# What are our training goals ?
# Why are we training them ?

Malcolm James Cook

*University of Abertay Dundee*

# What are our training goals

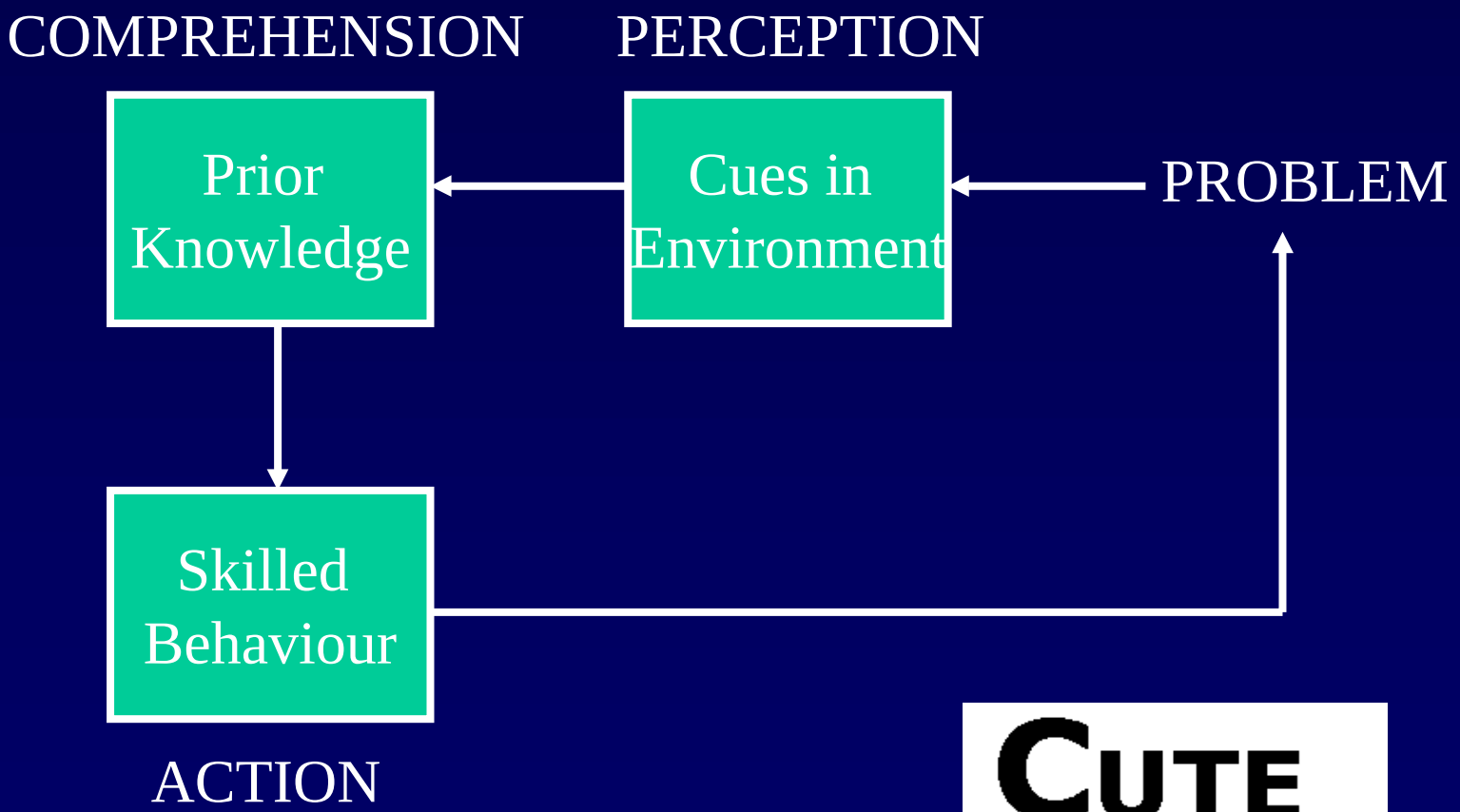
- Aims of the training course
  - safer flying [Lower risk and better recovery]
  - economical flying [Less maintenance or lower fuel usage]
  - comfortable flying
- Syllabus of the course
  - topics
- Training outcomes for many courses are the
  - capability to apply the knowledge in procedural operation of systems



# Understanding the Interaction between Goals

- At what point would you consider doing an action that may save your crew and passengers but increase maintenance costs ?
- Name those situations where you think fuel economy is definitely a secondary issue ?
- At what point do you or cabin staff inform passengers of an minor or major emergency ? How do you explain it ?

# General Model for Training



# Why are we training them ?

- The regulator requires it
  - cost is a downward pressure on training
- The customer requires it
  - a major hull loss could impact business
- Aircraft are more difficult to fly
  - in some ways they are
- The operating environment is changing
  - the sky is getting crowded

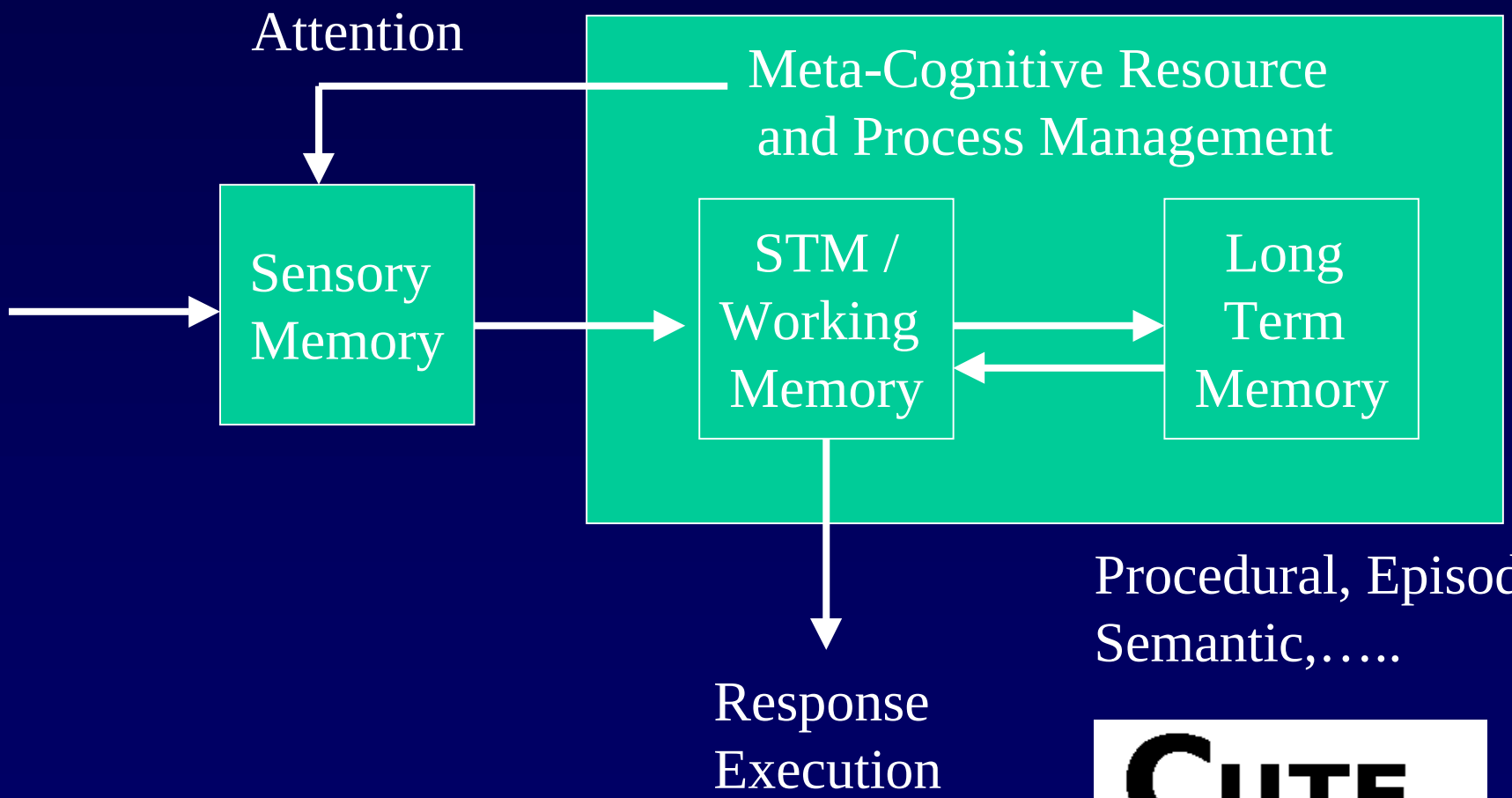
# Aircrew Training and Assessment

- Sources of pilots for airlines have changed
- Regulation of civil aviation aircrew training is increasing
- Increased level of cockpit automation
- Crew resource management and line-oriented flight training
- Increased use of civil simulators as training devices



Building Knowledge and Capability

# Human Cognition



# Notice Training Benefit

- Better use of attention and sensory memory to select information for further processing - resources are not unlimited.
- Use of skilled long-term memory or chunking to provide better comprehension and retention of information.
- More information to draw upon in understanding the raw data in working memory and to direct search for additional information.

# What is the purpose of training ?

- Knowledge Development
- Expertise Development
- Experiential Development
- Procedural Development
- Process and Resource Management
- **To reduce immediate cognitive demand in tasks by putting in place capability.**

# What does training do ?

- Creates capability - binding knowledge and experience.
- Refines information processing strategies.
- Automates critical responses.
- Increases multi-task capacity.
- Changes information processing and the knowledge used in procedural tasks.
- Increases the opportunity for self-review and monitoring.

# What does collective training do?

- Processing Information
- Structuring of Knowledge
- Common Attitudes
- Shared Expectations

# Predicted Benefits of Training

- Input is required to calibrate the system - perception of events.
- IF THE MODELS ARE WRONG ? THINKING OUTSIDE THE BOUNDARIES.
- Effective response selection is based on accurate comprehension.
- IF THE CUES ARE WRONG OR EASIER TO PROCESS INCORRECTLY ?
- Observable outcomes are required to validate the processes set up. [Process Time Scale]

# Examples of Human Errors

- Imperfect mental model of aircraft - shutting down wrong engine.
- Imperfect situational awareness - failing to use full throttle when required.
- High degrees of complacency - failing to check automatic system status.
- Limited consideration of alternatives - poor choice of crash location.

# Many Errors Not Based on Knowledge Errors

- Many errors are based on faulty information processing and not on knowledge.
- Studies indicate that failure to notice, followed by failure to comprehend are the most common types of information processing failure leading to accident development.
- Will practising to automaticity of skills increase the effective management of these problems ?



CUTE

# Is Knowledge Experience ?



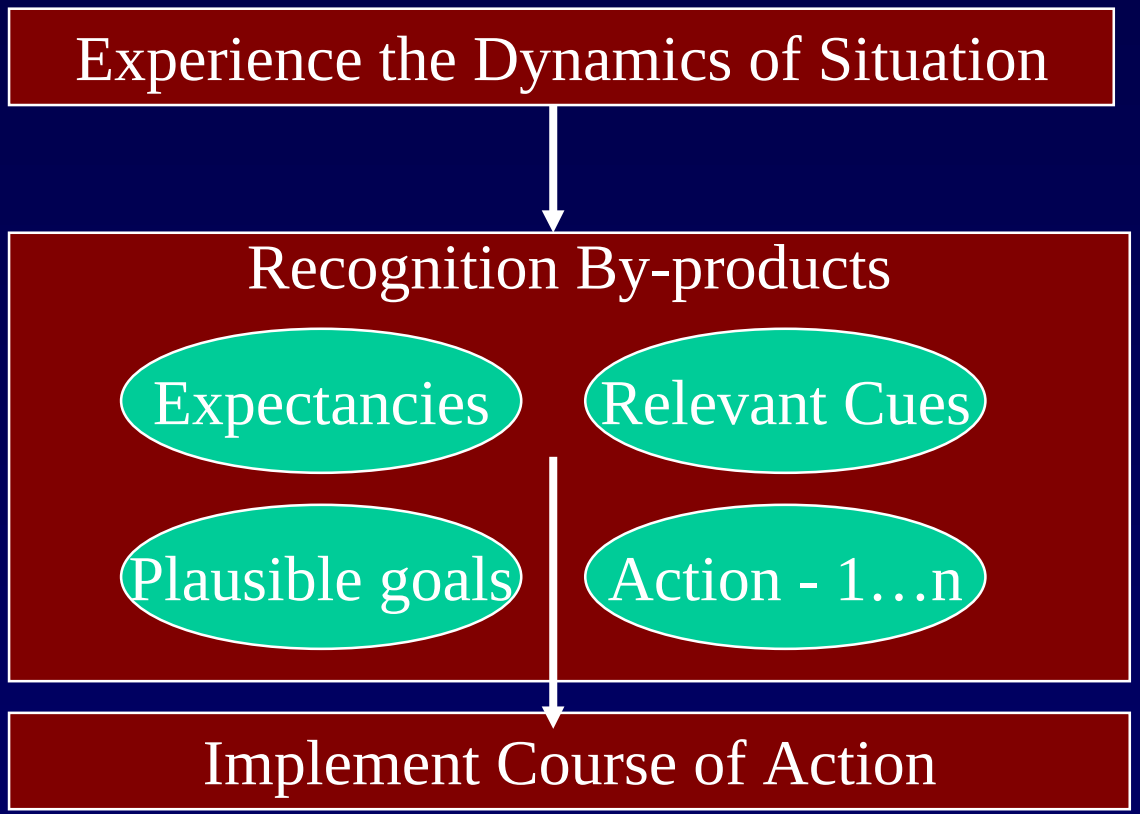
# Unusual Error Recovery : Based on Experience

- Gimli Glider - use of gliding knowledge and location of closed military bases allowed recovery.
- Dead Stick Landing of Hawk in Norway.
- Souix City Recovery - use of spare pilot capacity and aeronautics to recover after hydraulics failure.



Building Knowledge and Capability

# Klein's Recognition Primed Detection Decision Making Model




Level 1 SA

Level 2 SA

Level 3 SA

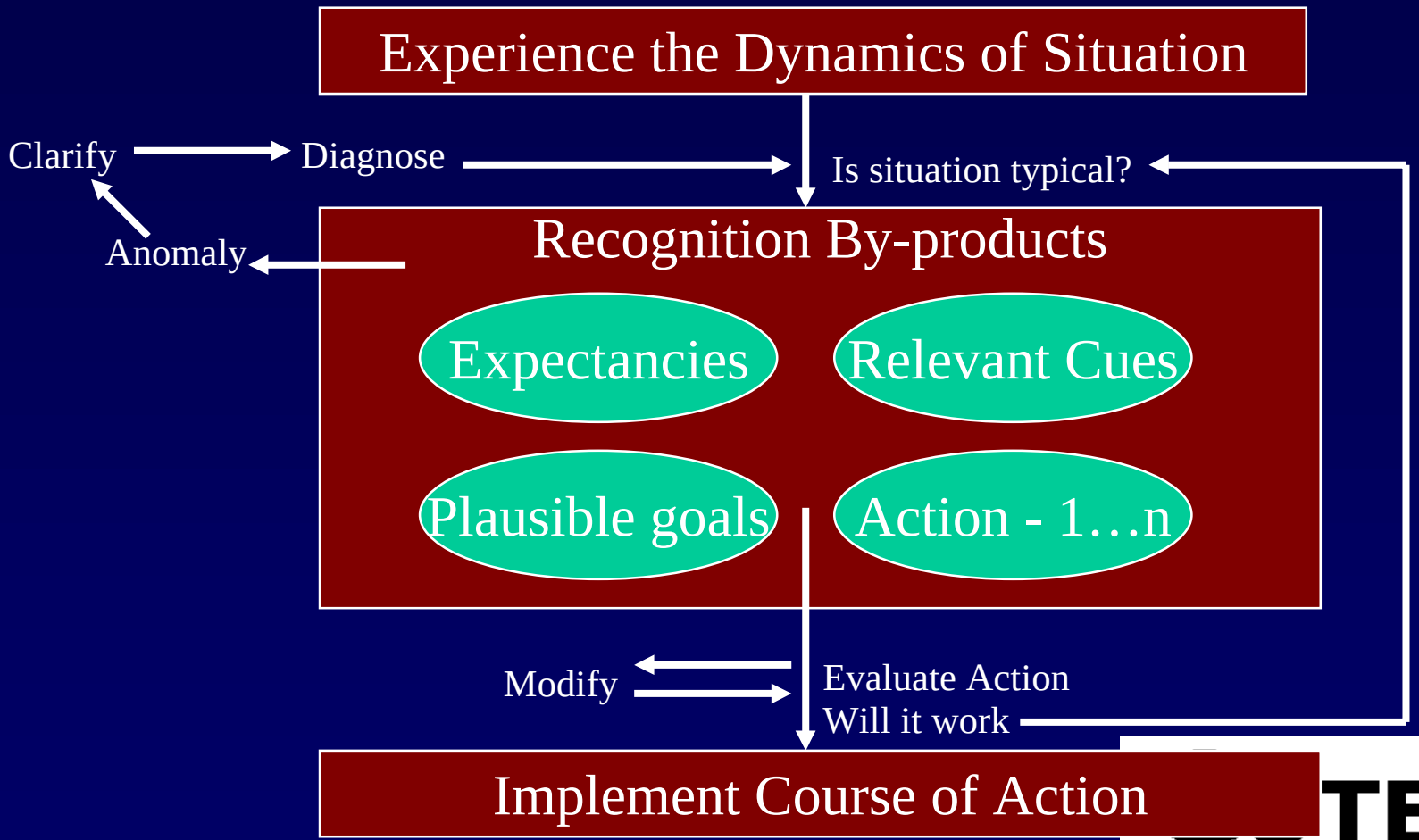
Matching Working Memory onto Long-Term Memory

# Predictions for Training

- Training cue identification results in superior performance.
- Procedural training of actions aids performance by reducing cognitive burden and increasing automaticity.
- Increased diversity of training creates more actions, improved expectancy, better understanding of goals and better identification of critical cues.
- Review of the plausible goals aids the direction of attention in supporting resource usage in perception.
- This mainly applies to familiar events.

Building Knowledge and Capability

# Full-On Klein



# Implications

- Cognitive Resource Predictions - Use of Resources.
- Early detection of anomalies is less demanding of cognitive resources.
- Failed action evaluation will result in action and observation - not a process re-trace of cognition.
- Additional qualifications - cognitive miser principle and satisficing.

# NDM Training

- Emphasis on situation awareness - choosing between courses of action.
- Emphasis on meta-cognition - concern for managing stress and controlling attention.
- Not a simple focus on practice and feedback.
- Decision strategy processing - no generic decision strategies.
- Identify the critical questions to be trained.



CUTE

# Why do pilots struggle with decisions ?

- The most common reason is lack of experience.
- High degree of experience to recognize as typical.
- This experience allows unusual events to be detected.
- High degree of experience to build narratives to diagnose and simulate alternative actions.
- High degree of experience to prioritise cues - workload.
- Do we think or just match ?

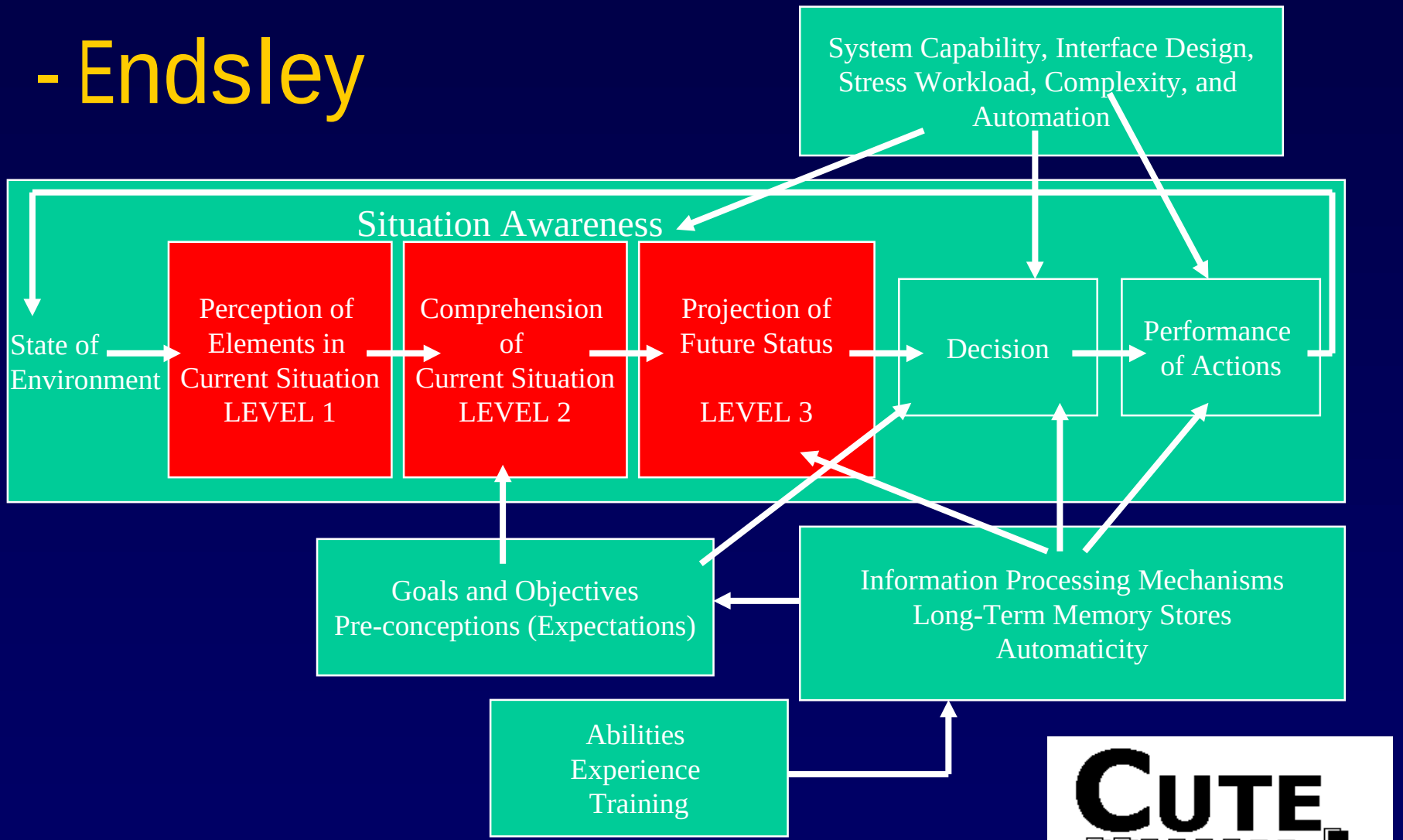
# Helping Pilots

- Identify the judgements and decisions needing practice.
- Provide tools to build scenarios to exercise and practice under time pressure and uncertainty.
- Design debriefing checklists to aid in directed learning.
- Show pilots there are coaching methods for accelerating skill development.



Building Knowledge and Capability

# Situational Awareness - Endsley



# Situational Awareness I

- Many failures are attributable to Level 1 SA - failure to notice significant events.
- The second most common cause of failures is Level 2 SA - failure to comprehend the events detected.
- Much effort is put into the training of the system interface to aid perception and comprehension.



# Situational Awareness II

- However, as both a bottom up and top down system human cognition makes errors resulting from - expectation (pre-conceptions) and action-based evidence suggests humans are poor at prediction of the consequences.

- Human operators are reluctant to change their current working hypothesis, perseveration.

# Situational Awareness III

- Relies on skilled memory performance - after repeated exposure to knowledge the encoding of familiar patterns is better - is there evidence that exceptions can be processed well as Klein suggests.
- Top-down and bottom up - but what of meta-cognitive and affective information processing influences.
- Is situational awareness explicit, implicit, declarative, procedural, episodic, semantic, strategic….

# Different Types of Knowledge

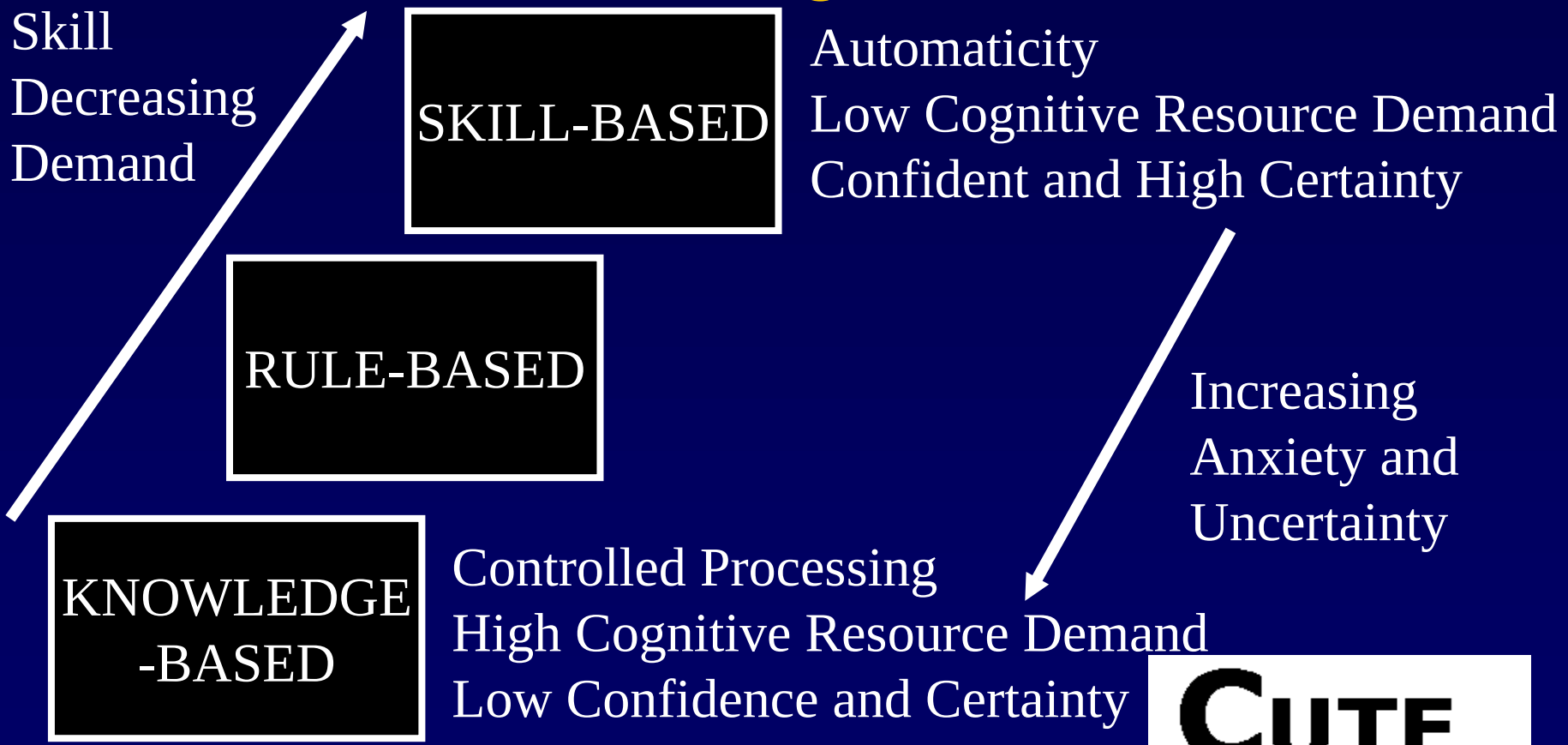
- Different memory stores may have different properties affecting -
  - storage
  - retrieval
  - durability
  - transfer
- See Healy and Bourne (1995).

# Training Changes Processing

- Workload Decreases.
- Use of Attention
- Automaticity Increases
- Types of Information Storage
- Affective Experience Changes

Building Knowledge and Capability

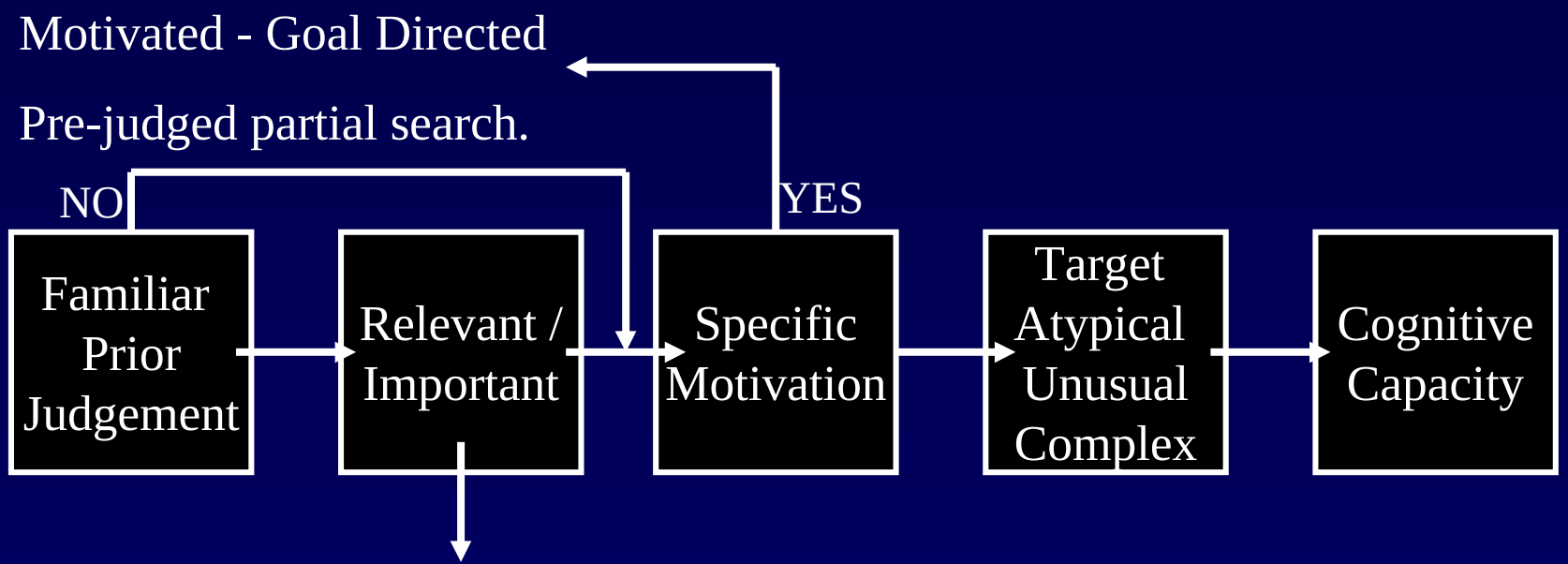
# Skill, Rule and Knowledge-Based



# Models of Skilled Behaviour

- Rasmussen's (1983, 1986) model of skilled behaviour.
- Skill-Rules-Knowledge Based Information Processing.
- Cognitive Resource Gradient - encourages human operators to stay in rule- or skill-based processing.
- Affective Experience Gradient - encourages human operators to stay in rule- or skill-based processing.
- Reaction against systems which encourage knowledge based processing and prevent the development of higher levels of skilled processing.

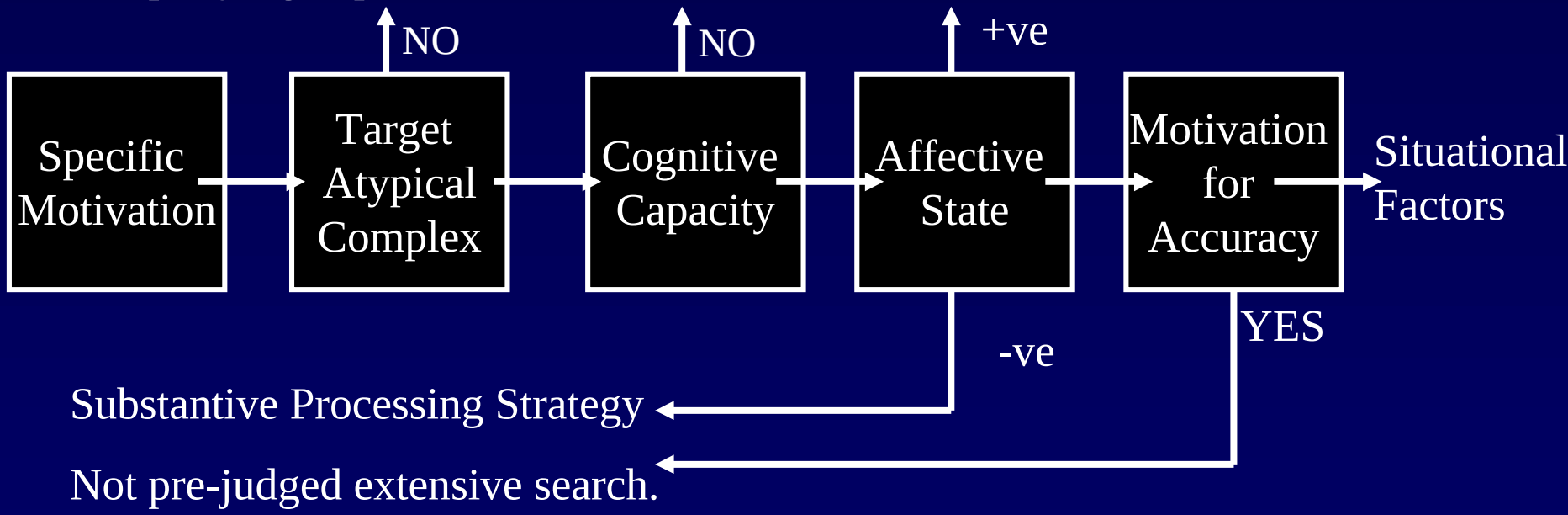
# Adapted Decision Strategy



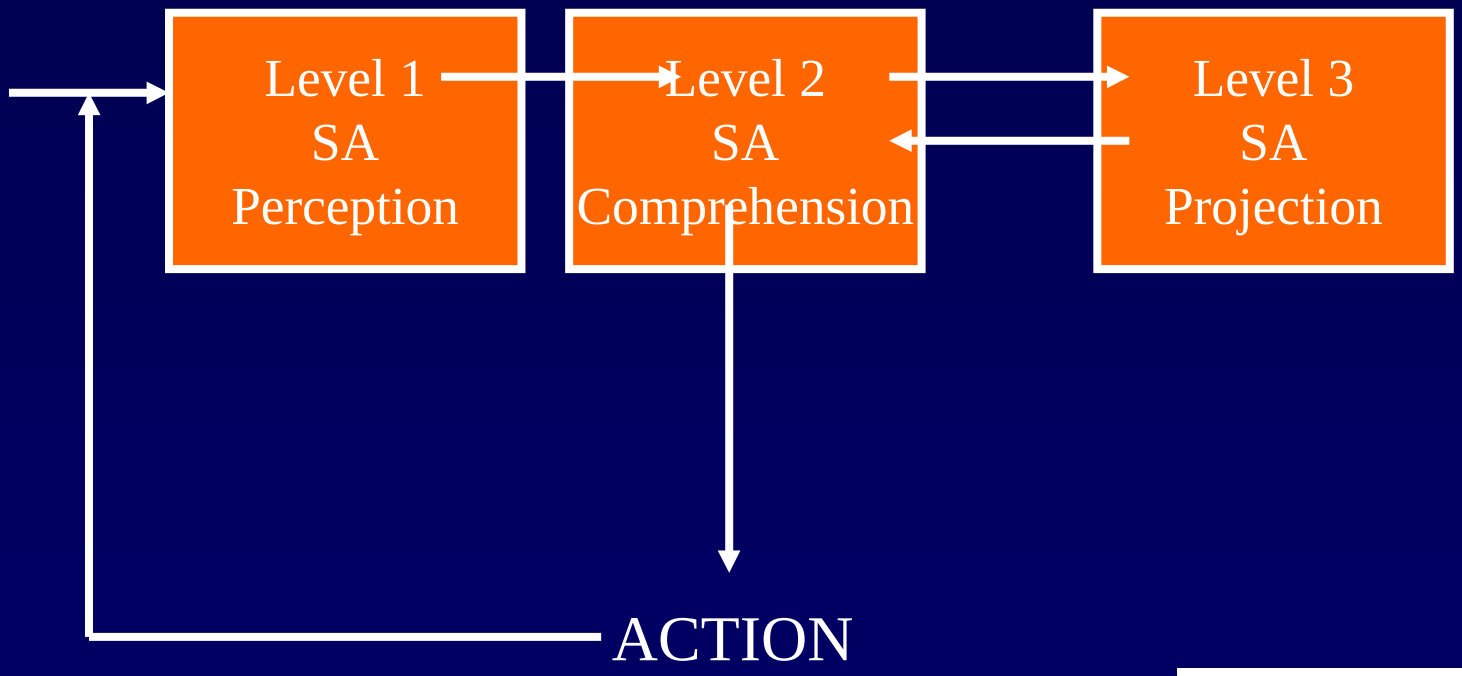
# Adapted Decision Strategy

Heuristic Processing Strategy

Not pre-judged partial search - affect as information.



# Impulse to Action



# Impulse to Action - Predictions

- Anxiety Increases the Likelihood of Poorly Considered Response.
- Cognitive Complexity Increases the Likelihood of Poorly Considered Response.
- Action Selection Decreases Anxiety.
- Action Selection Decreases Cognitive Demands.
- Action Selection Increases the Possibility of Deviation, Expectation Violation.

# Managing Cognitive Transitions

- Novel, Unfamiliar and Unexpected Events create -
  - additional demands on working memory
  - affective responses that influence information processing
  - require the use of social and individual meta-cognitive process management
- Importance of a shared mental model

# Critical Issues

- Automation
  - disengagement
  - undermines SA
  - increases complacency
  - works well, most of the time
  - puts operator into vigilance mode (supervising)
  - reduces skill

# Confidence, Trust and Uncertainty

- Trust - the reliance on another (human or agent).
- Confidence - the degree of certainty that the other (human or agent) will achieve a result.
- Uncertainty - the level of ambiguity (or inverse of familiarity) in the context or situation.
- Predictability - confidence * uncertainty.



# Psychological Issues

- Human Operator makes critical decisions and needs to be kept informed.
- Human Operators need to process information, to generate knowledge in order to make correct decisions and operate at top of SRK model.
- Human Operators like to feel confident in their execution of skilled behaviour (operate at S-Level) and conduct their processing to reduce any uncertainty.



# Summary of Aviation Training

- 1) Theoretical basis for training - shared mental model development.
- 2) The purpose behind human performance measurement.
- 3) Team and cognitive analysis tools should be used.
- 4) Event-based strategy for assessment or critical incident training approach.
- 5) Measures should be multi-level. What happened ? Why did it happen ?

# Summary of Aviation Training

- 6) Performance protocols need to support diagnostic learning.
- 7) Tools must be easy to use.
- 8) Involve the user in training development.
- 9) Training should be available for the instructor.

# Summary of Aviation Training

- Many protocols measure performance but do not provide sufficient detail to increase diagnostic analysis - What you see is all you learn.
- Training analysis tools must be easy enough to allow user and trainer driven exploration.
- The training analysis must be credible.
- The training system should enable the instructor and involve effective training measures related to tangible outcomes.

# Training Disasters

- Training systems must record vital information for diagnostic analysis of user performance - this aids future self-monitoring, review and evaluation.
- Training systems need to give built in feedback at time of action.
- Training systems must require limited expensive subject-matter experts but ensure effective self-tuition.
- Training systems may require effortful cognitive reconstruction of the events in a social environment that will foster effective team SMMs.



# Conclusions

- Being smart is not actually being smart per se.
- Being smart and useful involves maintaining an effective management of resources.
- The interrogative approach to training brings confidence and trust.
- An interrogative approach to operation creates a barrier where the response is pre-emptive and not reactive.

# Conclusions

- Most human interaction with complex systems is adaptive.
- Often processes or procedures to increase the balance of negative and positive outcomes results in re-adjustment to maximize +ve gains (Rasmussen, 1999).
- Adaptation is a slow process of Behavioural Evolution which may go unnoticed in operations.
- Training needs to re-instantiate the willingness to learn.



# Conclusions

- Novel situations can be catastrophic for fixed systems and modes of operation.
- Training can afford the opportunity to train recognition of such events and potential mitigating responses.
- In addition training can create the skills to cope with the experience of such events.

# Goals and Training

- Knowledge
- Cognitive Resource Management
- Self-Awareness and Team-Awareness
- Create Motivation to Learn