THE ROLE OF KNOWLEDGE STRUCTURES IN FAULT DIAGNOSIS

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An experiment was conducted to study how a person whose memory contains well-developed knowledge structures relevant to a particular problem uses these knowledge structures to direct fault diagnosis performance. In particular, the performances of twenty pilots with instrument flight ratings were studied in a fault diagnosis task (detection of a vacuum system failure). The pilots were initially read a scenario describing the conditions of flight under which symptoms indicative of a problem were detected. They were asked to then think out loud as they requested and interpreted various pieces of information (instrument readings, visible condition of the aircraft, etc.) in an effort to diagnose the cause of the problem. Only eleven of the twenty pilots successfully diagnosed the problem.

Pilot performance on this fault diagnosis task has been modeled in terms of the use of domain-specific knowledge organized in a frame system. Eighteen frames, all having a common structure, were necessary to account for the data from all twenty subjects. (Each pilot utilized some subset of these eighteen frames while diagnosing the fault.)

These frames represent prototypical states of nature (e.g., NOSE-DOWN DESCENT, STRUCTURAL ICING). Each frame has associated with it a set of enabling events and two slots. One slot represents alternative causes of the state of nature represented by the frame (e.g., POWER LOSS can cause DESCENT). The second slot indicates expected instrument readings and other observable conditions if that state of nature actually exists.

The eighteen frames are organized in a set of hierarchies, with one frame linked to another as a slot-filler in the "Possible Causes" slot of that frame.

When listening to the scenario, the pilot is hypothesized to activate one of the top-level frames in the frame system. This activation process may not utilize all of the information available in the scenario. Instead, certain cues are given selective attention. Three possible determinants of attention will be discussed.

Upon activation of a frame, the contents of its two slots ("Possible Causes" and "Expectations" are used to achieve certain objectives (find cause, check for instrument malfunction, etc.). The selection of objectives appears to be of critical importance in determining ultimate success or failure in diagnosing the fault.

Other factors contributing to the failures to correctly diagnose the fault include:

1. memory distortions;

2. activation of incorrect default values;

3. inheritance based on incorrect assumptions;

4. missing slot-fillers.