar situations. In contrast, the decision ladder also reflects a concern with the types of behaviours that can occur under other conditions, for instance, when experts are confronted with unfamiliar situations or when novices are engaged in performing various tasks.

4.3 Knowledge Elicitation

The decision ladder and the RPD model can also be compared in terms of the techniques that analysts use for knowledge elicitation. The primary technique that Klein and his colleagues employ to study expert decision making is the critical decision method. Klein (1989) discusses that in studies of non-routine events in a variety of incidents, the critical decision method was used to probe for information about "… options that existed, options that were actively considered, important cues, goals that shifted during the incident, and so on." (p. 64). In addition, with respect to a study that employed think-aloud protocols during simulated fire ground incidents, Klein (1989) reports that "The protocol analysis examined the extent to which remarks referred to cues or information present in the scenario itself, inferences based on the cues and knowledge of fire ground factors and procedures, actions, and goals." (p. 67). These statements illustrate that there is considerable similarity between the information that is sought by Klein and his colleagues and the various components of the decision ladder. Furthermore, my colleagues and I have used adaptations of the critical decision method to construct decision ladders for military systems (Naikar, Moylan & Pearce, 2006; Naikar & Saunders, 2003).

4.4 Knowledge Representation

The decision ladder and the RPD model can also be compared in terms of the formats that analysts use for knowledge representation. Figure 7 is an example of a format that Klein and his colleagues use. Figure 8 shows that the information in Figure 7 can be represented using the decision ladder. It might be argued that the terminology of the decision ladder is not well suited to the RPD model. This is because the decision ladder is a *generic* template. The terminology of the decision ladder can be altered to suit different applications or domains (e.g., Rasmussen, 1998; Rasmussen et al., 1994).

Situation Assessment-1	
Cues/knowledge	overturned truck on highway, ruptured fuel tank, engulfed in flames, intense heat (highway signs melted), another truck 50 feet away, citizen rescuing driver.
Expectations	potential explosion, life hazard
Goals	complete the rescue, extinguish fire, block traffic
Decision Point-1: Aid in driver rescue	
Decision Point-2: Call for additional units: rescue unit, police, foam	

Figure 7 An example of the format for knowledge representation associated with the RPD model. This figure only shows the representation of a portion of an incident. Adapted from Klein, G. A. (1989), Recognition-primed decisions, In W. B. Rouse (Ed.), Advances in Man-Machine System Research, 5, 47-92, Greenwich, CT: JAI Press Inc, with permission.

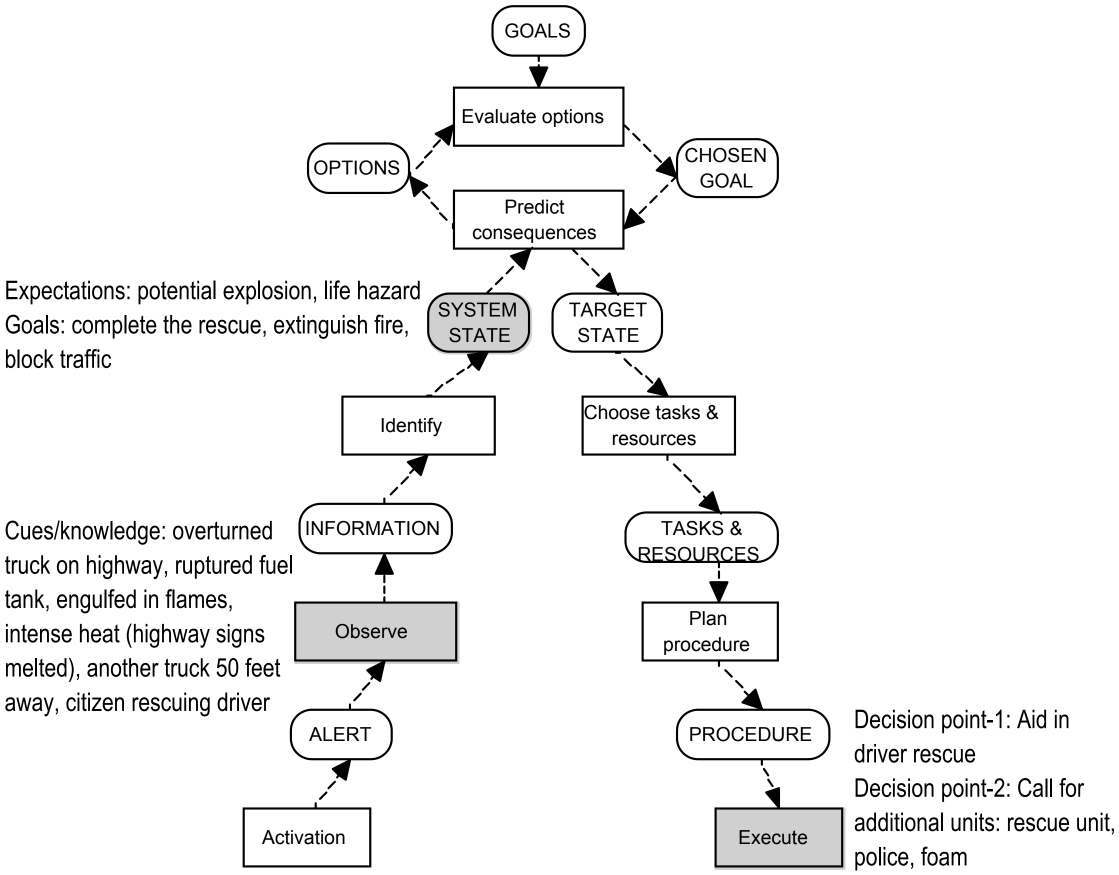

Figure 8 The representation of the same portion of the incident depicted in Figure 7 using the decision ladder

Another reason that Klein and his colleagues might prefer the format in Figure 7 is expressed by the following sentiment: "When we try to describe naturalistic decision making, we quickly realize that it makes little sense to concoct hypothetical information processing flow diagrams believed to represent causal sequences of mental operations, because they end up looking like spaghetti graphs." (Klein, Ross, Moon, Klein, Hoffman & Hollnagel, 2003, p. 81). The decision ladder is misleading because the nodes in the template are connected to each other with arrows. Rasmussen (1974) acknowledged that the decision ladder is an idealised description and that "The individual mental activities may not be clearly separated in time, and leaps backwards and forwards in the sequence may often occur." (p. 28). However, Rasmussen's intention was not to develop a template that represented the 'truth' about human information-processing but rather to develop a template that would be useful for design.

Moreover, the decision ladder is rarely used to represent sequences of activities. Instead, the decision ladder is used to represent the set of work requirements that are possible in a system (e.g., Naikar et al., 2006). The actual sequence of activities depends very much on the skills of workers and the nature of the task demands. The normative, rational sequence that forms the basic structure of the decision ladder reflects the fact that there are certain conditions under which this type of behaviour might be activated, for instance, when experts are confronted with unfamiliar situations or when novices are engaged in performing various tasks. Hence, designs must support this type of behaviour as well.

4.5 Implications for the Design of Decision Support Systems

The primary implication of the RPD model for the design of decision support systems is that such devices should support recognitional strategies for decision making (Klein, 1989). The RPD model describes how experienced decision makers can recognise a situation in a way that makes the selection of an option for dealing with the situation obvious. Decision support systems, therefore, should focus on helping users to develop situation assessments. In addition, the RPD model describes how experienced decision makers rely predominantly on mental simulation for option evaluation and development. Hence, decision support systems should help users to imagine how options will be implemented.

Nevertheless, Klein (1989) discusses certain conditions under which analytical strategies for decision making will be needed. These conditions include decision making when tasks are relatively unfamiliar, when there is low time pressure, when there are requirements for optimisation and justification of decisions, and when there is conflict about the way in which situations are understood or options are regarded. He emphasises that it should be clear that analytical and recognitional strategies for decision making are complementary. He points out that although tools or interventions that require decision makers to perform detailed analyses most of the time would be burdensome for users, it would be risky not to support analytical strategies for situations that do not fit the experience of decision makers. He argues that "The challenge is to develop decision aids that are useful under such conditions without disrupting the recognitional decision making needed for other task conditions." (Klein, 1989, p. 83).

The decision ladder has two sets of implications for the design of decision support systems. First, decision support systems should facilitate situation analysis, option evaluation and goal selection, and the planning, scheduling, and execution of action. Second, decision support systems should facilitate skill-, rule-, and knowledge-based behaviour or, in other words, different ways of moving through the decision ladder. CWA recognises that there is considerable empirical evidence that workers are more efficient at using skill- and rule-based levels of cognitive control and that they prefer to do so even when not explicitly supported to do so. Hence, decision support systems should facilitate workers in relying on these lower levels of cognitive control. However, there are certain conditions when higher levels of cognitive control may be needed, such as when workers are confronted with unfamiliar situations or when novices are engaged in performing a task. Hence, decision support systems should facilitate all three levels of cognitive control. Moreover, Rasmussen (1976) observed that whereas the mechanisms involved in these three types of reasoning are very different, and are usually studied separately, a large part of the problem for design lies in supporting their interaction, for example, when workers are suddenly confronted with unfamiliar tasks while performing their normally well-established and efficient routines.

5. Conclusion

This report has compared the decision ladder and the RPD model in terms of five main factors. These factors are origins, concepts, knowledge elicitation, knowledge representation, and implications for the design of decision support systems. The comparison highlighted that while there are several similarities between the RPD model and the decision ladder, there are a number of significant differences as well.

The similarities between the decision ladder and the RPD model occur mainly because they were both motivated by observations of expert decision making in natural settings. Specifically, both Rasmussen (1974, 1976) and Klein (1989, 1998) observed that experts rarely use analytical strategies for decision making when performing familiar tasks. Instead, experts are able to recognise and respond to situations on the basis of their prior experience. Subsequently, Rasmussen developed a template that was capable of representing the rule-based behaviour that experts can exploit when performing familiar tasks. In contrast, Klein focused on developing an explanation of how experts are able to recognise and respond to situations on the basis of their experience. Despite these differences in orientation, both the decision ladder and the RPD model are based on similar observations of expert decision making. As a result, the decision ladder template is capable of accommodating many aspects of the RPD model and distinguishing between the three variations that make up the integrated RPD model. In addition, there are similarities between the techniques for knowledge elicitation and the format for knowledge representation that are associated with the RPD model and the various components of the decision ladder.

The differences between the decision ladder and the RPD model arise, principally, due to two reasons. First, the decision ladder is concerned with representing what must be done in a system, independently of how it is done or by whom it is to be done, whereas the RPD model does not make these distinctions. As a result, the decision ladder does not accommodate the specific strategies that the RPD model proposes that experts use for recognising and responding to familiar situations, such as feature mapping, story building, and mental simulation. Moreover, whereas the RPD model focuses on human decision making, the decision ladder is not concerned with who carries out the activities that are required in a system, for example, whether the activities are carried out by humans or by automation. It is not the case, however, that these aspects of decision making are considered unimportant within the CWA framework. Instead, these aspects of decision making are deliberately analysed separately in other phases of CWA because it offers leverage points for design.

Second, whereas the RPD model focuses on expert decision making in familiar situations, the decision ladder is also concerned with the behaviours that can occur under different conditions, for instance, when experts are confronted with unfamiliar situations or when novices are engaged in performing various tasks. The RPD model, therefore, is concerned predominantly with rule-based behaviour. In contrast, the decision ladder accommodates skill-, rule-, and knowledge-based behaviour.

These differences between the decision ladder and the RPD model are reflected in their implications for the design of decision support systems. The RPD model focuses on supporting situation assessment by using strategies like feature-mapping and story-building. In addition, the RPD model focuses on supporting option evaluation and development by using strategies like mental simulation. The decision ladder is concerned with supporting activities like situation analysis, option evaluation and goal selection, and planning, scheduling, and executing action. In addition, the decision ladder reflects a concern with supporting skill-, rule-, and knowledge-based behaviour or, in other words, different ways of moving through the decision ladder.

Finally, the differences between the decision ladder and the RPD model do not mean that they are in competition with each other. Rather, the decision ladder and the RPD model complement each other. The RPD model provides a description of a well-established strategy of how experts make decisions in familiar situations. Although the decision ladder is not concerned with the strategies that experts use for decision making, the CWA framework is. Therefore, depending on the nature of the system being studied, the RPD model could be a key component of strategies analysis, the third phase of CWA. Conversely, although the RPD model is primarily concerned with describing a recognitional strategy for decision making, Klein (1989, 1998) appreciates that analytical strategies may be desirable under certain conditions. By separating what must be done in a work domain from how it can be done, the decision ladder recognises explicitly that different strategies are possible for performing a single activity. Consequently, the decision ladder deliberately leaves open the possibility for both recognitional and analytical strategies for decision making to be uncovered later during CWA and, as a result, facilitated in the design of decision support systems.

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Neelam Naikar

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The decision ladder template, one of the tools of Cognitive Work Analysis, attracts attention as a point of comparison for models of naturalistic decision making, such as the recognition-primed decision model. This report compares the decision ladder template and the recognition-primed decision model in terms of five main factors. These factors are origins, concepts, knowledge elicitation, knowledge representation, and implications for the design of decision support systems. The report concludes that while there are several similarities between the decision ladder template and the recognition-primed decision model, there are a number of significant differences as well.</td></tr>
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