Understanding the Perceptual Cycle in teams

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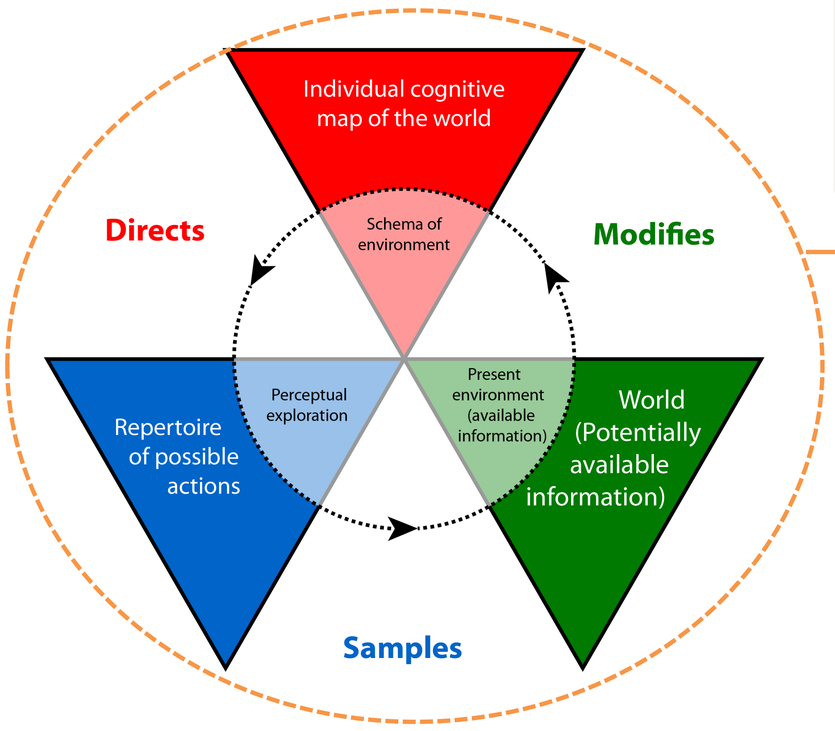
Perceptual Cycle Model

- Neisser's (1976)[1] view of perception
- Describes the reciprocal, cyclical relationship between an operator and their environment
- ➢ Via top-down processing knowledge **(schemata)** leads to the anticipation of certain types of information
- ➢ This then directs behaviour **(actions)** to seek out certain types of information and bottom-up processing allows information to be interpreted
- ➢ Environmental experience **(world information)** can modify and update cognitive schemata



Currently an **individual level of analysis:** describes the behaviour of one person acting in the world

- ✓ Important to consider as this level is the place where failures occur
- ✓ Individual's have a natural motivation to improve and learning takes place at this level
- × Over simplistic, failures that manifest at the sharp end are usually a consequence of preceding events in other layers of the system
- × Studying elements in isolation does not consider relations and interactions that occur

PCM applied to many incidents involving a high decision making component

- Ladbroke Grove rail crash
- Stockwell shooting
- Kegworth plane crash

Decision making is distributed amongst multiple individuals and technological agents

Aim: To explore the perceptual cycle of a team

Teams:

- Multiple individuals working within a common organisational perspective
- Compatible rather than shared experiences (situation awareness, schemata)

Method: Critical Decision Method

- Knowledge elicitation tool using cognitive probes to understand expert decision making in non-routine situations[2]
- Retrospective semi-structured interview in which participants recall a critical incident they were previously involved with
- Four phases of the interview:
  1) Incident identification
  2) Timeline construction
  3) Deepening probes
  4) "what if" queries
- Crew members interviewed separately at their helicopter base
- Critical incident defined prior to the interviews (with the PF), other crew members not aware which incident would be discussed
- Interviews occurred 6 months after incident

"What was your specific goal during the incident?"

"what was the primary decision that you made?"

"what information did you use to make that decision"

"Did your experience influence the decision that you made? If so, how?"

Crew member	Age	Hours of experience
Pilot Flying (PF)	48	5500
Pilot Not Flying (PNF)	55	9000
Winch Operator (WO)	65	6000
Winch Man (WM)	60	7500

Critical incident:

During a routine search and rescue winch training exercise over a vessel the pilots were alerted to 'high engine oil temperature ' (EOT) via a flashing amber caution light.

The digital scale had gone through amber readings into red, this resulted in one minute of flight time before the aircraft had to be shutdown.

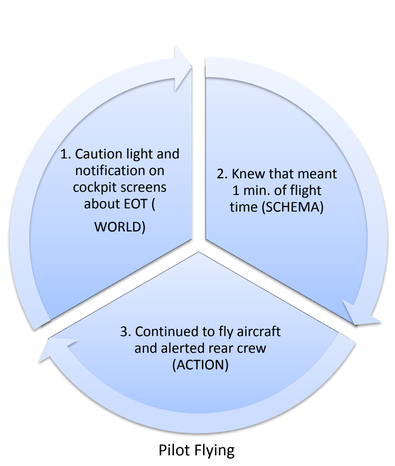
Data Analysis

- Qualitative analysis
- Interviews transcribed
- Text chucked into meaningful segments (~1 sentence in length)
- **Deductive thematic analysis**: themes generated from existing theory
  Coding scheme based on categories of the Perceptual Cycle Model

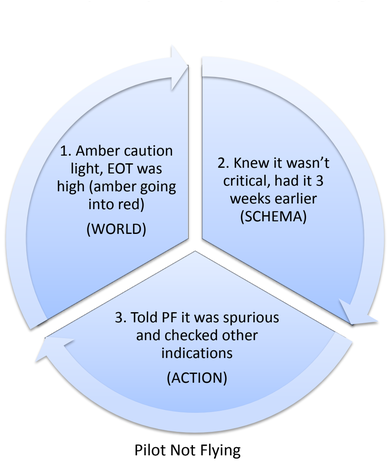
	Code name		
	Schema	**Action**	**World**
Definition	Organised mental patterns (templates) held by individuals that organise their representations of the world	The process of doing something, or the intention to do something	Externally available information in the environment
Description (for coding)	Statements relating to the use of prior knowledge, experience, expectations and about 'knowing' things	Statements relating to performing an action or discussing potential actions that could be taken	Statements relating to information existing in the world, could be physical things, conditions or states of being
Example	*"my expectation was that the engine would take a while to start in the rain"*	*"I turned on the engine"*	*"Caution light came on"*

Perceptual cycle representation of the critical incident

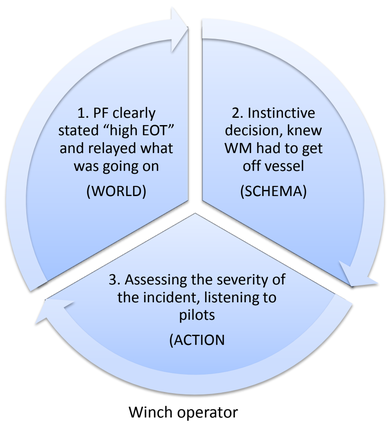
- Critical incident broken down into **7 phases**: Briefing → Dummy run → live run → onset of incident (high EOT) → immediate actions → diagnostics → return to base
- Individual crew members engaged in different perceptual cycles *(exemplified below, for the 'onset of incident' phase)*



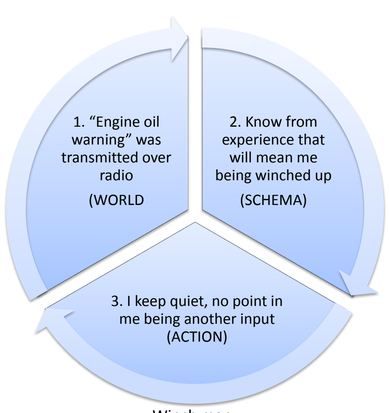
Pilot Flying



Pilot Not Flying



Winch operator



Winch man

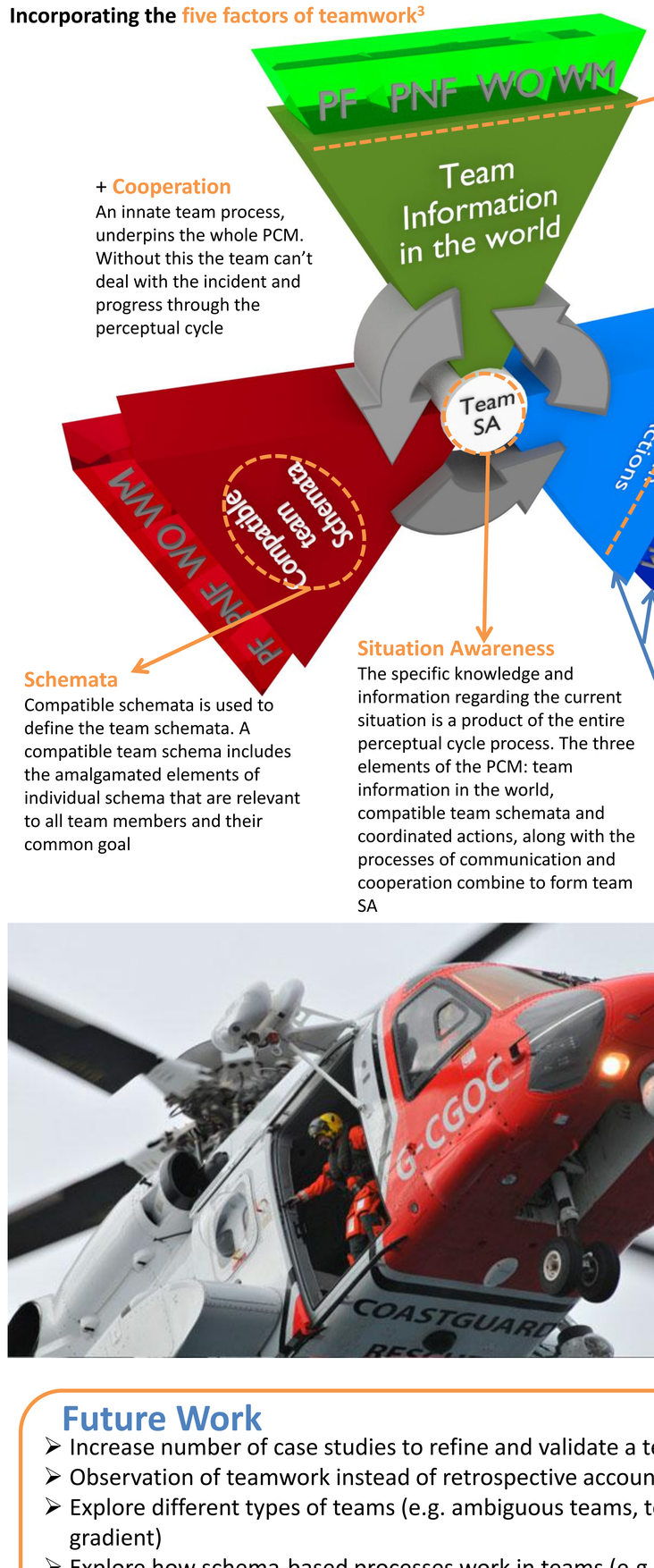
- Each individual possessed a schema for the situation that was relevant to their situation
- Two pilots held very different schema for the same situation → demonstrates the unique, individual nature of schemata and their potential influence in decision making

- **Individual representations of perceptual cycle:**
- ✓ Demonstrates how the model can be used to structure decision making data
- × Doesn't account for interactions that occur between crew members, e.g. the verbalised schema from the PNF became information in the world for PF

Question: What are the processes that transfer information around a team perceptual cycle?

Perceptual cycle at the team level

Incorporating the five factors of teamwork[3]



Communication
The process that transfers information amongst team members. Allows individual schemata or actions to be vocalised and become world information for the team

+ Cooperation
An innate team process, underpins the whole PCM. Without this the team can't deal with the incident and progress through the perceptual cycle

Coordination
The process by which individual actions become coordinated team actions. Not necessarily performed simultaneously, but coordinated towards a common goal.

Schemata
Compatible schemata is used to define the team schemata. A compatible team schema includes the amalgamated elements of individual schema that are relevant to all team members and their common goal

Situation Awareness
The specific knowledge and information regarding the current situation is a product of the entire perceptual cycle process. The three elements of the PCM: team information in the world, compatible team schemata and coordinated actions, along with the processes of communication and cooperation combine to form team SA

Inter- and independencies

- Individual team members have exposure to different pieces of information = **independencies**
- Through communication, coordination and cooperation these independencies become part of the common goal (compatible schemata, coordinated action and team world information) = **interdependencies**
- Both need to be represented

Conclusions

Humans are not linear information processors. It is necessary to to consider the perceptual cycle of the whole team and the individual contributions made by each team member.

Future Work

- ➢ Increase number of case studies to refine and validate a team PCM
- ➢ Observation of teamwork instead of retrospective accounts
- ➢ Explore different types of teams (e.g. ambiguous teams, teams with a strong authority gradient)
- ➢ Explore how schema-based processes work in teams (e.g. contention scheduling and frequency gambling)

[1] Neisser, U. (1976). *Cognition and Reality*, W.H.Freeman and Co., San Francisco.
[2] Klein, G. A., Calderwood, R. & Macgregor, D. 1989. Critical Decision Method for Eliciting Knowledge, *IEEE Transactions on Systems, Man and Cybernetics,* 19, 3, 462-472
[3]Rafferty, L., Stanton, N.A. & Walker, G.H. 2010. The famous five factors in teamwork: a case study of fratricide. *Ergonomics,* 53(10), 1187-1204