LESSONS FROM EXPERIENCED OPERATORS – CASE STUDIES IN CRITICAL DECISION MAKING

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ABSTRACT

The ***Lessons from experienced operators project*** is an industry funded research project managed through Water Research Australia (WaterRA). This project aims to capture the lived experience of water industry operators, to gain an insight into their decision-making processes. These include everyday decisions made by operators, along with complex and time critical decisions, that are often made under pressure or with competing priorities.

This paper presents a modified Decision Ladder (DL) Template which has been applied to describe frontline worker decision-making across several industries, ranging from healthcare through to aviation, shipping and process industries. In the ***Lessons from experienced operators project***, the modified DL Template has been used for better understanding the decision-making processes used by water industry operators when faced with a range of operational situations.

A case study is presented, selected from the project Training Guidance Report (Milestone 3 of the ***Lessons from experienced operators project***). This report was produced to give examples and guidance of how the on-the-job experience of water industry operators can be utilised as a valuable teaching tool for new and developing operators. This is achieved using incident stories from operators to develop case study resources for training purposes. This was to demonstrate the power of the modified DL Template to better understand the critical decision-making process of experienced water industry operators, to facilitate training for new operators.

1.0 INTRODUCTION

Through previous technical competency projects and industry consultation, WaterRA identified a need for research into the workplace experiences and decision-making processes of water industry operators. This is an area of the Australian water industry that has received very little attention. This is despite a growing body of evidence indicating the influence of human factors on exacerbating water quality safety incidents.

The ***Lessons from Experienced Operators project*** focuses on the learning journey and the experience that contributes to some of the water industry's most valued operator skills. These include troubleshooting, problem-solving, and critical thinking. It is these skills that underpin decision-making by water industry operators in the provision of safe drinking water and wastewater treatment. Experienced water industry operators use these skills to provide a vital contribution towards a water utility's ability to meet its public health and environmental protection objectives.

The following briefly outlines the theory and models that underpin the research and training guidance development milestones for the ***Lessons from Experienced Operators project.***

1.1 Modified Decision Ladder Template

For this work a modified DL Template has been used (Lilburne et al. 2019), which shows

the decision-making progression an individual can move through when encountering an operational problem. These activities are **situation analysis**, **knowledge-based reasoning**, and **planning and execution**.

Figure 1 and 1a shows the modified DL Template, with the 'state of knowledge' (i.e. the 'known' information) shown as ovals, and the processing of new information as rectangles. The modified DL Template decision-making progression starts from **situation analysis**, moves through **knowledge-based reasoning** at the top, and then down the righthand side (**planning and execution**), as shown by the arrows.

1.2 Situation analysis

This study applied the three-level model of situation analysis proposed by Endsley (1995) for field and control room operators (Figure 2):

- **Level 1 - Perception**. The perception of the condition, attributes, and dynamics of relevant elements in the environment.
- **Level 2 - Comprehension**. The understanding of the situation based on the combined elements of Level 1, which are used to form a complete picture of the environment.
- **Level 3 - Projection**. The projection of the near future onto the elements in the environment.

1.3 Knowledge-based reasoning

There are three levels of reasoning used in decision-making by frontline workers, these are:

- **Skill-based** – refers to the execution of highly practised actions with minimal requirement for conscious reasoning.
- **Rule-based** – refers to activities that involve the use of rules. These rules may have been learned from manuals and procedures, through formal training, or by working with other experienced workers.
- **Knowledge-based** – refers to an activity or task that is carried out almost in a completely conscious manner, where a beginner is performing the task for the first time, or where an experienced worker is faced with a completely novel or challenging situation.

How operators integrate the above reasoning modes can be described by the Recognised Primed Decision (RPD) model (Figure 3). Experienced personnel, in real-world settings, do not make decisions by laboriously comparing multiple options to select the best choice. Instead, they use situation analysis to understand the environment and context, and then perform mental simulations to select an option or goal state. They evaluate and modify the option or goal until the most appropriate course of action is decided (Klein, 1999).

1.4 Planning and execution

This study adapted the work of Schakel and Wolbers (2019), who described a planning and execution model for rapid response scenarios. Responders will adapt their mode of organizing through three simultaneous activities:

1. **leadership**
2. **accountability (and responsibility)**
3. **communication**

Figure 4 shows a planning and execution process model with modes of organising

(**incident control**, **frontline** and **small teams**), adapted from Schakel and Wolbers research and contextualised to the water industry based on the Australasian Inter-Service Incident Management System (AIIMS) approach. The model demonstrates how during an incident, team members are routinely transitioning between modes of organising, assessing, and evaluating the frontline situation and working within their functional groups to plan and execute what is required to bring an incident or situation back under control.

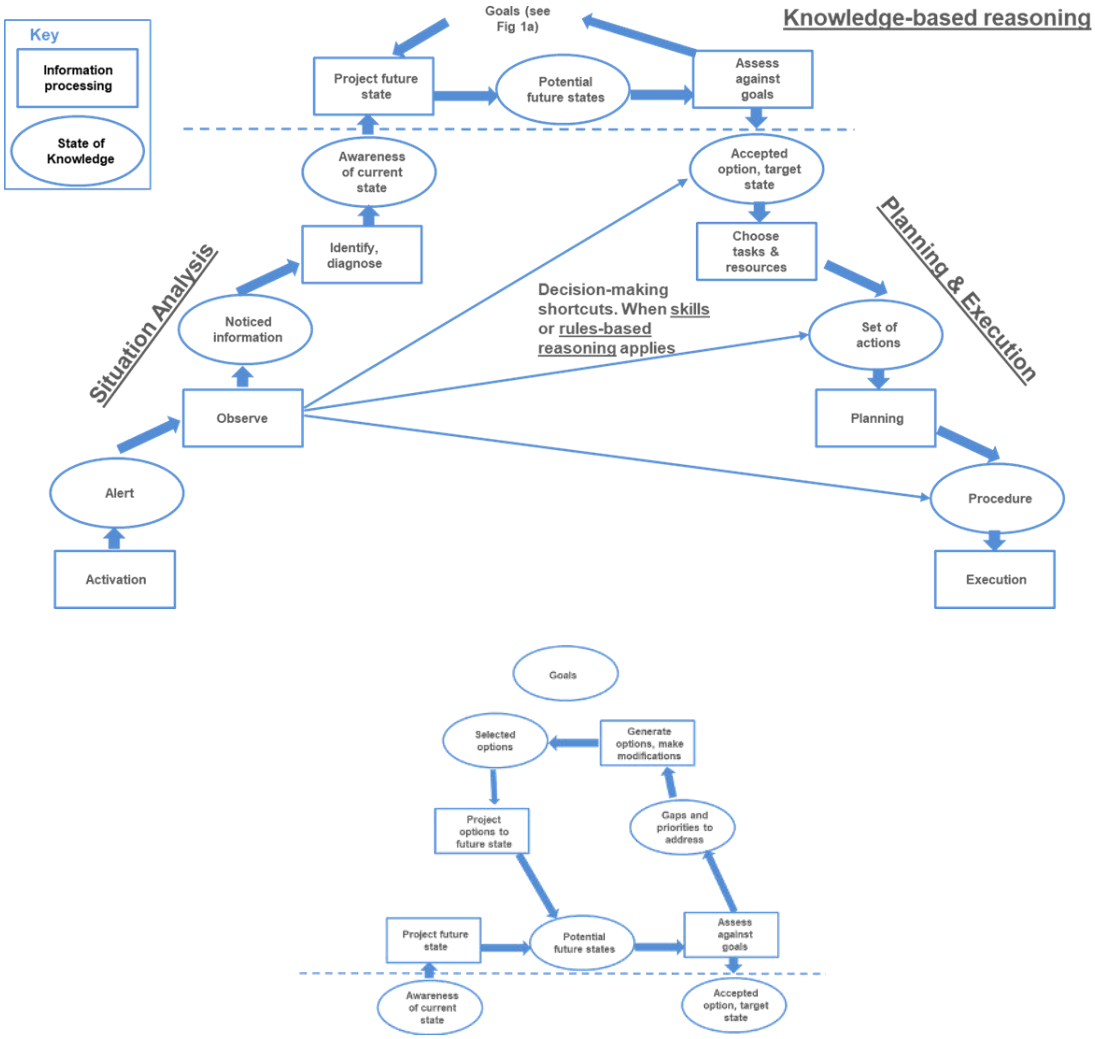

Figure 1 and 1a: *Modified Decision Ladder Template (Lilburne et al. 2019) and detail of the 'Goals' decision-making loop from modified DL Template.*

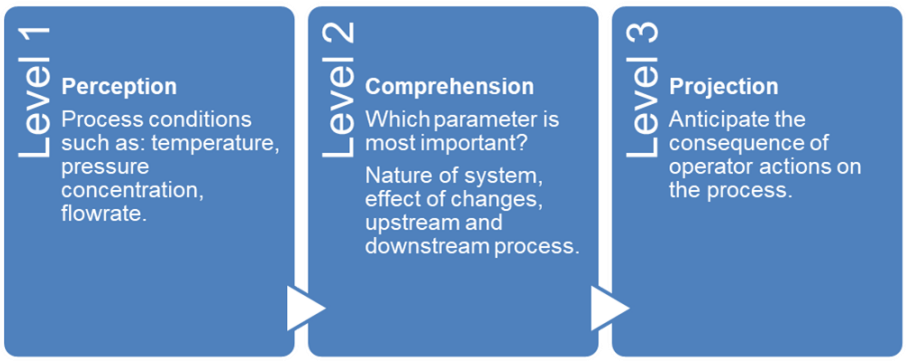

Figure 2: *Three levels of situation analysis (Endsley 1995).*

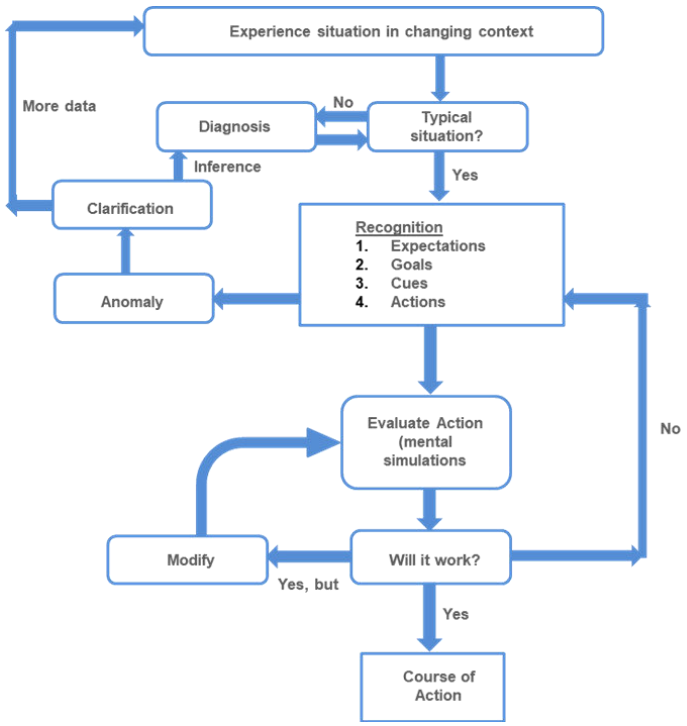

Figure 3: *Recognised Primed Decision (RPD) Model (Klein, 1999).*

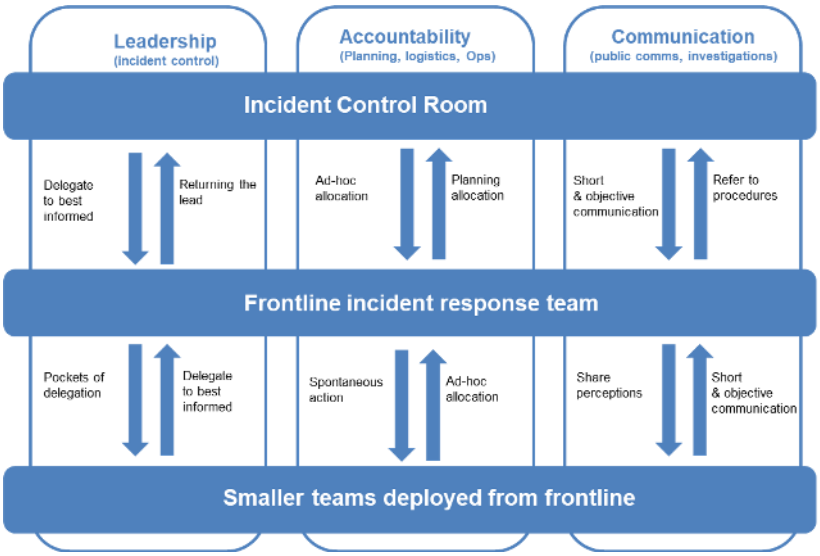

Figure 4: *Process model and modes of organising (Schakel & Wolbers, 2019) contextualised to the water industry & AIIMS.*

2.0 DISCUSSION

The Training Guidance Report is the main project deliverable for the Lessons from Experienced Operators project. It builds on the outputs from the background literature review and the operator interview phases of the project, to give examples and guidance of how the incident and scenario stories from water industry operators can be utilised as a valuable teaching tool for new and developing operators.

2.1 Case studies from operator stories

Three case study examples are provided in the Training Guidance Report, which map to the three activity areas in the modified DL template:

- Situation analysis
- Knowledge-based reasoning
- Planning and execution

The sections below give a brief overview of the **planning and execution** case study presented in the Training Guidance Report. The full case studies are provided in the Training Guidance Report presented using the case study template format.

2.1.1 Case study overview – The job that went off with a 'bang'

Table 1*: Overview of the planning and execution case study taken from the Training & Guidance Report.*

Case study Title	Incident overview	Key concept
The job that went off with a 'bang'	A team of network service contractors were on a job working on a sewer pipe stack. They were using an excavator to dig down to the sewer line when the excavator bucket hit a buried gas main and ripped it out of the ground. The operator in charge of the job was blown over by the initial gas release from the broken gas main. He was unharmed and got back on his feet. He realised very quickly from his training and experience that the excavator had broken into a gas main. The operator in charge of the job instructed the excavator operator to put the bucket back down on top of the main to reduce the gas as much as possible and then the team evacuated the area, ensuring that the tenant living in the adjacent property also safely evacuated. Following the information set out in the job JSEA, the police and local gas company were called and attended site. The police arrange evacuation of the surrounding area and the gas company investigated and arranged repair of the gas main. A running repair of the gas main was made live in-situ. Residents were then allowed to return to their homes. The team who was originally assigned to the sewer stack job were redeployed for the next 4-5 hours to attend residents' houses to re-light pilot lights on appliances. A more permanent mains repair was made later by the gas company. The sewer stack repair job was eventually completed several weeks later, after incident investigations concluded.	Planning and execution

2.1.3 Discussion of the incident

The bang after the gas main broke let the team know they had a leak, although they were initially not sure if it was water or gas. The lead operator was trained as a gas fitter and so knew how to deal with gas, the properties of gas, and safety implications.

Regarding the course of action chosen, the main motivation of the operators was self-preservation – everybody leave site as quickly and safely as possible. From experience, the

lead operator knew to drop the excavator bucket on the main to suppress the leak, with the primary concern being a gas explosion.

The operator who provided the case study believed the networks team did the right things, especially since they had the wrong information from Dial before you dig and no idea the gas main was even there. Key factors that resulted in a 'safe' outcome for the team:

- Mostly the team's training - Plumbing training, confined space training, response training for confined space.
- Procedures - The JSEAs were used to make the emergency calls (incident occurred around the year that JSEAs were becoming a must do). The company had a situation a year before where they were picked-up by an auditor for poor paperwork, after which they improved their JSEAs.
- Making sure to keep calm throughout the incident, taught through confined space incident training.

2.1.4 Lessons learned

- The official (Worksafe) incident follow-up found the cause was with the poor installation of the gas main (location and shallow depth). Information available from Dial before you dig wasn't correct.
- The network service team's contracting company got a pat on the back for the quality of their documentation (JSEA) and for following the procedures correctly.
- The JSEA had no effect on the immediate incident, the initial response was just automatic based on training and experience of the operators.
- The JSEA was crucial for the police and gas company call-outs etc, and protected the company the networks team worked for from liability.

3.0 CONCLUSION

Critical decision-making is a process involving situation analysis, knowledge-based reasoning, and planning and execution, to achieve an end goal or outcome. The modified DL Template provides a tool to better understand and communicate the decision-making process of water industry operators. The case study presented demonstrates the application of troubleshooting, problem solving and critical thinking skills during the key stages of decision-making, specifically in the context of **planning and execution** during a process incident.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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