# 2.6 Problem-Solving and Decision-Making

## Definitions

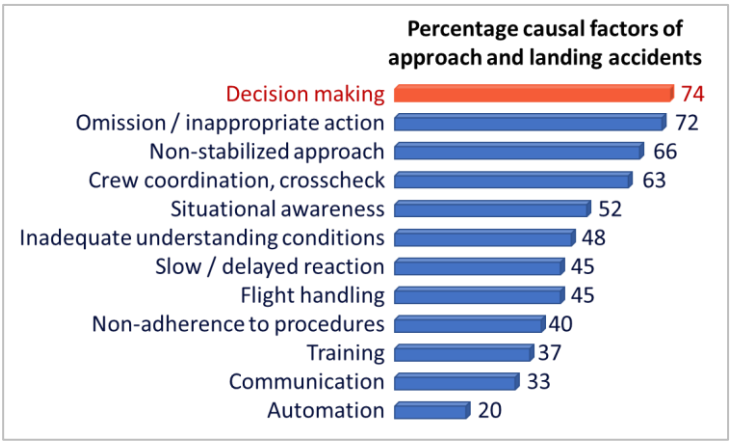
Competence in problem solving and decision making is central to a pilot's ability to perform under pressure in abnormal situations. At first glance, it may appear that the competency is split into two sections: solving the problem and making decisions. However, these two concepts are so intertwined that it is impossible to separate them. You cannot make a valid decision if you do not understand the problem, and you cannot problem solve without making good decisions.

The IATA Competency is defined as:

**Problem Solving and decision Making (PSD)[i] :** Identifies precursors, mitigates problems, and makes decisions

Data from the Flight Safety Foundation ALAR tool kit[ii] shows that decision making is the highest causal factors of approach and landing accidents.

The FAA places similar emphasis in its training, using the concept of Aeronautical Decision Making:




**Aeronautical Decision Making (ADM)[iii] :** Aeronautical decision making is a systematic approach to the mental process used by pilots to consequently determine the best course of action in response to a given set of circumstances

This definition highlights 4 main elements:

- *systematic approach* – ADM procedures are available for this
- *mental process* – ADM is a step-by-step process
- *best course of action* – ADM reviews of alternatives
- *circumstances* – ADM is dependent on situational awareness

These 4 elements can also be seen throughout the CAE Observable Behaviors for PSD:

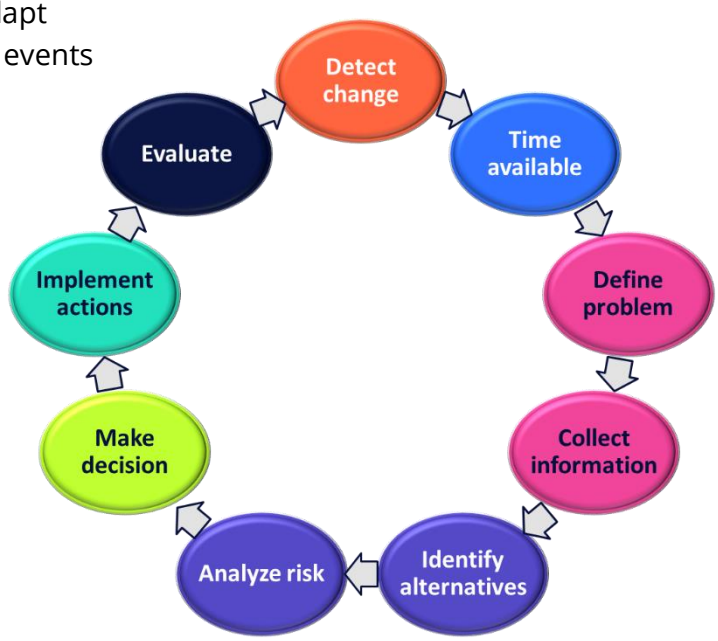
| | |
|---|---|
| **PSD**<br><br>**Observable Behaviors** [iv] | **PSD 1** Identifies, assesses, and manages threats and errors in a timely manner<br>**PSD 2** Seeks accurate and adequate information from appropriate sources<br>**PSD 3** Identifies and verifies what and why things have gone wrong, if appropriate<br>**PSD 4** Perseveres in working through problems while prioritizing safety<br>**PSD 5** Identifies and considers appropriate options<br>**PSD 6** Applies appropriate and timely decision-making techniques<br>**PSD 7** Monitors, reviews, and adapts decisions as required<br>**PSD 8** Adapts when faced with situations where no guidance or procedure exists<br>**PSD 9** Demonstrates resilience when encountering an unexpected event |

## Decision Making Cycle

To formulate the systematic approach and step-by-step process defined in the ADM definition, the PSD OBs can be broken down into a few parts:

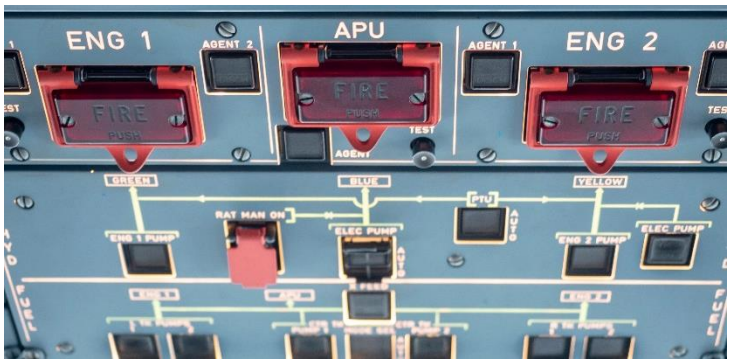
- PSD1 - TEM
- PSD2/ 3 - Information collection
- PSD 4 - Prioritizing safety- Risk management
- PSD 5 - Generating options and alternatives
- PSD 6 - Timely decision making
- PSD 7/8 - Monitor, review and adapt
- PSD 9 - Resilience in unexpected events

These parts can be ordered to form a decision-making cycle. Let us discuss each step:



## Step 0: Detect the change

When something starts to diverge from the norm, sometimes our attention is drawn directly to it, but sometimes the onset can be more subtle. Therefore, detecting the change to start the problem solving and decision-making cycle is step 0.




When a fire warning, attention getter, audio alert or loud noise signals a change, it can be startling. This can have a significant effect on crew performance and is discussed in section 3 of this Human Performance Guide. Equally, the change may be realized in a less dramatic way, in conversation with the crew, ATC, or through a standard monitoring cycle. It can be more concerning is when changes are difficult to spot – the onset might be slow, insipid, or masked by other tasks and functions.

However, when the change occurs – it is important to detect it as soon as possible, so that we can start to define the problem to be solved. This requires resources – knowledge, attention, and time.

## Step 1: TIME

Once the change is detected, without an exact diagnosis, it is important to understand the time limitations. Does the change require immediate action and solution, or is there time available for thought?

If time is critical, for example, if there is a fire in the cockpit or multiple bird strike, there may be no time to carry out full procedures or for in-depth crew discussions. It is simply a case of applying a known rule to the scenario as best possible.

However, if there is an engine malfunction at during cruise, there may be much more time to discuss options and decisions as a crew.

At this stage, it is not about calculating the time available but making a choice between **time available** or **no time available**.

There are some techniques to 'buy time' such as discontinuing an approach, entering the hold, and shedding non-essential task or missions.

## Step 2: DIAGNOSE

The next phase of the cycle includes two parts, which may occur concurrently, one after the other, or as a repeating cycle:

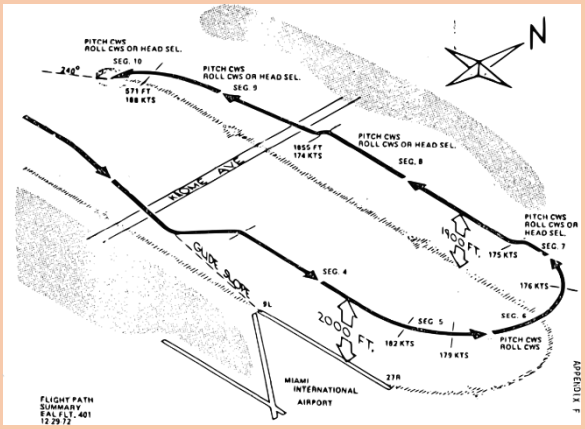
- Identify and define problem
- Collect information

The output of this step is to ensure the problem is diagnosed and understood. This may require information from multiple sources, which may need to be delegated. The Eastern Air Lines flight 401 shows the importance of delegating tasks when diagnosing the problem. Someone must maintain responsibility for the flight path of the aircraft at all times!

**Eastern Air Lines Flight 401**[v]

On Dec 29, 1972, the Lockheed Tristar crew were attempting to lower the gear on approach to Miami International Airport. On checking the gear indications, the FO noted that the nose gear indicator had not illuminated green for 'down and locked.' The captain elected to break off the approach and enter a holding pattern to gain more time to diagnose the problem. On entering the hold, the autopilot was engaged and the crew began to discuss the problem. However, as the distracted crew attempted to resolve the landing gear problem, the autopilot was inadvertently set into the wrong mode. As seconds ticked by, the aircraft lost altitude:

- 80 sec – maintained level
- Dropped 100 ft
- 2 mins – maintained level
- Began gradual descent
- 70 sec - Engineer alert triggered
- 50 sec – half assigned altitude




The following was the last conversation from the cockpit voice recorder:

F/O: We did something to the altitude.
Capt.: What?
F/O: We're still at 2,000 feet, right?
Capt.: Hey—what's happening here?

Less than 10 seconds later, the aircraft crashed, killing 101 of the 177 souls on board.

This tragic loss of life highlighted the importance of the first priority – to fly the aircraft:

*Aviate, Navigate, Communicate*

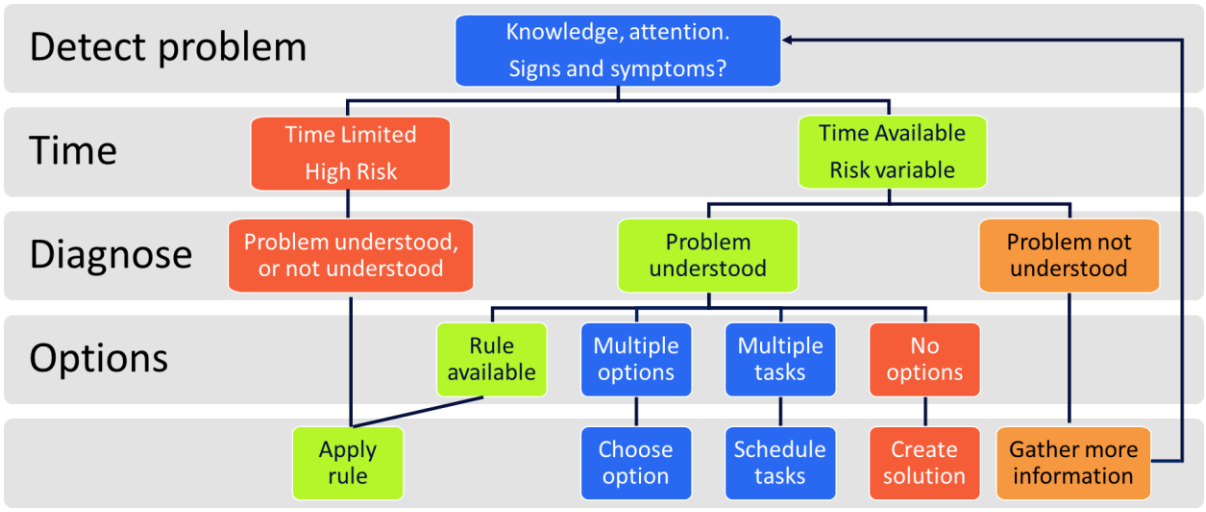
## Step 3: OPTIONS


Defining the options available also includes two steps:

- Identify alternatives
- Analyze risk

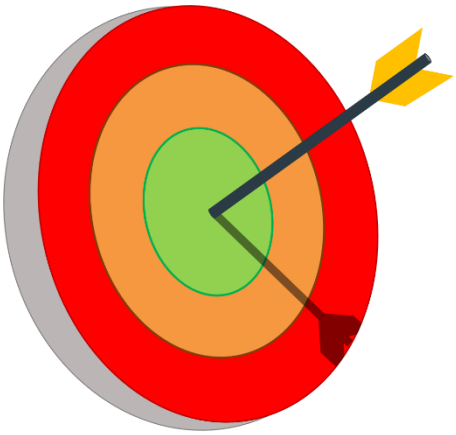
In some cases, you need to collect more information in order to define the options and analyze the risk. For example, to determine the appropriate diversion location, the crew may need to check weather conditions and calculate landing distance to find out which landing runway is feasible. Additional information may be obtained from dispatch, ATC, or even technical support from the maintenance department. Each option must have its risk identified to find the safest practicable option.

In considering the options, this flow chart can map out further actions or identify where more information is needed.




In some situations, the decision-making process is a balancing act, weighing all the different conditions and possible alternatives against each other. The easiest decisions are those you take when still on the ground, but there will be many more complex decisions to make. As discussed in section 1, Threat and Error Management (TEM) is the foundation of all of the CBTA Pilot competencies. The main aim of all the competencies is to be the countermeasures to threats and errors.

A useful way of considering the options available can be via the risk target. The risk target is three rings, with the central green circle being the target for all aeronautical risk-based decisions.



- **Green:** Low risk, where all tasks are properly completed, and all threats and errors are recognized, detected, and corrected.
- **Amber:** Increased risk, where some tasks may not be properly accomplished, or where some threats and/or errors escape detection and start to become reduce safety margins.
- **Red:** High-risk, where many tasks are not properly completed or missed entirely, and where threats and/or errors will escape correction.

Teams must assess the risk of each option, balance the risk with all mitigations available, and then communicate this to ensure a shared mental model and understanding of the options. There may be tactics to mitigate the risk, such as buying time, reducing workload, or changing the mission.

## Step 4: DECIDE

This step should be relatively simple if the prior steps have been carried out correctly. After crew discussions, it is ultimately the captain's responsibility to make the decision, informed by all the previous steps.

They must balance the time available with the resources they can use to accomplish the current and intended operation, and to ensure that they retain a suitable margin that will allow threats and errors to be recognized and corrected or mitigated before they increase the level of risk.

## Step 5: ALLOCATE TASKS

The decision made will likely require tasks to be allocated, including:

- who will be PF and PM?
- who will land?
- who talks to ATC?
- who speaks to passengers?
- what should the cabin crew be doing?

It is very important that each crew member knows the tasks allocated to them. This communication will take many forms, including collective planning and briefings.

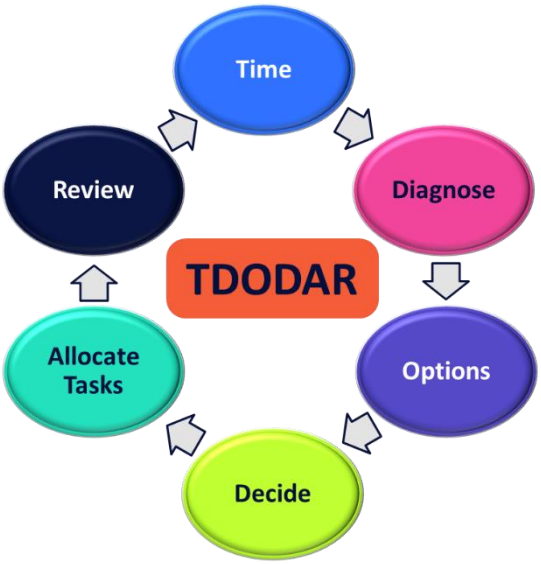
## Step 6: REVIEW

No decision should remain unchallenged or without review, especially when conditions can change very quickly. To confirm the ongoing validity of the decision, each of the decision cycle steps should be reviewed to check for any new, modified, or previously overlooked facts, options, or risks. The crew's actions and the expected results must be monitored and compared with every evolving situation. This review/evaluation can potentially lead to a change of decision. Changes may occur in the weather, aircraft or system status, ground unit capacity, crew and/or passengers. Decisions may need to be changed if these factors deteriorate or improve.

## TDODAR

Note that after detecting the change, the steps 1 to 6 described above spell out TDODAR:

- **T**ime
- **D**iagnose
- **O**ptions/Risks
- **D**ecision
- **A**ssign
- **R**eview




There are many commonly used decision-making mnemonics. Most widely used are TDODAR and FOR-DEC. Both follow the cycle described above but use slightly different terminology. Ultimately, it is recommended that pilots use the process adopted by their operator.

## FOR-DEC

The decision-making process called *"FOR-DEC" (For Decisions)* has a dash in the middle that reminds the user to complete the first three stages before a decision is made and implemented. Like TDODAR, each letter stands for a thought process and actions that need to be taken.

**Facts**: Collect the facts to fully assess and diagnose the situation, including the primary causes and contributing factors. Facts to consider include the time available and status of the aircraft, airfield, environment, and crew.

**Options**: Discuss with the crew - this may include asking for assistance from other resources such as ATC, NOC, cabin crew, MCC, if appropriate.

**Risks & Benefits:** Crewmembers consider and discuss alternative courses of action and balance the risks to find the safest option.

**Decision:** Choose the most appropriate option and consider a back-up option for later if necessary. Communicate the decision by the "5 C's":

Cockpit – Cabin – Controller – Company – Customer

**Execution:** This phase requires effective Workload Management (See WLM chapter). The essential tasks are prioritized and managed by distributing and delegating as needed.

**Check:** Review the previous steps.

## Other PSD processes

There are several other decision-making acronyms that can be seen across aviation documents. Some of them are listed below. Whilst all are different, they match the concepts as discussed in TDODAR and FOR-DEC above.

| | |
|---|---|
| **SPORDEC**<br>▪ Situation catch<br>▪ Preliminary actions<br>▪ Options<br>▪ Rating<br>▪ Decision<br>▪ Execution<br>▪ Controlling | **PIOSEE**<br>▪ Problem<br>▪ Information<br>▪ Options<br>▪ Selection<br>▪ Execution<br>▪ Evaluation |
| **3P**<br>▪ Perceive<br>▪ Process<br>▪ Perform | **DECIDE**<br>▪ Detect<br>▪ Estimate<br>▪ Choose<br>▪ Identify<br>▪ Do<br>▪ Evaluate |

Whichever decision-making process used; it is key to remember to fly the aircraft first!

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*Aviate – Navigate - Communicate*

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The main criticism of any decision-making cycle is that people do not feel like they used the process intuitively. This is, when making day to day decisions, people do not recognise the steps of the cycle as they go through them. One reason for this is lack of training. Now that we've defined the cycle above, it can be easily shown that just in deciding what to have for dinner, this process works:

- Detect change – I'm hungry!
- Time – How much time do I have to prepare a meal?
- Diagnose – What's in the fridge, what dietary requirements do I have to consider?
- Options – What is healthy, what is not, what meets my requirements?
- Decide – Order Pizza! 😊
- Allocate Tasks – Who is ordering, who is paying, who is collecting?
- Review – Did I make the correct choice; can I add salad to make it better?

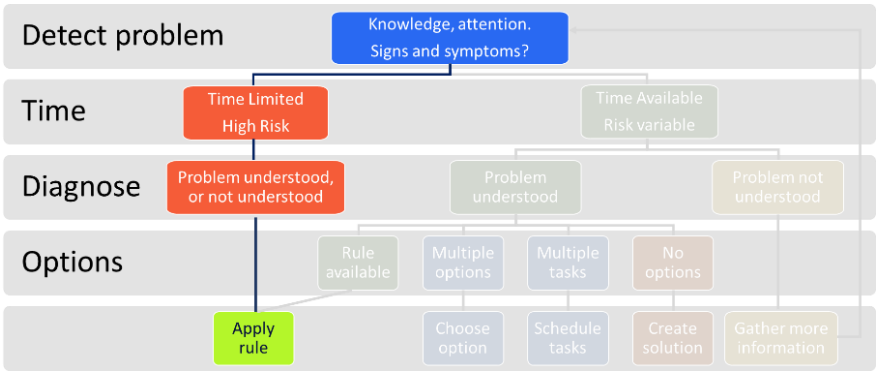
## Naturalistic Decision Making

Even though we know a decision-making cycle works, there are times when humans take mental shortcuts to achieve the decision and action in a faster way. Much research has been carried out into this process called *Naturalistic Decision Making (NDM).*

**Naturalistic Decision Making (NDM)[vi]:** How people make decisions and perform cognitively complex functions in demanding, real-world situations.

Much of the research was initiated by Gary Klein, initially sponsored by the US Army Research Institute[vii], and is equally focused on aviation, emergency services, and other military operations. The team studied real world situations and attempted to compare the experts' problem solving a decision making to a process model, such as TDODAR, but most did not match. Klein and his colleagues found that people who make effective decisions do not necessarily go through a prescriptive process or generate and evaluate multiple options. The process is more intuitive.

The research showed that expert decision-makers recognise situations and patterns of information. In these cases, the flow chart of decision making is simplified to the simple outcome of 'apply rule'.




This is called *Recognition-Primed Decision Making*.

Sometimes though, a situation is novel and cannot be matched to any previous experience. In this case, we collect more information and assess the situation. We use knowledge and experience to generate the first suitable solution and a quick plan. Then, we mentally simulate the plan and identify any risks.

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***"Superior pilots use their superior judgment to avoid situations in which they have to use their superior skills."***
*Astronaut Frank Borman[viii]*

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## Summary

- ICAO sets out Observable Behaviors for the pilot competency, Problem Solving and Decision Making (PSD).
- PSD techniques are applied within the FAA Aeronautical Decision Making (ADM) topic.
- The PSD OBs can be ordered to make a decision-making process/ cycle
- There are many decision-making cycle mnemonics such as TDODAR and FOR-DEC.
- Aviate Navigate Communicate
- A more experienced operator may use the mental shortcuts seen in Naturalistic Decision Making, or Recognition Primed Decision Making (RDM).
- Pilots should use whichever PSD framework is recommended by their operator.

## Further Reading

- Klein, G. A., Sources of Power: How People Make Decisions. United States: MIT Press. 2017.

## References

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i IATA GM: Competency Assessment and Evaluation for Pilots Instructors and Evaluators

ii Flight Safety Foundation. ALAR Tool Kit. Nov 2000.

iii FAA Advisory Circular (AC) 60-22- Aeronautical decision Making

iv IATA GM: Competency Assessment and Evaluation for Pilots Instructors and Evaluators

v Eastern Airlines, Inc. L-1011, N310EA, Miami, Florida, December 29, 1972. Aircraft Accident Report. National Transportation Safety Board. June 14, 1973. NTSB/AAR-73/14. Retrieved February 8, 2016.

vi https://en.wikipedia.org/wiki/Naturalistic_decision-making

vii Klein, G. A., Orasanu, Judith M.; Calderwood, Roberta; Zsambok, Caroline. Decision Making in Action: Models and Methods. Ablex. 1993.

viii Khoy Hing, L. Life in the Skies: Everything You Want to Know about Flying. Singapore: Marshall Cavendish International (Asia) Private Limited. 2013