Experimental Studies of the Lattice Theory Formalism of Mental Models

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THEMATIC MATERIAL EFFECTS USING THE WASON 2-4-6 TASK

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A common obstacle that impedes problem solving is the tendency to seek only confirmatory data. Wason (1960) devised a rule discovery task, the Wason 2-4-6 task, in which the participant was expected to devise and test hypotheses. The Wason 2-4-6 task and a derivation of the Wason 2-4-6 task using a thematic scenario was used to determine if the presentation of a concrete, rather than an abstract problem, would alter the individual's problem solving strategy. Results demonstrated that the presentation of a realistic problem did not alter problem solving strategies. Participants continued to rely heavily on confirmatory problem solving strategies and exhibited confirmation bias. Those participants who did not solve the problem generally did not utilize disconfirmatory strategies optimally. In some cases, disconfirmatory data were completely disregarded. It is suggested that individuals do not always employ optimal problem solving strategies, often being mislead by the solitary use of a confirmatory strategy. Maladaptive problem solving techniques can have detrimental results in situations where several possible answers exist, such as in a medical diagnosis or in response to faults in complex systems.

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Complex systems are comprised of numerous displays and controls associated with interconnected dynamic state variables. Limitations in human information processing rates and the fallibility of working memory make it impossible for operators to account for and interact with all of these variables simultaneously. Many engineering psychologists have suggested that, in order to effectively control a complex system, an operator must have a Mental Model of the system. Despite prolific use of the term however, there is little empirical evidence to support the existence of Mental Models.

Moray has suggested lattice theory as a comprehensive formalism of the structure of Mental Models. Lattice theory is particularly suited for depicting the interrelationships of components and subsystems that comprise complex systems. The number of elements in a lattice can be reduced through a homomorphic (many-to-fewer) mapping. The resulting lattice is simpler (contains less information) but is still a complete description of the system.

Moray suggests Mental Models are hierarchically organized lattices of homomorphic mappings of the properties of a system in the world into the mind. He claims that if operators are indeed using Mental Models in this form, they are expected to attend to a limited set of variables that give sufficient (if partial) knowledge of the system. By observing which aspects of the system an operator attends to, an experimenter should be able to identify the structure of the Mental Model.

An empirical study of the lattice theory formalism of mental models is discussed. The Conant Method of subsystem decomposition demonstrates a quantitative means of identifying the subset of system elements which provide the most information about a system component in question. The results suggest that a complex system can indeed be reduced to a manageable number of crucial system variables which could comprise a lattice in a Mental Model.