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Situation awareness and decision making

1. Introduction

An A320 crew reported an in-flight problem with the elevators and decided to divert. The ensuing captain's report described precisely their analysis of the situation, decision process, actions, and how the decision to divert was ultimately reached.

Surprisingly, however, subsequent read-out of the Post Flight Report and decoding of the DFDR contradicted the crew and indicated that the ECAM had displayed an aileron fault warning and nothing about the elevators.

In this event, the crew wrongly interpreted the ECAM message for some reason that may be explained by a lapse of attention and/or by the fact that they had perceived a slight nose-down tendency during the take-off phase of the flight.

The important point is that, as a consequence of this misperception, the crew's awareness of the situation was flawed and the ensuing decision process was based on incorrect assumptions. This illustrates how perception is critical in the situation assessment process and thus in decision making.

This article will describe why, when faced with a challenge, situation awareness is crucial in implementing the appropriate actions. It will as well explain how situation awareness may lead to either the application of an "off the shelve" solution (referred to as mental template) or to a decision making process. The last part of the article will identify some of the main obstructions to sound decision making.

2. Situation awareness

Situation awareness implies a clear and up to date understanding of what is going on around us. To help us do so we use mental templates that are the product of our experience and which will be triggered in specific situations.

Pilots are educated and trained to use their experience to recognize the situation as an instance of a familiar type (a "typical situation"). Once it has been recognized as 'that' type of situation, the pilots can trigger the corresponding mental template.

The chosen mental template incorporates goals and intentions, typical actions, expectations and relevant cues. It pinpoints as well how to monitor the typical expected actions. For example, while "ready for take-off", the crew's template contains key parameters and a selected number of potential failures, which are crucial for this phase like:

- Tower clearance, runway length, wind, engine power…
- Engine failure, runway incursion, wheel bursts…

In the elevators/ ailerons confusion case described in the introduction, the main problem was with the assessment of the situation. This illustrates the importance of gathering the information to properly assess the situation, and represents where the crew should put its initial mental effort. The relevant clues should not be missed. An evaluation of the situation should be done to ensure a proper diagnosis.

To ensure a good assessment of the situation, try to think about the situation changing the point of view: "can it be something else?", "are we missing something?"

If the pilot does not recognize a "typical situation", he will not be able to trigger the appropriate mental template and suitable actions, but will have to make a decision. The decision is defined with reference to situation awareness. Situation awareness is necessary in maintaining control of the situation and managing the risk assessment.

3. Decision making

3.1. The decision process

We all take many decisions every day. Decision making is the process of selecting a course of action among one or several alternative(s).

Before deciding we should assess the situation, analyze the problem, and then collect the information that will be used in our decision making. The problem must be precisely identified and assessed in the context of a specific situation. The decision should include:

- Clear and organized objectives
- Considered alternative actions
- Anticipated potential consequences

If the solution is not reached, the loop starts again.

How safety is taken into account in the decision making process depends on the situation (e.g. flight phases) and the ability to anticipate potential consequences.

To put it simply, the pilot are trained to:

► Perceive the critical information in the environment

► Understand and assess the relevance and the importance of these informations in accordance with his/her own objectives

► Predict what will happen next

► Adjust accordingly if possible.

In the cockpit, decisions have the following characteristics:

► They are intimately related to the evaluation of the situation

► They are "good" only if they may be applied with the appropriate knowledge and skills

► They have a limited life span: due to the dynamics of the situation, a decision is "good" only for a defined amount of time

► They cannot always been split from actions. Sometimes it is the possible actions which lead and orient the decision (e.g. Go Around, TCAS…).

In aviation, every decision may have a major impact due to:

► The dynamics of the situation

► The interconnection of information

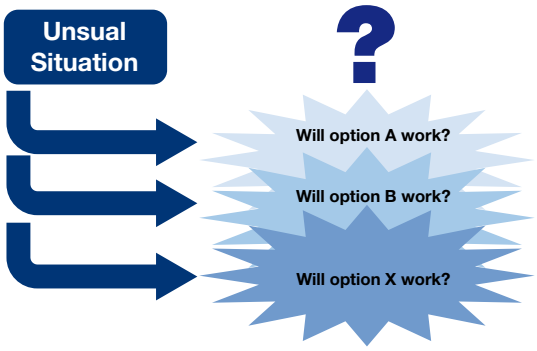
► The irreversibility of some crew actions (no "undo"!).

3.2. Mental simulation

Mental simulation is a conscious process that will allow choosing one option by evaluating consequences.

In case of a diversion (i.e. pax medical emergency or engine problems), the crew needs to decide if it is best to return to the original airport, to continue as planned, to land at the nearest suitable airport…? In this case there is no doubt on what has happened. The situation is clearly identified and assessed. Here the crew really needs to

Decisions based on mental simulation



mentally consider each option and its feasibility (safety but also operational and commercial consequences, such as: how much fuel ? what weather, what about the passengers, the maintenance ? etc…). In dynamic situations, once the decision is taken, it becomes most of the time irreversible due to the evolution of the situation.

The following traps may seriously impair this mental simulation:

► The crew can choose an option that is poor or inappropriate: for example the crew can decide something, which is perceived as a "best solution" and then realize that they cannot implement it

► The crew can choose and accept the first alternative that might work without going through the complete mental simulation process and this may lead to a premature termination of evidence search.

Not only is the decision important, but the decision follow-up as well because sometimes the situation may evolve quickly and differently from what was expected.

Tips to improve the mental simulation:
► Try to widen the range of options
► Question the capabilities (can you make it, individually and as a crew)
► Look for negative evidence:"Is there anything telling us we are wrong?"
► Decision follow up: watch how the situation evolves and be ready to adapt your decision or strategy accordingly.

3.3. Time pressure

When assessing the situation, time pressure is important, as flying is a dynamic process. A trap when attention is focused is to loose time consciousness: thus pilots may believe they have plenty of time to think and evaluate the situation.

Under pressure, fewer options are envisaged and the evaluation of each option is limited. It is why often the first acceptable solution is taken.

Example of the Hudson accident: (extract from the NTSB report)

"*About one minute after the bird strike, it was evident to the flight crew that landing at an airport may not be an option. The captain indicated that, because of time constraints, they could not discuss every part of the decision process; therefore they had to listen to and observe each other. The captain further stated that they did not have time to consult all written guidance or complete the appropriate check-list, so he and the first officer had to work almost intuitively in a very closed-knit fashion.*"

In this event, the crew had to take an irreversible decision. In similar circumstances, some pilots may have been paralyzed or blocked by the analysis and the important stress experienced at that time.

Tips to manage the time pressure:
► Fix a decision deadline
► Stabilize the situation
► Assess time factors (fuel!), be aware of the available time
► Prioritize
► Manage workload and use all resources
► Do not forget to fly the aircraft.

3.4. Decision aids

Procedures are tools to support decision making because they provide to the crew:

► Element of diagnosis

► Actions to perform

► Elements/ conditions to control.

Aircraft systems also support decision making by giving information for situation assessment and decision. The ECAM for example, which is based on a need to see concept, will provide the check lists and status of the aircraft for all anomalies detected by the aircraft systems.

4. Constraints to decision making

4.1. Level of fatigue, stress, workload and distraction

When pilots are tired, the tendency will be to ignore some information (fixation on a specific item).

Stress will favor "short term" decisions (short benefit decisions) and may be detrimental to the decision process.

When workload is too high, the quality of decision making process deteriorates.

In the Hudson accident, the crew was able to manage their level of stress (resulting from high workload and time pressure) and they avoided the "tunnel vision" created by stress, which narrows the attention. They were also able to face series of aural alerts and many ATC communications, which did not distract them from their action plan.

4.2. Personality type

Personality may also impair the decision:

► Invulnerability: it won't happen to me!

► Impulsivity: I have to act, to do something!

► Macho: I can do it!

► Anti-authority: don't tell me!

► Resignation: what will be the interest of doing this?

Even if people cannot change personality, pilots should be aware of their natural trend in order to know their weaknesses and thus manage the decision process accordingly.

4.3. Expertise/ Experience

Experience plays an important role in situation awareness and in the management of stress:

► An experienced pilot may take inappropriate shortcuts in the decision process

► A less experienced pilot may miss important points and priorities when taking his decision.

4.4. Risk perception

Too deep analysis may be a trap for decision making, for example when the two pilots are head down trying to analyse a situation, thereby forgetting to fly the aircraft.

Pilots tend to favor decisions, which will reduce their perception of risk. The main risk is the feeling of "not being able to do in the available time". Risk may be underestimated, possibly because a previous similar situation was successfully managed.

4.5. Individual biases

Let's look at some bias (not an exhaustive list!) which may impact decision making in flight:

► Frequency bias : tendency to over or underestimate the probability of occurrence of a particular event, because our evaluation is based solely on our personal experience

► Conformity bias: tendency to look for data (instrument values, events, etc) that support and confirm our decision rather than information that would contradict it. The confusion between elevators/ ailerons is a typical example

► Familiarity bias: tendency to choose the most familiar solution (linked to our preconceived ideas or to our experience)

► Recency : tendency to pay more attention on the most recent information and ignore the more distant one

► Illusion of control : We tend to believe we have more control on events than we really do. Thus we tend to underestimate future uncertainty. We believe we have control to minimize potential problems in our decisions.

4.6. Group thinking biases

Each member may affect the collective decision making process. The crew should have the same information to build collective situational awareness and check for a common understanding and agree on goals:

► Authority bias: tendency to agree with the opinion held by the captain because of rank; and for the captain not to listen to the copilot's inputs (thinking he/she is the boss)

► Group conformity or group think bias: tendency to agree with opinions held by the majority. In a two crewmembers cockpit, this will be similar to the authority bias.

► Source credibility bias: tendency to reject something from a person that we do not like or on whose abilities we have preconceived ideas.

5. Conclusion

Situation awareness is key to implementing the appropriate action plan. It calls for the performance of a real, timely and complete assessment of the environment. It then serves as the basis either for the application of a mental template or for the launching of a decision making process.

A decision should include:

► Clear and organized objectives

► Considered alternative actions

► Anticipated potential consequences.

Reaching a good decision is critical but may be a difficult exercise, especially in a dynamic situation. It is therefore important to bear in mind the following two common pitfalls to reaching a sound decision: time pressure and human biases.

When taking a decision:

► Manage the time stress and do not rush into action

► Know yourself and beware of the obstructions to effective decision making.

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