

Human Performance & Limitations - Module H — The Mind Aloft

Judgment, Automation & the Cockpit

Chapter 22 — The pilot, the crew and the machine: judgment and decision-making, personality, attitude and situational awareness, communication and crew resource management, automation, and the human-centred design of the cockpit and its displays.

BOOK

Human Performance & Limitations

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EXAM

DGCA CPL / ATPL — HPL

CHAPTER

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Plate 22.0 — Good decisions and good design share one goal: to fit the machine to the human, not the human to the machine.

15. Judgment & Decision Making

WHAT THIS SECTION COVERS

Why decisions matter, how to seek advice, risk assessment fundamentals, and the dynamic nature of "good" decisions.

Making good decisions is one of the important aspects of piloting an aircraft. **Good decisions** can help lead to safe, successful flights, whereas **bad decisions and even indecision** have led to many aircraft accidents. Talk to your instructor and other pilots about different flying situations to obtain advice about what a good decision would be in a given circumstance.

When flying with another pilot, it is possible to increase the chance of a good decision being made by **discussing the potential problems beforehand**. If as an inexperienced pilot you are flying with someone of more experience and you see him doing something you consider to be dangerous, you should **immediately question their course of action**.

Join live classes for guided practice and doubt clearing.

BEST PRACTICE — ALWAYS MORE TO LEARN

A good pilot is one who always realizes there is more to learn. When making a decision a pilot will be influenced by his **previous experience**, the **probability of an occurrence**, and whether the information he is receiving **matches that expected**.

15.1 Risk Assessment

Risk assessment is based on:

- The **probability of the risk occurring**.
- The **impact of that risk** if it did occur.

You will have to weigh up the risk and the possible consequences of the risk in order to determine your course of action.



Figure 22.1 — Risk assessment: weigh the probability of an event against its impact to decide how to manage it.

REMEMBER

Making good decisions is one of the most important aspects of piloting an aircraft. Good decisions can help lead to safe, successful flights, whereas bad decisions and even indecision have led to many aircraft accidents. **Always strive to make good decisions.**

16. Personality, Attitude & Situational Awareness

WHAT THIS SECTION COVERS

Desirable pilot traits, the meaning of being Pilot-in-Command, factors that destroy situational awareness, and how to maintain it.

16.1 Personality, Attitude and Behaviour

Someone who is **too introverted or anxious may not make a good pilot**. Examples of desirable characteristics in a pilot are:

- The ability to cope with stress and adventure.
- The ability to assess and control risks.

As captain of an aircraft, you will need to show **good leadership skills**.

SOP — BEING PILOT-IN-COMMAND

While acting as pilot-in-command you should ensure that you **stay in command** — you should be **properly organized and prepared**.

16.2 Situational Awareness

A good leader displays good situational awareness and accurately assesses his own performance. The following factors can interfere with accurate situational awareness:

1. Stress
2. Boredom
3. Fatigue
4. Emotional disturbance
5. Poor communication
6. Interruptions

MAINTAINING GOOD SA — SOP

In order to maintain good situational awareness, **gather as much information as possible**. Do not rush into making a decision. Make sure you consider all the options. **Do not make the mistake of seeing something that is not really there just because you want it to be there.**

EXAM TIP — SA INTERFERENCE MNEMONIC

"SBF-EPI" → *Stress, Boredom, Fatigue, Emotional disturbance, Poor communication, Interruptions.*

17. Mechanics of Decision Making

WHAT THIS SECTION COVERS

The seven-step decision cycle and the dynamic nature of decisions in flight.

Pilots operate in a **dynamic and constantly changing environment**. A good decision reached a minute ago will *not necessarily* be the same good decision in two minutes' time.

17.1 The Seven Steps

1. **Recognize and identify the problem** — have a clear definition of what needs addressing.
2. **Consider the nature of the problem** — type of issue, why it needs a decision, hoped-for results.
3. **Analyze or research the problem** — gather all information so informed choices can be made.
4. **Develop a list of possible solutions** — list decisions and their consequences.
5. **Select the best alternative** — choose the best solution for the situation.
6. **Execute the best choice** — taking action is often the hardest part.
7. **Follow up and communication** — keep the process going with constant communication; **Feedback** determines the overall success of and reaction to the decision.

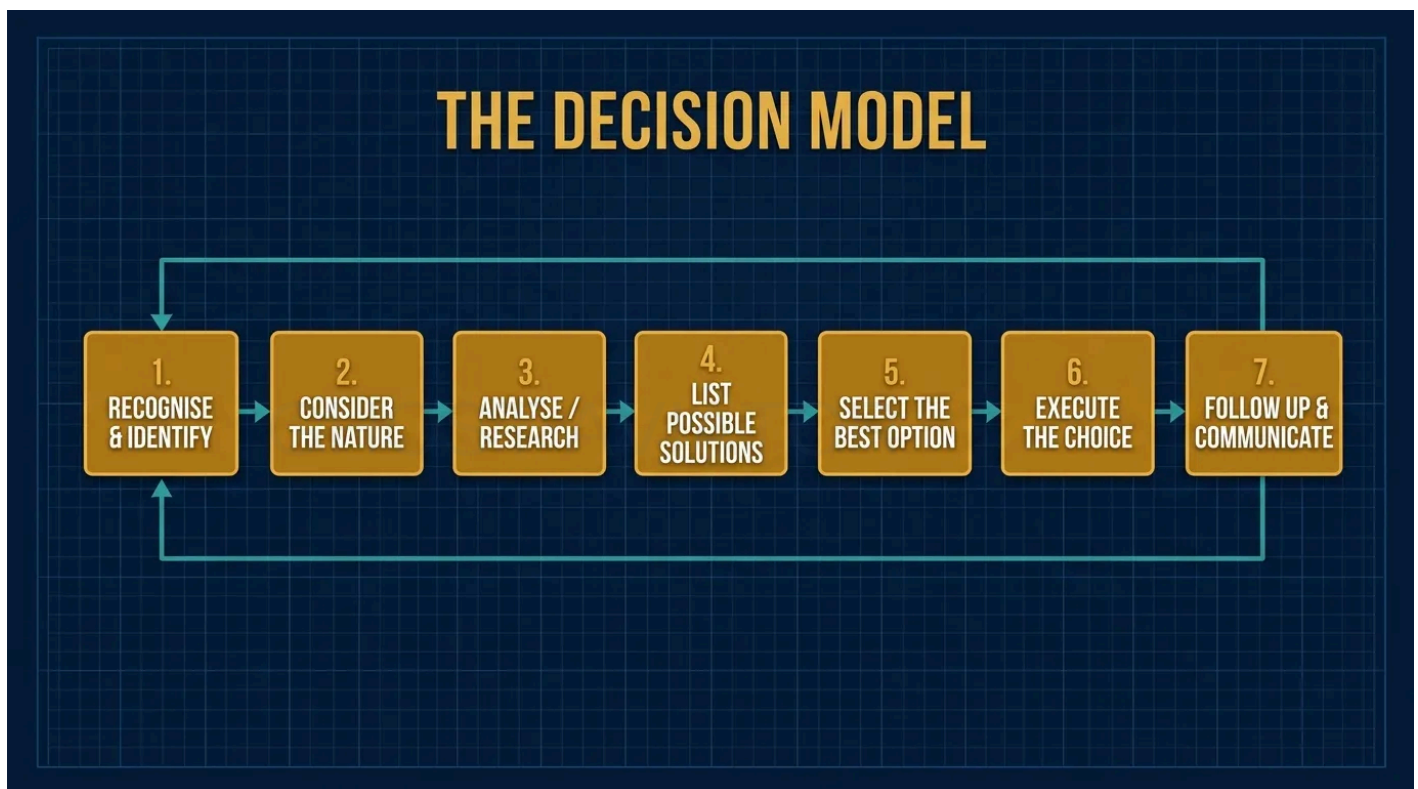


Figure 22.2 — A structured decision model: recognise, consider, analyse the options, decide, act, and review.

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EXAM TIP — DYNAMIC DECISIONS

A good decision a minute ago may not be a good decision two minutes from now. **Re-evaluate continuously.**

18. Communication & Team Work

WHAT THIS SECTION COVERS

Why communication matters, attitudes that destroy teamwork, and the danger of "expectation".

When piloting an aircraft — whether with a passenger, another pilot or an instructor — **good verbal communication** will help the flight go more smoothly and contribute to flight safety.

Concise and unambiguous communication is essential to the safe conduct of air traffic.

18.1 Barriers to Communication & Team Work

Several things can be done by team leaders to facilitate good teamwork. *In the end, it is the team leader who takes the decisions on behalf of the team.*

HAZARDOUS ATTITUDES — BARRIERS

Some of the barriers to communication and teamwork are:

- Aggressiveness
- Arrogance
- Anti-authoritarian behaviour
- Impulsiveness
- Feelings of invulnerability
- Resignation

18.2 Expectation

HAZARD — EXPECTATION BIAS

Do **not assume** you have heard what you are expecting to hear. **Actively listen.** Clear, concise and unambiguous communication is essential to the safe conduct of aviation.

19. Automation

WHAT THIS SECTION COVERS

Definition and evolution of automation, the mismatch between automation and the human element, and qualities of human-centred automation.

Automation refers to a system or method in which many of the processes of production are automatically performed or controlled by self-operating machines, electronic devices, etc.

Through microprocessor technology, navigational tasks and aircraft system management have been automated, making the flight crew more *peripheral* to the actual operation of the aircraft. Pilots who at one time had direct authority over all aspects of aircraft control and management have now become responsible for the **management of complex hardware and software interfaces**.

These technological advances have given rise to **new forms of error**. Automation is almost always introduced with the expectation of reducing human error and workload, but what frequently happens is that **the potential for error is simply relocated**. More often than not, automation does not replace people in systems; rather, it places the person in a different, and in many cases, *more demanding* role.

19.1 Definition of Automation

"The technique of controlling an apparatus, a process or a system by means of electronic and/or mechanical devices that replaces the human organism in the sensing, decision-making and deliberate output."

19.2 Evolution of Transport Aircraft Automation

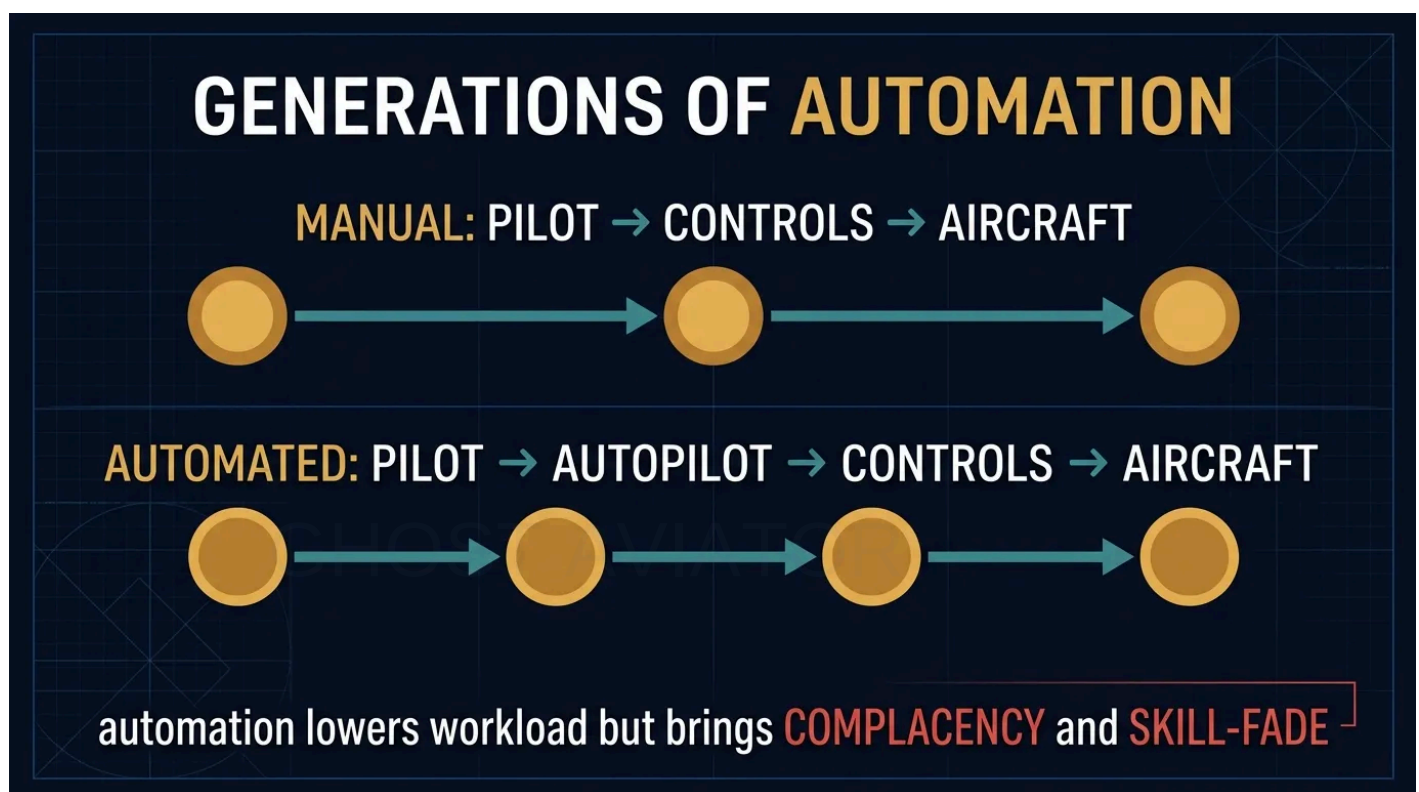


Figure 22.3 — Automation moves the pilot from direct control toward supervising the automatics — improving workload but bringing complacency and skill-fade.

19.3 Mismatch Between Automation and the Human Element

Nevertheless, a few accidents point to a mismatch between automation and the human element. Studies identified **nine categories** to focus on:

1. Situational awareness
2. Automation complacency
3. Automation intimidation
4. Captain's command authority
5. Crew interface design
6. Pilot selection
7. Training and procedures
8. The role of pilots in automated aircraft
9. (Studies concluded scope for improvement in fields like: human capabilities and limitations, ergonomics, cognitive suitability and instrument standardization.)

HAZARD — AUTOMATION SIDE-EFFECTS

Although cockpit automation may provide pilots with more time to think, it may encourage pilots to reinvest only some of this mental free time in flight-related thoughts. While manual workload has reduced, **mental workload has not been reduced by the same amount — in fact it may have been increased**. Automation may not always reduce workload in phases of flight in which it is usually high (e.g. arrivals/landings at busy terminals). High cockpit automation may reduce pilot attention with the consequence of **'being out of the loop'**.

HAZARD — RELIABILITY ≠ SAFETY

All forms of automated assistance for the human operator must be highly reliable, but this may also induce **complacency**. Human expertise may gradually be lost and if the machine fails, the human operator may accept an inappropriate solution or become unable to formulate a satisfactory alternative.

19.4 Qualities of Human-Centred Automation

Human-centred automation should possess these qualities in proper measure:

- Accountable
- Subordinate
- Predictable
- Adaptable
- Comprehensible
- Flexible
- Dependable
- Informative
- Error-resistant
- Error-tolerant

BEST PRACTICE — COMPLEMENTARY, NOT ALTERNATIVE

Pilots, computers and machines are **not alternatives, but complementary factors** in ensuring flight safety. Achieving the correct balance benefits safety. Automation has undeniably led to an improvement in flight safety.

20. Human Characteristics & Cockpit Design

WHAT THIS SECTION COVERS

Personality types, cultural differences, anthropometry, eye datum, cockpit seats and the design considerations driving them.

20.1 Personality

Personality involves two major factors:

- **Neuroticism – Stable** continuum
- **Introversion – Extroversion** continuum

Extroverts are said to be impulsive and sociable; **introverts** are more withdrawn and cautious.

A low-neuroticism personality is one of an emotionally stable person, whereas a high-neuroticism person will worry and get upset easily.

TRAIT VS STATE ANXIETY

High neuroticism = high trait anxiety (a personal trait of that person). As opposed to **state anxiety**, which is a *transient state of anxiety present in anyone at any time*.

20.2 Cultural Differences

The way people behave, think and interact with each other generally — as well as what motivates them — will be partly a factor of their national and cultural background. One culture may value subordinates speaking up, whereas another culture may value subordinates who obey their superiors unquestioningly. The latter might perceive a subordinate who points out a concern as being impolite, aggressive or disruptive.

20.3 Competencies

The main area where personality and background culture are important is **interpersonal interaction**. In terms of competencies, this means **communication, leadership and teamwork** — crew interactions or interactions with outside agencies such as air traffic control.

20.4 Design Considerations

The following human characteristics must be taken into account in the design of aviation systems:

- Physical dimensions
- Capability for data sensing
- Capability for data processing
- Capability for motor activity
- Capability for learning
- Physical and psychological needs
- Sensitivities to physical environment
- Sensitivities to social environment
- Coordinated action
- Differences among individuals

20.5 Hardware, Design of Flight Decks, Size & Anthropometry

MURPHY'S LAW

"If equipment is designed in such a way that it can be operated wrongly, then sooner or later, it will be."

Therefore a great deal of attention is required to design the equipment. **The most important requirement in the design of both displays and controls is STANDARDIZATION.**

20.6 Anthropometry

This is the study of **human measurement**. The information is grouped into:

- Static measurements
- Dynamic measurements
- Contour surface measurements

It is not practical to design a cockpit for both the very short and the very tall individual. Those in the **central 90 % of size distribution** will be catered for. Normally the design of aircraft uses measurements taken from the entire population **disregarding both the 5 % lowest and the 5 % highest.**

20.7 Eye Datum

Cockpit space must be designed around a defined position of the pilot's eye. This may be called the **Eye Datum**, the **Design Eye Position** or the **Reference Eye Point**.

Position	Effect
Too high	Poor view of instruments, obstructed high view, good downward view
Just right	Optimum view of outside and instruments
Too low	Good view of instruments but poor forward and downward view

Once the design eye position has been set, the size of the cockpit can be established.

20.8 Design of Cockpit Seats

It is of the utmost importance that the seating is comfortable and adjustable to the individual pilot's size and shape. Pilots should adjust their seats to establish a comfortable position giving full control movement, with **optimum instrument scan and outside visibility**. This position should be used for **all phases of the flight**.

SOP — RESTRAINT

Restraint should be provided by a **5-point harness with a negative 'G' strap**.

21. Hardware — Displays & Controls

WHAT THIS SECTION COVERS

Digital vs analogue display selection, the standard "T" layout, three-pointer altimeter pitfalls, and the eight basic considerations for control design.

21.1 Presentation Requirements

Information Type	Best Display
Purely quantitative information	Digital
Qualitative information	Analogue (more easily assessed)

21.2 Conventional Analogue Standard 'T' Display

A standard 'T' layout has the **artificial horizon / attitude indicator** at the centre with the **altimeter, airspeed indicator and direction indicator** grouped around it. **Digital Display** and the **Compass**. The conventional analogue type of compass card gives a better picture of the aircraft orientation than would a digital readout.

21.3 Combination or Analogue and Digital Displays

In some instances, both digital information and analogue information can be combined in a single instrument.

HAZARD — THREE POINTER ALTIMETER

The three-pointer altimeter can easily be **misread** and produces significantly **more reading errors** than the single-pointer altimeter.

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21.4 Hardware, Controls — Basic Considerations

Principle	Description
Standardization	Control of location and sense of use from one aircraft to another should be standardized.
Frequency of Use	Controls used frequently or for protracted periods should be located so that they do not require the pilot to adopt an awkward or fatiguing position.
Sequence of Use	Controls that should normally be used in a given order should be laid out so that the sequence of use is represented in that layout.
Importance	Important controls must be located in easily reached and unobstructed positions.
Visual/Tactile Dissimilarity	Switches and knobs that control different systems or functions should look and feel different from each other.
Symbolism	Controls, if possible, should be designed to contain some reference to their function.
Simultaneous Use	Controls which may require simultaneous use should be located to enable this to take place.
Warnings	All warnings should be 'attention getting' without being startling. The most conspicuous visual warnings rely on head and gaze orientation .

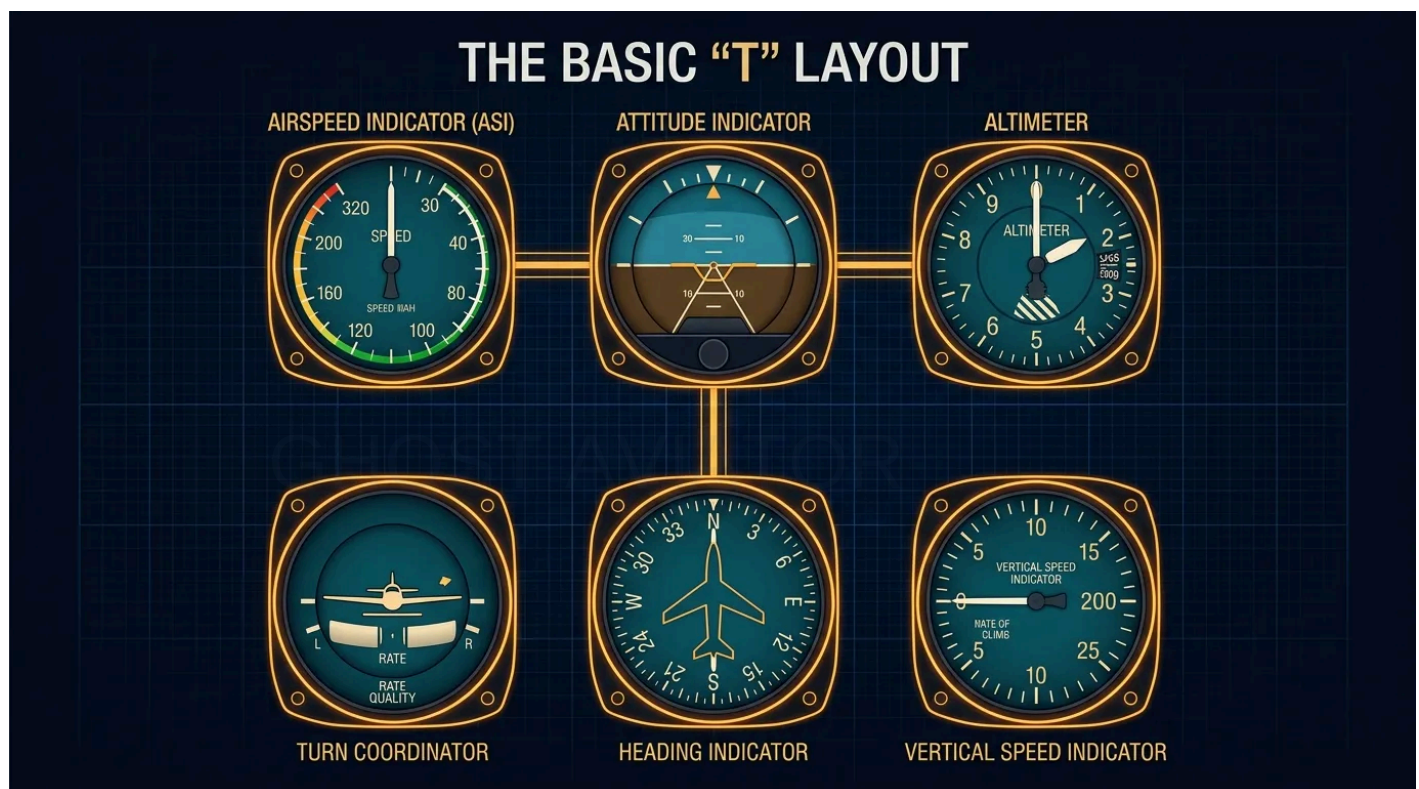


Figure 22.4 — The basic 'T' layout: attitude indicator on top, with airspeed, altimeter and heading arranged around it for a fast, standard scan.

✦ END OF CHAPTER 22 ✦

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