

Bridging Human Reliability Analysis and Psychology, Part 1: The Psychological Literature Review for the IDHEAS Method

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Introduction

- In response to SRM-M064020 to the Advisory Committee on Reactor Safeguards (ACRS), the NRC has sponsored the development of a hybrid human reliability analysis (HRA) method
 - Integrated **D** Human **E**vent **A**nalysis **S**ystem (IDHEAS)
- In supporting IDHEAS development, we conducted a literature review to develop a technical basis for the hybrid HRA method
 - Systematic translation of research findings on cognition into a cognitive framework that can inform HRA
 - Explicit links were established between:
 - types of human failures,
 - the performance mechanisms, and
 - associated performance measures that are used for quantification
- This presentation provides an overview of the literature review
 - Introduce macrocognitive functions
 - Overview the psychological processes in each macrocognitive function
 - Part 2 discusses the cognitive framework developed from the literature review

Overview of the Literature Review

- Goals of the literature review:
 - Identify psychological and cognitive mechanisms for human performance
 - Identify proximate causes of failure
 - Identify factors that influence human performance
 - Provide a foundation for and contribute to the development of the IDHEAS method and the underlying cognitive framework
 - Identify information that is relevant to the NPP domain
 - Individual and team performance
 - Performance when working with procedures
 - Research with highly trained or expert personnel
 - Cognitive failures operators make in NPP control rooms
 - Reasons behind operator errors
 - Effects of performance influencing factors (PIFs)

Overview of Macrocognition

- Macrocognition refers to cognition in real-world settings
 - Human performance “in the field,” where
 - Decisions are complex, have to be made quickly by domain experts, in risky or high-stakes situations (Klein et al., 2003)
 - Focuses on what humans do with their brains, rather than on the fundamentals of how the brain works
- This real-world, higher-level focus is more appropriate for HRA
- There are a number of different macrocognitive models
 - Different researchers divide the span of cognition slightly differently
 - None of the existing models were developed as a generic model that applies globally, nor were they developed for NPP domain
- We therefore adapted macrocognition to NPP operations using O'Hara's generic primary operator tasks and IDAC

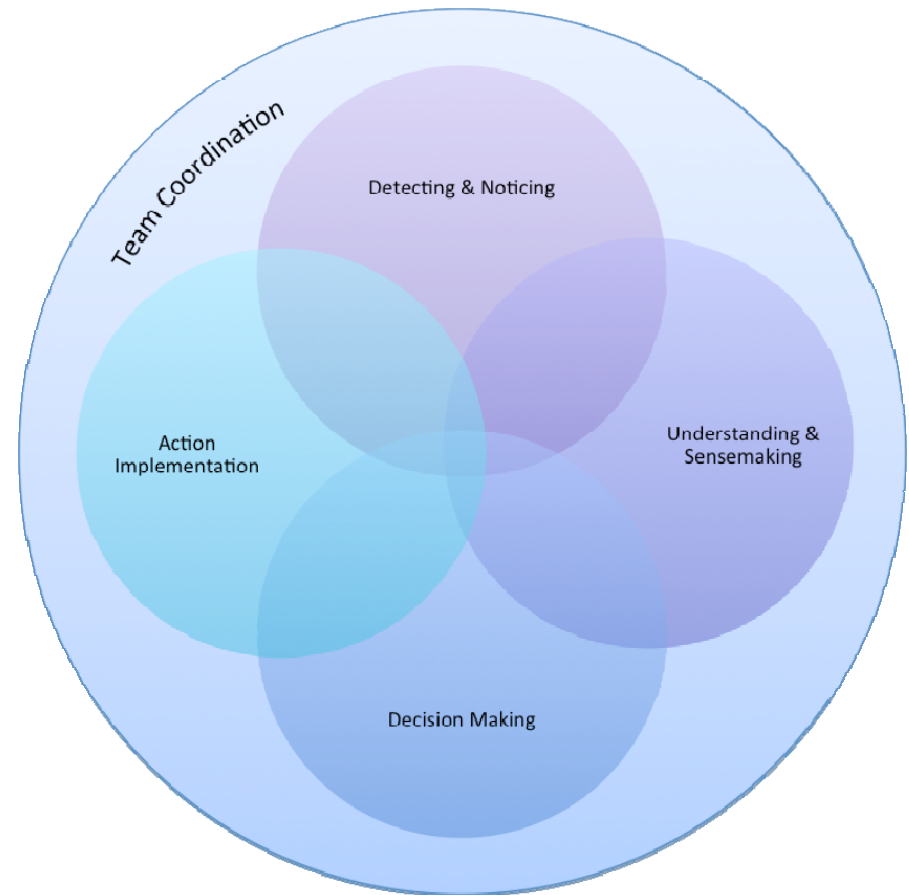
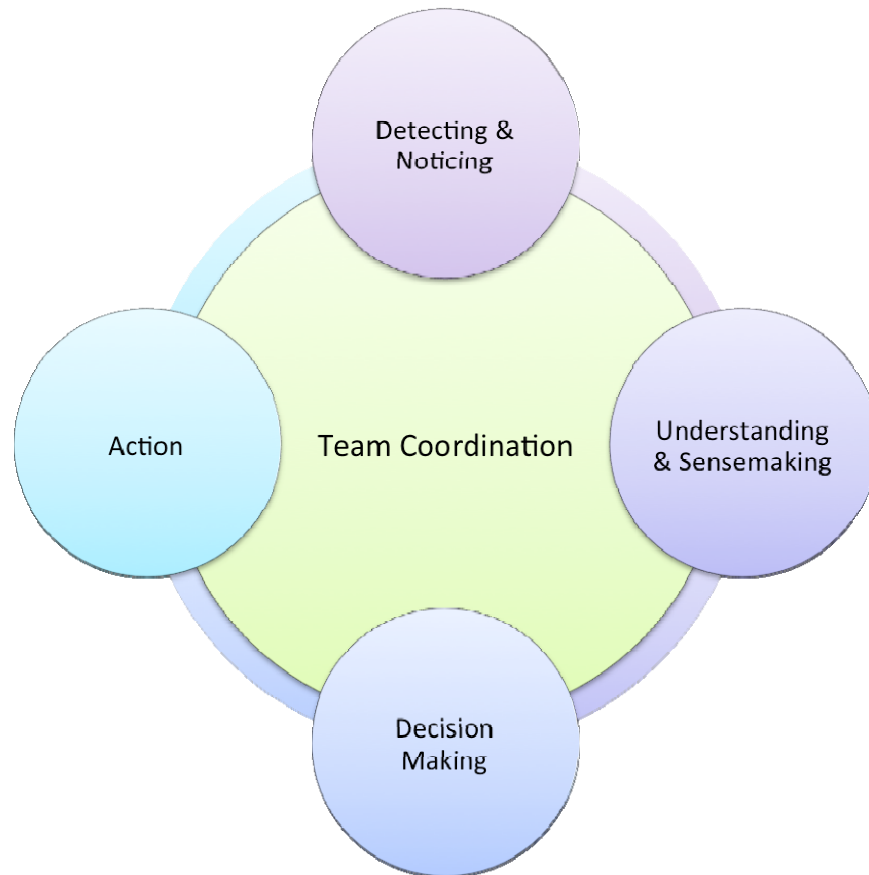
Macrocognitive Functions in the Cognitive Framework

- Detecting and Noticing
 - The process of perceiving important information in the work environment, with emphasis on sensory and perceptual processes that allow humans to:
 - Perceive large amounts of information, and
 - Focus selectively on those pieces of information that are pertinent to present activities
- Understanding and Sensemaking
 - The process of understanding the meaning of the information that has been detected
 - Ranges from automatic, effortless recognition and understanding to more effortful thinking and deliberate attempts to make sense of multiple pieces of information

Macrocognitive Functions in the Cognitive Framework

- Decision Making
 - Involves goal selection, planning, re-planning and adapting, evaluating options, and selection
 - Driven by procedures
 - Done by experts
- Action Implementation
 - Involves manual action, singular or series, discrete or dynamic
 - Assumes other macrocognitive functions were carried out correctly
- Team Coordination
 - How well people interact with each other as the individual or crew works on the given task
 - Coordination, collaboration, and communication between individuals
 - Supervision, command and control

Relationship Between the Functions



Conclusion

- The authors conducted a literature review and organized the results of into a cognitive framework that suits NPP operator tasks
 - Cognitive mechanisms were identified for each macrocognitive function
- This presentation was intended to introduce the macrocognitive functions and provide a high-level overview of the psychological processes involved in each function
- Part 2 (the next presentation) provides more discussion and an example of the cognitive framework

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