Aspects of Human error: a brief introduction

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The psychology of human error

- Rasmussen, J. Duncan, K. & LePlatt, J. (Eds.) (1987), New technology and human error, Wiley.
- Reason, J. T. (1990) Human error. Cambridge University Press.
- Norman, D.A. (1988). The psychology of everyday things. Basic books

Human error and accidents

- Donald Mackenzie (1994)
  - 34 incidents
  - 1,100 computer-related accidental deaths (‘79 - ’92)
  - 4% of deaths due to physical causes
  - 3% of deaths due to software error
  - 92% of deaths due to human-computer interaction
- Air Traffic Control company (last month)
  - “90% of ATC incidents, controller or pilot human error”
- NB could be human human interaction, what do we mean by “user interface”?

Interaction with new automation

- Medical
  - North Staffordshire Royal Infirmary
  - Introduction of new radio-therapy machine meant that corrections to irradiation distance, previously done manually, were done automatically by the new machine. This feature of the system was not recognised for 9 years
  - 401 people died by mid 1993

Interaction with warnings

- Military
  - US Frigate Stark, hit by Exocet Missile while on patrol in Persian Gulf. Air Defence system operator had turned off the audible warning of hostile aircraft because of too many false alarms

The classic mode error

- Air
  - A320 Strasbourg accident. Crew may have selected the wrong mode of descent. Aircraft descended at 3,300 ft per minute instead of 3.3 degree glide slope
  - One indication of the mode difference is a display which reads 33 in the former and 3.3 in the latter
  - There were other indications which were not noticed.
  - The aircraft had no GPWS

Some effects of new technology

Require new knowledge, procedures, etc.

- *Change* tasks and *add* tasks for the human
  - *"I can't fly anymore, but I can type 50 words a minute now"*
- Invite new forms of human error
  - *Mode confusion - why is it doing this now?*
- Open up novel ways toward system breakdown
  - *Wrestling with automated systems*

Breakdown not due to single causes

Typical signature of failure today:

1) circumstances come together that are challenging but not unmanageable

2) through a cascade of miscommunications and mis-assessments

3) the interaction between human, machine and operational environment breaks down

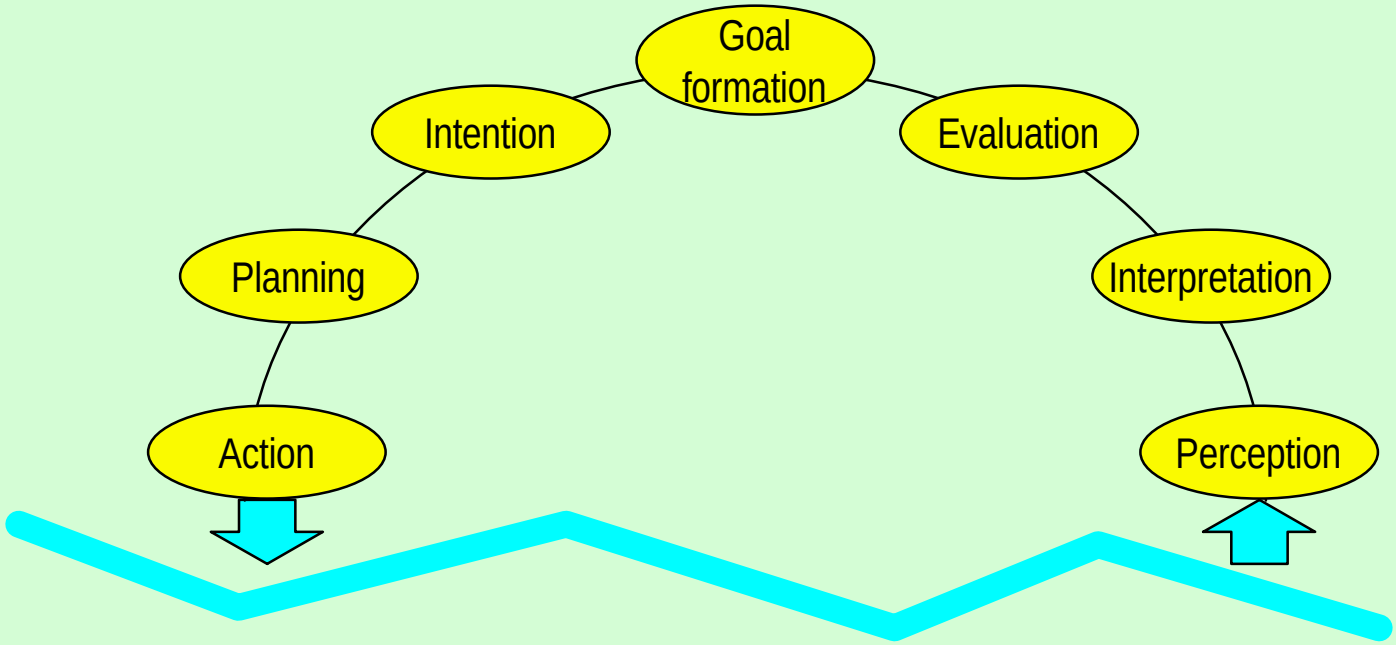
The nature of error

- Errors are not always meaningless events
- Errors may be random
  - the novice shooter
- Errors may have pattern
  - the sharp shooter with a defective sight
- Errors and intentionality are intimately linked
  - spelling mistakes

A behavioural account of error

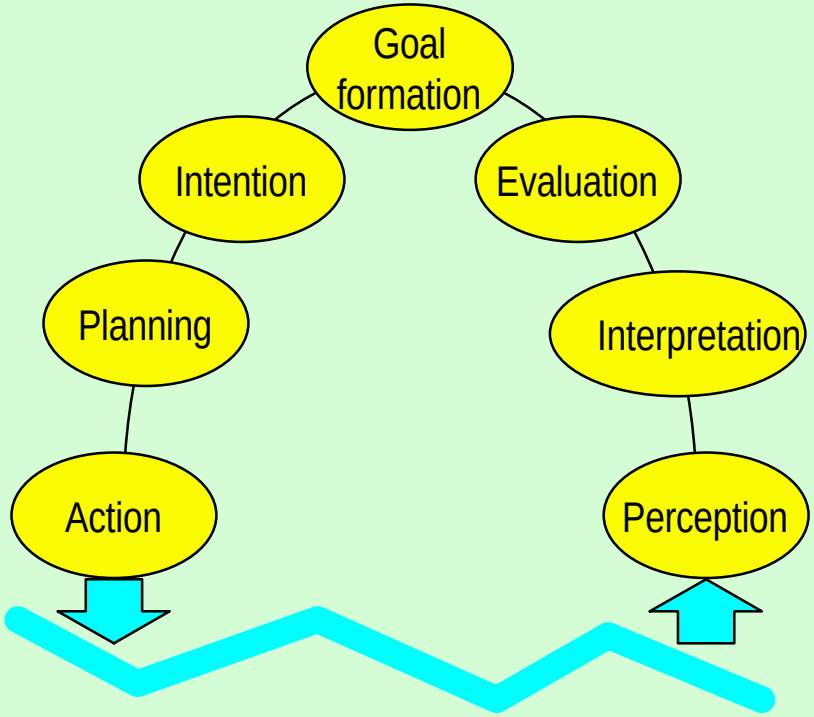
- What are the actions required to complete a task?
- What are the possible deviations from this task?
  - omission
  - commission
  - qualitative
  - timing
  - sequence
- Emphasis on events and traces or sequences of behaviour
  - The trace of erroneous action
  - “H.P. rotor drive covers had not been refitted and ground idle engine runs not conducted”

A simple model of performance



Error in the simple model

- Slips and lapses
  - action that occurs is not what was intended
  - involves failure of execution/storage.
- Mistakes
  - Action that occurs was as intended but did not succeed in meeting goal.



An example of a slip

BAC 1-11: My first officer was flying the leg. After T/O I carried out the usual checks. Brakes, U/C up, PAX notices off etc. Weather; lovely blue sky. W/V 270/18, Temp +30C! At 1500 feet I noticed the flaps were retracted, I thought John had retracted them early. Usually the flap is retracted at 2000 feet plus in VFR or 3000 noise abatement. Almost immediately he mentioned that the flaps were retracted. “Oh, I see you have brought the flaps in” he said. “No” I replied “I haven't touched them”. He said he hadn't either. Shortly after this he noticed the U/C was still extended. I raised it at 220 knots. There can be no doubt I raised the flaps instead of the U/C after take-off. I had no memory at all of doing this. Why would I do this potentially dangerous thing on an aircraft with which I was completely familiar? I have no idea: no sickness, no stress, nothing dramatic personally.

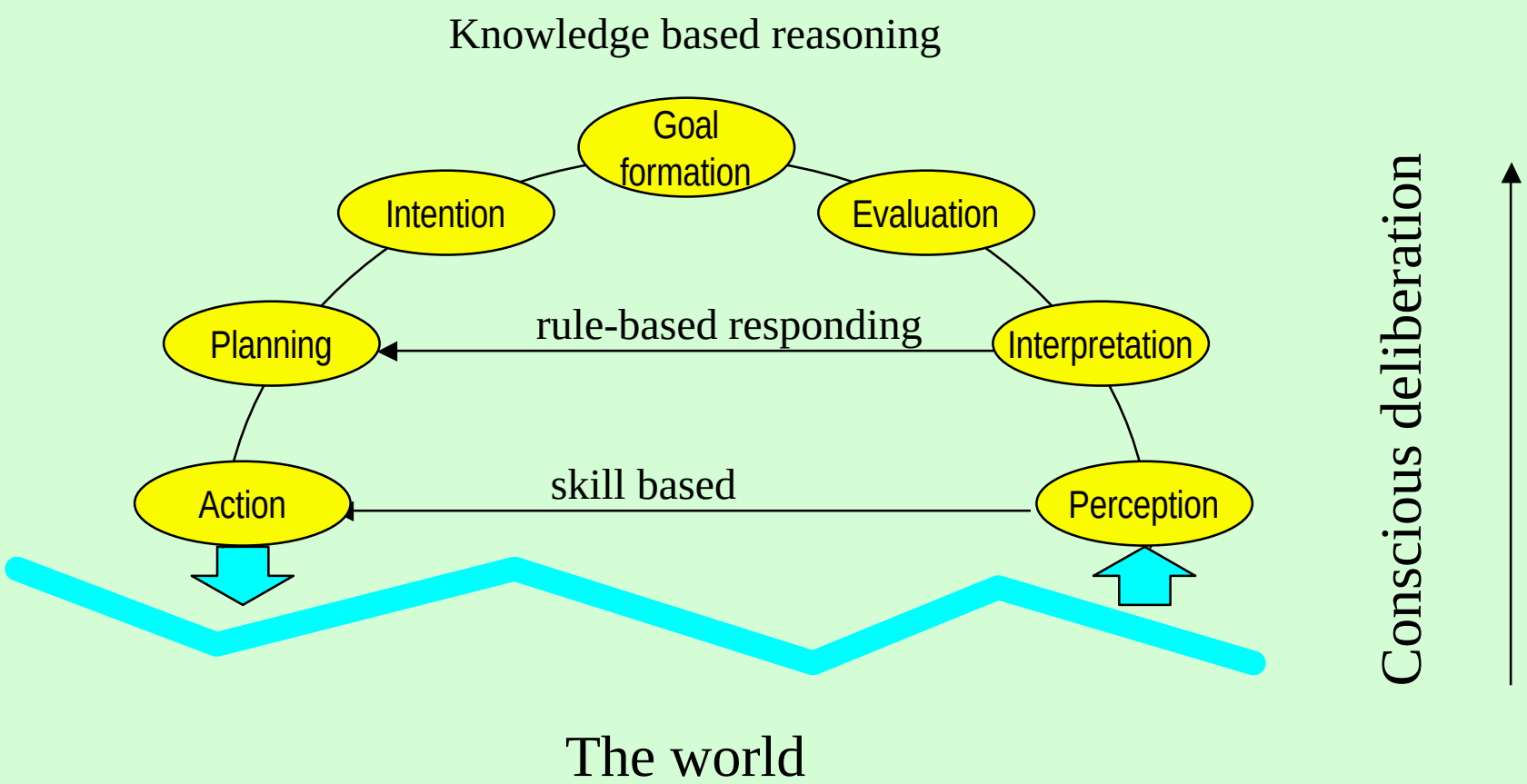
CHIRP incident database

An example of a mistake

Approximately 13 minutes into the flight the turbofan on the No.1 (left) engine fractured causing a series of compressor stalls in that engine. The pilots did not know what had happened, the indications they received were excessive vibration felt throughout the airframe, noise and a smell of fire in the cockpit. Their initial reaction was that they had a fire. The following comments were spoken by the first officer; It's a fire Kevin. It's a fire coming through. In response the commander disengaged the auto throttle and said; Which one is it though? The 1st officer replied; Its the le its the right one. The commander then requested the first officer to throttle it back. In fact it was the left hand engine that was faulty; the first officer had identified the wrong engine and it was a perfectly healthy right engine that was throttled back.

AAIB Kegworth accident report

Human action is not always deliberate and plan based



Rasmussen's model

Performance level	Characteristics
Skill-based performance	automatic, unconscious, parallel with other activities
Rule-based performance	recognising situations and following associated procedures
Knowledge-based performance	conscious problem solving

Practice

interaction breakdown

iri

DIRC

How to change gear

- Wait until engine sounds ready for a change
- Depress the left-most pedal with your left foot while at the same time taking your right foot off the rightmost pedal
- Once the pedal is fully depressed work out what the new position of the gear lever has to be
- Move the gear lever to that new position
- Gently depress the rightmost pedal with your right foot while simultaneously releasing the leftmost pedal with your left foot until the leftmost pedal is fully released and the car engine sounds about right

Disruption :- moving up the levels

- Automatic, unconscious behaviour is disrupted when:
  - unexpected external cues are detected
  - unexpected actions are detected
  - outcome is not as planned
  - If this does not occur latent errors may be introduced
- Rule based behaviour is disrupted when:
  - Situation cannot be interpreted adequately
  - No appropriate procedures can be found for the situation
  - procedures are mis-remembered
  - outcome is not as planned

The Narita incident

– From an internal airline report on an in-flight pylon/wing fire incident in which “there was no indication of fire presented to the crew when a fire actually existed”.

> **"...numerous EICAS messages began to appear, indicating a deteriorating mechanical condition of the aircraft. The first was OVHT ENG 1 NAC, closely followed by BLEED DUCT LEAK L, ENG 1 OIL PRESSURE, FLAPS PRIMARY, FMC L, STARTER CUTOUT 1 and others. [In total] the crew received and had to sort out 42 EICAS messages, 12 caution/warning indications, repeated stick shaker activation and abnormal speed reference information. An electronic system 'nightmare'".**

Skill level and error types

Performance level	Error types
Skill-based performance	Skill-based slips
Rule-based performance	Rule-based mistakes
Knowledge-based performance	Knowlege-based mistakes

Knowledge-based mistakes

- Confirmation bias
  - People richly interpret ambiguous scenes to reach an explanatory model. They then seek confirmation and disregard disconfirming information.
- Availability bias
  - Recently presented information, information that is currently visible and information that is emotive are given undue weight in decision making
- Selectivity
  - Problem solver's attention is directed to aspects of current problem that is perceptually salient in preference to logically important aspects
- Availability and selectivity often conspire

The Kegworth accident

- Confirmation bias
  - when the Kegworth pilots idled the wrong engine the symptoms went away, confirming their diagnosis
- Availability bias
  - there was no fire bell but this did not stop the crew diagnosing a fire
  - fire drills are a common simulator training exercise
- Selectivity
  - smoke in the cockpit during the Kegworth accident was strongly weighted piece of evidence
  - smoke is perceptually salient (up your nose!) airborne vibration metre is not

Summary

- Errors can be described at a behavioural level
- But to understand human reliability we have to look at the cognitive processes involved in the production of action and thus error
- Slips and mistakes are the results of different processes
- They have different implications for design and assessment