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1. Introduction to Aviation Psychology

What this section covers

Definition of aviation psychology, its aims, and how its tools support flight safety and efficiency.

Aviation Psychology is a specialty in applied psychology that focuses on understanding human behaviour, emotions and mental states as they relate to the operation and control of aviation systems and their influence on the safety and efficiency of flight.

The *aim* of aviation psychology is to understand and to predict the behaviour of individuals in an aviation environment. Its study is aimed at improving **safety, efficiency and comfort**.

Practitioners of aviation psychology bring the tools and techniques of psychology to bear in order to **describe, predict, understand and influence** the aviation community to achieve those aims.

Exam Tip — The Four Action Verbs

Remember the four practitioner verbs: **D – P – U – I** → *Describe, Predict, Understand, Influence*.

2. Human Error & Human Reliability

What this section covers

The inevitability of human error and the four areas where pilot errors usually originate.

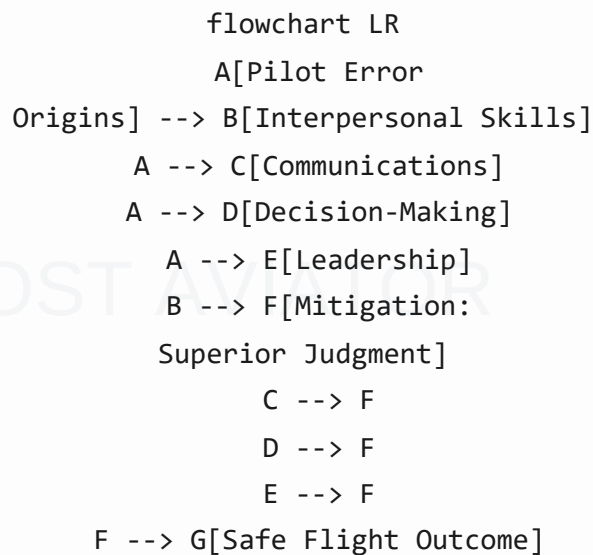
It has long been accepted that **human errors are inevitable**. The majority of pilot-related errors are considered to be failures of:

- Interpersonal skills
- Communications
- Decision-making
- Leadership

This does **not** mean that the frequency of error cannot be reduced, or that the effects cannot be avoided or mitigated.

Golden Maxim — "Superior Pilot"

"A superior pilot uses his superior judgment to avoid situations that would require his superior skills."



3. Workload

What this section covers

Cognitive (mental) workload definition, the four task factors that drive it, indirect factors and observable symptoms.

Workload = the amount of mental effort needed (and expended) to process information. Here we discuss **cognitive (mental)** workload, as opposed to physical workload. Workload is linked to almost all other areas within cognition and performance, particularly *attention, vigilance, fatigue, decision-making and multi-tasking*.

Effects of High Workload

High workload is associated with **increased errors, fatigue, task degradation and poor performance.**

3.1 Four General Task Factors Affecting Workload

1. 'Difficulty' of the task
2. Number of tasks running in parallel (concurrently)
3. Number of tasks in series (switching from task to task)
4. The time available for the task (speed of task)

Indirect factors also play a role: *duration of task, fatigue and level of arousal.*

3.2 Symptoms of Increasing Workload

- Attention and task focusing
- Task shedding and re-prioritization
- Implications for Situation Awareness
- Increased use of decision short-cuts and less scrutiny or review
- Increased fatigue and chance of error

The area that deals with all such activity is called the **working memory** ('Information Processing').

Exam Tip — Workload Drivers

Mnemonic "**DPST**" — *Difficulty, Parallel tasks, Series switching, Time available.*

4. Information Processing — A Functional Model

What this section covers

How sensory inputs are converted into reasoned actions through five mental stages, and the central role of working memory.

We receive information from the world around us through our senses: **sight, hearing, touch, smell and taste**. The "Gestalt laws" formulate basic principles governing how objects are mentally organised and perceived.

4.1 The Five Stages of Reasoning

1. **Detection**
2. **Perception**
3. **Decision Making**
4. **Action** (responses are selected and executed)
5. **Feedback**

flowchart LR
S[Sensory Input
Sight / Hearing / Touch /
Smell / Taste] --> D[1. Detection]
D --> P[2. Perception]
P --> DM[3. Decision Making
Working Memory]
DM --> A[4. Action
Response Executed]
A --> F[5. Feedback]
F -.alters action.-> DM
LTM[(Long-Term Memory)] <--> DM
STM[(Short-Term Memory)] <--> DM

4.2 The Brain — Central Decision Maker & Response Selection

Once information has been perceived a decision must be made as to the response. Information is continuously entered into and withdrawn from both long-term and short-term memories to assist the decision process. The decision involves **input, processing, actions and feedback**. The information comes from many sources and requires *conscious processing* in working memory. A problem at any stage of information processing could affect the outcome.

To carry out multi-tasks we must learn skills through **Motor Programmes**.

4.3 Stimuli

The senses provide stimuli to our brain which has the ability to retain them for a short time, from the time they arrive. We may not have the processing capacity to deal with them all.

Exam Tip — First Stage

First stage in the information process = **Sensory stimulation** (not "Attention", not "Perception").
Detection is what follows.

5. Types of Memory & Sensory Memories

What this section covers

Three memory types, key features of sensory memory, iconic memory for sight, and sensory adaptation.

5.1 The Three Types of Memory

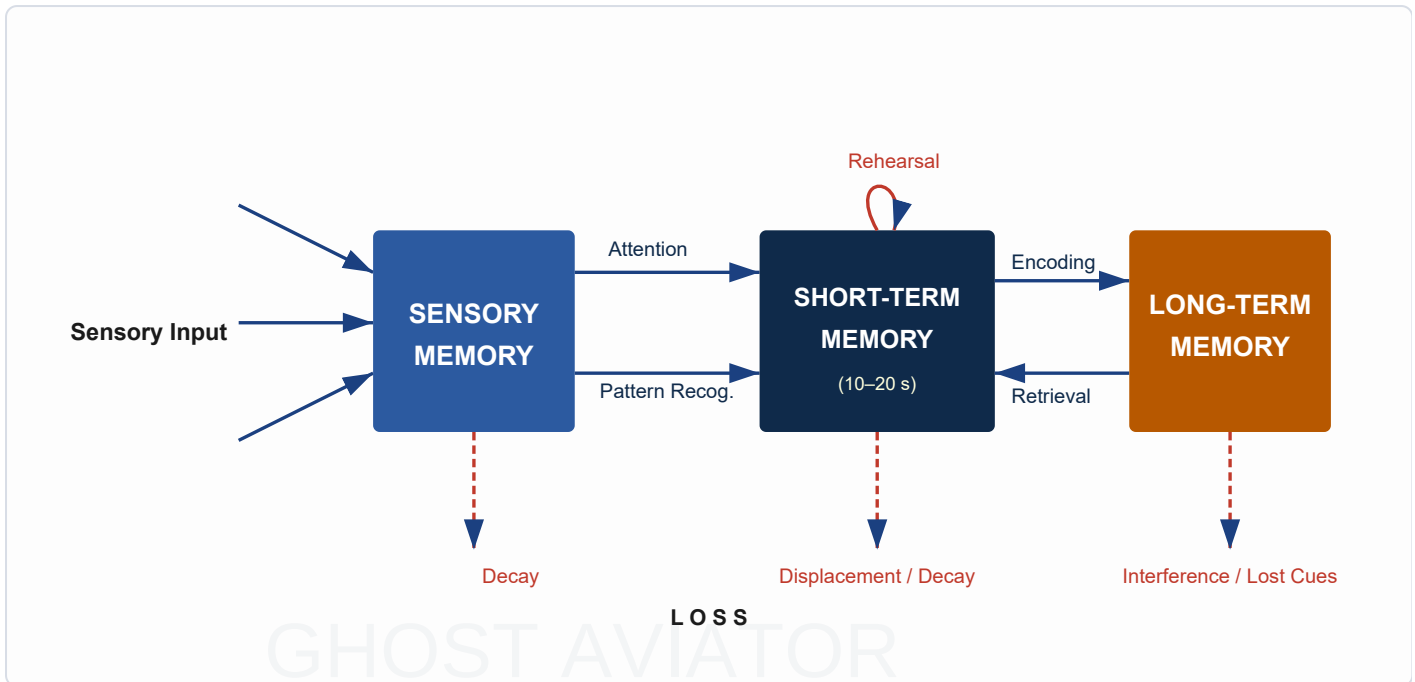
- **Sensory memory**
- **Short-term (or working) memory**
- **Long-term memory**

5.2 Receptors & Sensory Memories — Key Features

- There is a **separate memory store for each sensory system**.
- The input **decays rapidly**.

The sensory stores for **sight and sound** are the most important, and knowledge of these is necessary.

5.3 Information Processing Model — Diagrammatic View



5.4 Sensory Memory for Sight — Iconic Memory

The **Iconic Memory** is the visual sensory store. It only lasts for between **0.5 and 1 second**.

70–80 % of the information processed by humans is received through the **visual channel**.

5.5 Sensory Adaptation (Habituation)

All senses adapt, either partially or completely, to their stimuli after a period of time.

Exam Tip — Sensory Memory Values

Iconic memory = 0.5–1 second. Visual channel carries **70–80 %** of all received information.

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6. Anticipation & Perception

What this section covers

How sensory input becomes meaning, the role of expectation, mental models and the concept of funneled perception.

6.1 Perception

Perception involves the **conversion of the sensory information received into a meaningful structure**.

Sensory information that we *expect* to receive is more easily perceived and integrated when it actually occurs, compared with totally unexpected information.

"We can 'perceive' only that which we can 'conceive', but we perceive only a fraction of the information reaching our senses at any moment."

The process of perception is greatly assisted by our ability to form **mental and three-dimensional visual models**.

6.2 Funneled Perception

Perception of a situation can differ depending upon the starting point of an observer.

Hazard — Confirmation Bias / Funneling

In an abnormal situation, if a pilot has an apparently correct explanation for the problem, the chance that he/she now **ignores or devalues other relevant information** not fitting into the mental picture is *increasing*. Stay open-minded; verify, don't rationalize.

7. Attention

What this section covers

Definition, the two types of attention, why an attention mechanism is required, the cocktail party effect and the dangers of attention mismanagement.

Attention is the process of directing and focusing psychological resources to enhance perception, performance and mental experience. To pay attention to something is to concentrate on it — a stimulus, threat, decision or calculation. Critically, **attention is limited**; if some attention is being used for one thing, it cannot be used for something else.

7.1 Types of Attention

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1. **Selective Attention** — inputs are sampled continually to decide their relevance to the present task at hand.
2. **Divided Attention** — when our central decision-making channel can *time-share* between a number of tasks, executing several mental activities at almost the same time (e.g. switching attention from outside the aircraft to the airspeed indicator and monitoring the progress of a motor programme such as flying or taxiing on a relatively subconscious level, while making a radio call at the same time).

The human brain has **different reservoirs of resources** for information-gathering, information-processing, or the action phase.

7.2 Lack of Attention

The major danger for pilots is the **poor management of attention**.

7.3 Attention Mechanism — Why It Is Required

Because of two potentially limiting stages in processing information:

- a. There is a limit to the number of items held or maintained in short-term memory (working memory).
- b. Our channel capacity is limited.

7.4 Choice of Item

Attention is the deliberate devotion of cognitive resources to a specific item. Although attention can move very quickly from item to item, it can only deal with **one at a time** — so the pilot must consciously prioritize.

7.5 The Cocktail Party Effect

With many conversations occurring all around, one conversation can suddenly break through to attention because a word or phrase was particularly meaningful — the classic example is a person hearing their **own name** mentioned in another conversation that they were not paying attention to.

Exam Tip — Cocktail Party Effect

Defined as the ability to *pick up relevant information unintentionally*. It demonstrates that the brain monitors even unattended channels for personally significant cues.

8. Vigilance & Complacency

What this section covers

Definition of vigilance, the three states (hypo, optimum, hyper), causes and signs, plus the trap of complacency in automated cockpits.

Vigilance = the capability to be sensitive to potential changes in one's environment, i.e. the capability to reach a level of alertness above a threshold for a certain period of time — rather than the state of alertness itself.

8.1 Hypo (Low) Vigilance

Mainly due to the **monotony of the task, tiredness, the need for sleep and a lack of stimulation**. It may occur at any moment of the flight. Decrease in sensory perception and sensation of muscular heaviness are indications of low vigilance.

A state of *high fatigue* is liable to cause phases of drowsiness and hypo-vigilance, which result in a reduction of performance and unconscious phases of **micro-sleep**.

SOP — Managing Hypo-Vigilance

Healthy food and organising periods of rest during the flight can mitigate the effects of low vigilance.

8.2 Hyper Vigilance

In its most acute forms, an extremely **agitated state of panic or near panic**. Characterised by indiscriminate attention to all sorts of minor and major threat cues, as the person frantically searches for means of escaping the anticipated danger.

Hazard — Hyper Vigilance

Hyper vigilance is a state of **panic** that often results in *regrettable decision-making*.

8.3 Optimum Vigilance

Lies somewhere between hypo and hyper vigilance.

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8.4 Complacency

A state of **self-satisfaction** with one's own performance coupled with an **unawareness of danger, trouble or controversy**.

Hazard — Complacency

Complacency is **extremely dangerous in aviation**. You get so used to things being done the same way that you become less vigilant to hazards in your surroundings. **Automation may make pilots complacent due to low workload**.

flowchart LR
A[Vigilance Spectrum]
A --> H[HYP0
Drowsiness, Micro-sleep
Cause: Monotony, Fatigue]
A --> O[OPTIMUM
Best Performance]
A --> Y[HYPER
Panic, Indiscriminate Attention]
H -.->|risk| C[Complacency
Low workload, Automation]
Y -.->|risk| R[Regrettable Decisions]

9. Motor Programmes (Skills) — Anderson Model

What this section covers

What motor programmes are, the three phases of skill development per the Anderson model, and how skill enables resource management.

Motor Programmes, or "Skills", are behavioural sub-routines which are **learnt by practice and/or repetition** and are **held within the Long-Term Memory**. They can be carried out without conscious thought.

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In the *initial phase* of flight training the pilot is competent enough to fly the aircraft at this stage but does *neither* have a great deal of confidence in his/her abilities *nor* in the whole system.

What Makes a Pilot "Skilled"

A pilot is skilled when he trains or practices regularly, knows how to manage himself/herself and knows how to **keep resources in reserve for coping with the unexpected**.

9.1 Anderson Model — Three Phases

- a. The Cognitive Phase
- b. The Associative Phase
- c. The Automatic (Autonomous) Phase

flowchart LR
C[a) Cognitive Phase
Conscious effort,
understanding rules] --> AS[b) Associative Phase
Refinement,
fewer errors]
AS --> AU[c) Automatic Phase
Subconscious execution,
resources freed for new tasks]
AU --> SKILL[Stored as Motor Programme
in Long-Term Memory]

Exam Tip — "Flying a coordinated turn is ..."

Skill-based behaviour — not attention-based, not experience-based. It draws from procedural memory in the LTM.

10. Reflexes, Reaction Time, Surprise & Startle

What this section covers

Reflex types, what reaction time depends on, and the operational impact of the startle reflex on pilots.

Reflexes occur with little or no involvement of the central nervous system.

10.1 Reaction Time

There is a delay between detection, stimulus and muscle contraction called **reaction time**. Reaction time depends on the type of reflex action being used.

10.2 Three Types of Reflex Actions

Type	Description	Example
Unconditioned	Instinctive natural reflexes	Blinking
Conditioned	Reflexes that may be <i>learned</i>	Foot-on-rudder on swing
Trained	Reflexes that may be <i>increased by repeated practice</i>	Stall recovery inputs

10.3 Surprise and Startle

The **startle reflex** is a reflex-like event that blinks the eyes and causes a whole-body 'jerk' to occur (similar to that sometimes caused in sleep). The reflex has a relatively basic neural pathway from the sense organ. Many things can cause (or contribute to) a startle reflex:

- Sudden noises
- Unexpected tactile sensations
- Abrupt shocking perceptions
- The sensation of falling
- An abrupt visual stimulus

There is little evidence that a startle reflex alone creates much of a sustained or lasting impact on cognitive functions, although there are some minor and short-lived physiological changes such as *raised heart rate*.

Key Value — Startle Recovery

A skilled motor task will be momentarily disrupted by a startle reflex but return to normal within **5 to 10 seconds**.

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10.4 Effects on Pilots

The main effects of the pure startle reflex on pilots are:

- **Interruption** of the on-going process.
- **Distraction of attention** toward the stimulus.

These happen almost immediately and can be quickly dealt with if the cause is found to be *non-threatening*.

Hazard — Fear Potentiates Startle

A perception of fear can cause a startle reflex to be **potentiated** (more pronounced) should it occur, and attention to become more focused. In a state of fear, very little is required to trigger a full '**fight or flight**' response.

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11. Quantitative Overload & Human Reliability

What this section covers

When workload is acceptable, what overload looks like, error rates with practice, and the cumulative nature of errors.

Quantitative Overload — a very high workload can be interpreted as '**Stress**'.

SOP — Acceptable Workload

Workload may be said to be acceptable if it requires about **60 %** of the crew resources, depends on the pilot's expertise and corresponds to the amount of resources available.

11.1 Most Common Symptoms of Overload

- A sharp degradation of performance
- Funneling of attention or focus
- Regression
- Mental "blocking"
- Mood swings

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- Restlessness and trembling
- Panic

11.2 Human Reliability

The rate of human error during simple and repetitive tasks might be expected to be **1 in 100**, but after practice, a rate of **1 in 1,000** could be achieved.

Definition — Human Reliability

The individual functioning in the manner in which he or she is supposed to function.

11.3 Error Generation

Errors tend to be cumulative. One slip rarely stays isolated — it sets up the next.

Worked Example — Human Error Rate

A pilot performs 200 routine pre-flight checks per week.

- Before practice (1 in 100): expected errors $\approx 200 \div 100 = \mathbf{2 \text{ errors / week}}$.
- After practice (1 in 1,000): expected errors $\approx 200 \div 1,000 = \mathbf{0.2 \text{ errors / week}}$ (i.e., about 1 every 5 weeks).

Practice yields a 10-fold reduction in error rate, but never reaches zero — hence the value of cross-checking and SOPs.

12. Short-Term & Long-Term Memory

What this section covers

Duration and capacity of short-term memory, methods to expand it, the three subtypes of long-term memory and its capacity characteristics.

12.1 Short-Term Memory (Working Memory) — 10 to 20 Seconds

Short-term memory enables information to be retained for a short period of time. That information will be lost in **10 to 20 seconds** unless it is actively rehearsed and deliberately placed in our long-term memory.

Auditory information is considered easier to retain than visual information as it is easier to rehearse sounds than data in a visual form.

12.2 Limitations of Short-Term Memory

The capacity of our short-term memory is limited. The maximum number of unrelated items which can be maintained in the short-term memory is about **7 ± 2** . Once this limit is exceeded one or more of the items are likely to be lost or transposed.

12.3 Methods of Increasing Short-Term Memory

Method	Description
Chunking	Breaking items to be remembered into small pieces and remembering them one at a time.
Association	Used to remember spoken lists of items. A wild and bizarre association is imagined and attached to each item on the list.

Worked Example — Chunking an ATC Clearance

Raw clearance string: "VTBL VTBS RWY01L SQK4732 ALT FL310 HDG270" — 7+ unrelated tokens, near STM limit.

Chunked: "VT-BL → VT-BS" (route), "RWY 01L" (departure), "4732" (squawk), "FL310" (level), "HDG 270" (heading) = **5 chunks** — comfortably within 7 ± 2 .

12.4 Long-Term Memory — Unlimited Time Period

It is believed that information is stored in the Long-Term Memory for an **unlimited time period**, although frequently there may be *retrieval problems*.

12.5 Three Subtypes of Long-Term Memory

Type	Definition	Example
Semantic Memory	Stores general knowledge of the world	Knowing that "QNH is altimeter setting"
Episodic Memory	Memory of events or 'episodes' in our life	Recalling your first solo flight
Procedural Memory	Skills are included within the make-up of the LTM	Executing a coordinated turn

Exam Tip — Memory Quick Facts

- STM duration = **10–20 seconds**, capacity = **7 ± 2** items.
- LTM capacity = **unlimited**, but retrieval problems may exist.
- Motor programmes live in **LTM (Procedural)**, not STM.

13. Learning, Retention & Motivation

What this section covers

Types of learning, methods to retain information, and the role and sources of motivation.

13.1 The Learning Process

Learning is an **internal process** which allows the mental acquisition and retention of data. Types include:

Insight

The data is intellectually and cognitively understood and is retained. *Observational Learning / Imitation* — data from an outside source is replicated. *Experience* — learning from our mistakes.

Skill Learning

Involves **motivation, attention, observation, much practice and corrective feedback**.

13.2 Retention of Information

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Retention can be increased by:

- a. **Mnemonics** — the practice of improving or helping the memory, or the systems used to achieve this.
- b. **Memory Training**

13.3 Motivation

Motivation is the combination of a person's desire and energy directed at achieving a goal. It is the **cause of action**.

Type	Examples
Intrinsic	Satisfaction and feelings of achievement
Extrinsic	Rewards, punishment, and goal obtainment

Not all people are motivated by the same thing and over time their motivations might change.

SOP — Motivation and Performance

The learning process is vastly improved with motivation, and **high performance is rarely achieved without it**.

14. Experience, Response, Cognition & Hallucination

What this section covers

How experience shapes us, response characteristics with age, error of commission, response times, cognition in flight, and hallucinations.

14.1 Experience

We all have the ability to learn from our experiences and mistakes, and from those of others.

14.2 Response

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Any response will cause a detectable change which, in turn, will be noted by the senses. The feedback may alter the action being taken.

- **Auditory stimuli (noises)** are more likely to attract attention than visual stimuli, but they are also more likely to be responded to in error.
- An increase in age between **20 and 60 years** tends to lead to *slower but more accurate* responses.

14.3 Response Error (Error of Commission)

If an unexpected stimulus occurs, we will be more likely, under pressure, to make an error of commission.

14.4 Response Times

Response to reaction time is the interval between the onset of a given signal and the production of a response to that signal.

14.5 Cognition in Aviation

Cognition = the mental faculty or process of **acquiring knowledge by the use of reasoning, intuition or perception**. In aviation, flight puts the pilot into an environment which can **distort sense organs**, and the changed perspective which is experienced in flight can result in information being presented which is *outside the individual's expectations*.

14.6 Hallucination

A hallucination is actually a **false perception characterised by a distortion of real sensory stimuli**. (Not a fabrication of stimuli — the stimuli are real, but their perception is distorted.)

14.7 Workload and Limitations

Too high *or* too low a workload can result in degraded performance. Several types of situations may cause mental overload.

Exam Tip — Age and Response

Between **20 and 60 years** → responses become *slower but more accurate*. Experience compensates for slower reflexes.

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**.

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.

```

flowchart TD
    A[Identify Risk] --> B{Probability  
of Occurrence}
    A --> C{Impact  
if it Occurs}
    B --> D[Combine Probability × Impact]
    C --> D
    D --> E{Acceptable?}
    E -- Yes --> F[Proceed with Mitigation]
    E -- No --> G[Modify Plan / Don't Fly]

```

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.

Join live classes for guided practice and doubt clearing.

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.

flowchart LR
S1[1. Recognize
& Identify] --> S2[2. Consider
Nature]
S2 --> S3[3. Analyze
/ Research]
S3 --> S4[4. List Possible
Solutions]
S4 --> S5[5. Select Best
Alternative]
S5 --> S6[6. Execute
Best Choice]
S6 --> S7[7. Follow Up &
Communicate]
S7 --> FB[Feedback]
FB -.re-evaluate.-> S1

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.

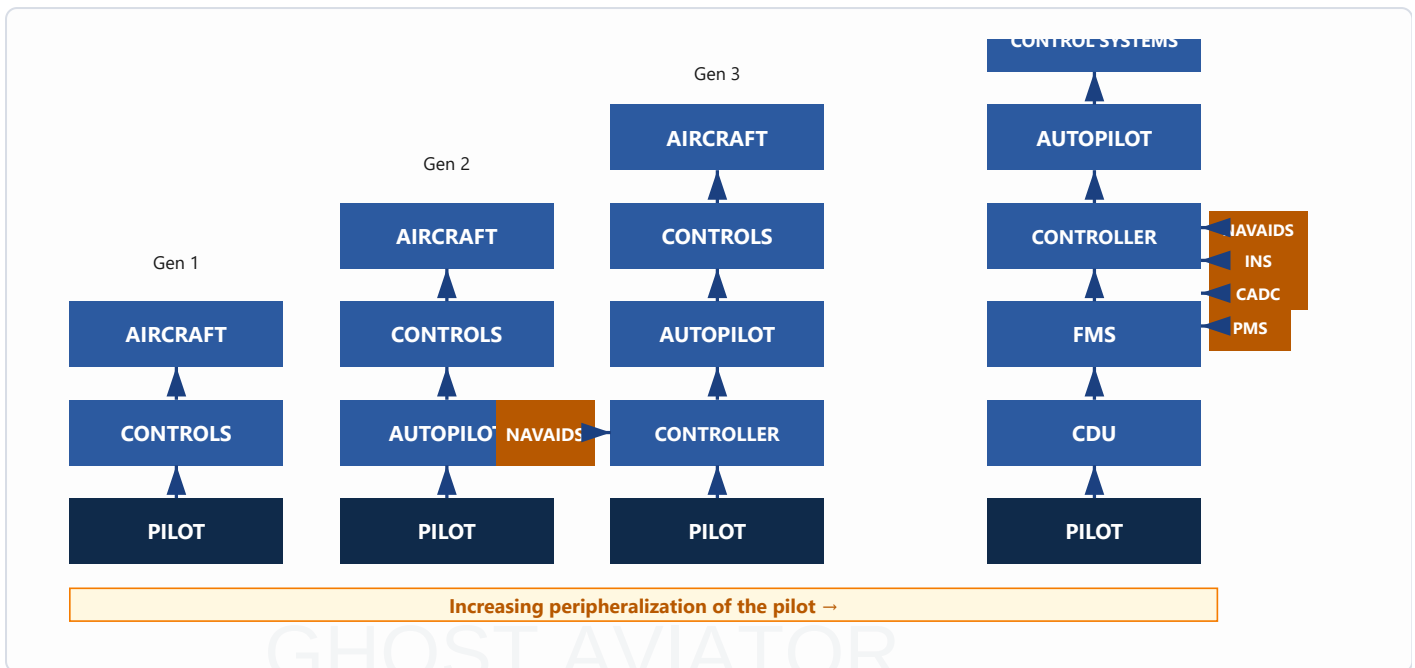
Through microprocessor technology, navigational tasks and aircraft system management have been automated, making the flight crew more *peripheral* to the actual operation of the aircraft. Pilots who at one time had direct authority over all aspects of aircraft control and management have now become responsible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



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

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- **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.

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 .

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STANDARD "T" LAYOUT

Attitude Indicator at centre · ASI-ALT-DI grouped around



22. Stress Tolerance, Fatigue & Arousal — Well-Being of Operational Personnel

What this section covers

Stress, arousal, fatigue, environmental tolerances, life stress scoring, stress management, and the arousal-performance relationship.

Three of the many factors which may influence the well-being of operational personnel are:

1. Stress and fatigue
2. Body rhythm disturbance
3. Sleep deprivation or disturbance

Other factors affecting physiological or psychological well-being include: *temperature, noise, humidity, light, vibration, workstation design and seat comfort.*

22.1 Stress, Arousal and Performance

The different stress levels generated within individuals by a particular stressor will differ. A **moderate level of stress may improve performance**. Stress promotes an **increase in physical strength** rather than promoting mental performance.

- The response of a person to the event or circumstances to which he is exposed is known as **arousal**.
- Arousal is a measure of a person's **readiness to respond effectively** to a given stress factor.
- Personality, character, training and experience will influence levels of arousal in a given individual.

22.2 The Effects of Stress

In an active, outward-going, highly trained person, *too little* stimulation or stress arousal will lead to the onset of **boredom and even drowsiness**. An introspective, under-confident person, if highly aroused, might be unable to function at all — even in circumstances that he is competent to deal with.

22.3 Stress Factors (Stressors)

Stress factors are **cumulative**. Stress occurs under various conditions:

- Pilot must revise his plan of action and does not immediately have a solution
- Inexperienced pilots when situational demands exceed their individual capabilities
- Pilot is convinced he will not be able to find a solution to the problem
- Physiological factors — hunger, thirst, pain, lack of sleep, fatigue

SOP — Key to Reduced Workload

Thorough flight planning is the key to reducing cockpit workload.

22.4 Environmental Tolerances

Temperature, pressure, humidity, noise, time of day, light and darkness can all be reflected in performance and also in well-being. Heights, enclosed spaces, and a boring or stressful working environment can also influence performance.

22.5 Managing Stress

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Recognising stress, accepting it and developing a coping strategy is essential for stress management. Training and experience help to ward off stress and high levels of arousal. Successful completion of a stressful task will reduce the amount of stress experienced when a similar situation arises in the future.

SOP — Stress Self-Management

To avoid stress, know your limits and fly well inside them. If you are aware that you are under stress, consider whether it would not be wiser for you to stay on the ground rather than to fly when you are not up to it. Make sure that **cockpit housekeeping** is of a high order and that all documents, charts and associated equipment are appropriately stored and accessible. **High-quality headsets** will reduce cockpit noise levels. Temperature can often be regulated using the cabin heating or ventilation system.

22.6 Life Stresses — Psychological Scoring

Pilots suffering from life stress should be aware that this can affect their concentration and performance when at the controls of an aircraft. The descending order in which the factors affect a person:

Death of spouse/child → Divorce → Marital separation → Death of a close family member → Injury / illness → Marriage → Loss of job → Retirement → Pregnancy → Sexual problems → Birth → Change of financial status → Siblings leaving home → Change of eating habits → Change of residence → Loan/debt/mortgage → Vacations → Minor violations of law.

Life Event	Score
Death of a spouse or partner	100
Divorce	73
Marital separation	65
Death of a close family member	63
Personal injury or illness	53
Loss of job	47
Retirement	45
Pregnancy	40
Sexual problems	40
Son or daughter leaving home	29
Change of residence	20
Bank loan or credit card debt	17
Vacation	13
Minor law violation	11

Cumulative Score	Interpretation
< 60	Free of life stress
60 – 80	Normal life stress
80 – 100	High life stress
> 100	Under serious life stress

Note: such schemes need to be treated with caution because of wide individual variability.

22.7 Indications of Stress

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Stress causes: **mental blocks, confusion, channelized attention, resignation, frustration, rage, deterioration in motor coordination, high pitch voice and fast speaking.**

Easily Observable Indications of Stress

Perspiration, flushed skin, dilated pupils and fast breathing.

22.8 Tiredness and Fatigue

Tiredness and fatigue, though related concepts, differ in their long-term physical effect on the body. To deal with normal tiredness it is sufficient to ensure that periods of activity and periods of restful sleep comply with the normal pattern for a person's age and physical condition.

Ordinary tiredness results from normal physical and/or mental exertion over a normal waking period. If a person is tired, *a good night's sleep* is the only requirement for that person to be fit the following morning.

Definition — Fatigue

Fatigue is a **very deep tiredness due to the cumulative effects of a stressful lifestyle and/or living and working environment.**

- The effects of fatigue can be *insidious*.
- They can creep up slowly on the sufferer.
- The sufferer may be unwilling to recognize or admit that he is suffering from fatigue.
- Tiredness and fatigue can kill, but fatigue is harder to recognize.

Causes of Fatigue

- Long-term ill health, either physical or mental
- Regular sleep deprivation, for whatever reason
- High levels of stress and/or anxiety over a prolonged period
- A disturbed body cycle (e.g. jet lag, changing work shift patterns)
- Long-term difficulties in personal or work-based relationships
- A stressful living and/or working environment (e.g. high levels of noise, or unreasonable physical or mental demands)

Symptoms of Fatigue

- Memory lapses
- Frequent mistakes in speech and actions

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- Rapid changes of mood
- Diminished awareness
- Tiredness
- Lack of coordination

Minimum Self-Help Program

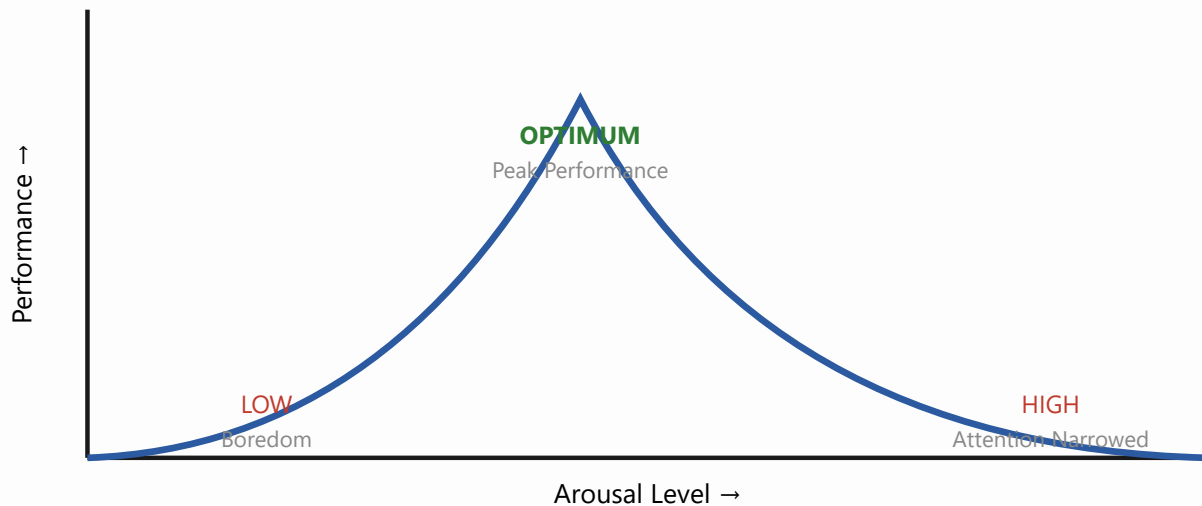
- Accept the fact that you are fatigued
- Eat a balanced diet and healthy food
- Try to take the stress out of your life
- Make sure that you get regular, undisturbed sleep
- Avoid alcohol and caffeine
- Always consult a doctor

22.9 Arousal

Arousal is a major aspect of many learning theories and is closely related to other concepts such as *anxiety*, *attention*, *agitation*, *stress* and *motivation*.

Arousal Level	Effect
Low Arousal	In cruise, attention can wander; information missed or misinterpreted
Optimum Arousal	Central Decision Maker at its most efficient. Lower for difficult/cognitive tasks; higher for tasks requiring endurance and persistence
High Arousal (Overload)	Real danger of attention becoming narrowed

Yerkes-Dodson Curve — Arousal vs Performance



Exam Tip — Stress Promotes...

Stress promotes an **increase in physical strength** rather than mental performance. A moderate level of stress may **improve** performance.

23. Body Rhythm Disturbance — The Circadian Cycle

What this section covers

The biological clock, the 24-hour vs 25-hour cycle, melatonin's role, jet-lag rules and re-synchronization rates.

23.1 Stimuli and Attention

Our bodies are continuously receiving stimuli through our **five senses**. This information is stored briefly in our sensory memory and, if we perceive it to be important, it is transferred to our short-term memory or Central Decision Maker. Some stimuli are better than others at getting our attention. We can split our attention between several different things by concentrating on them in rapid succession.

23.2 The Circadian Circle

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The Circadian Circle represents our level of alertness throughout the day. Circadian rhythms are internally generated by a **self-sustaining (autonomous) biological clock** located in the **hypothalamus**, which functions as the main control centre for the autonomic nervous system by regulating sleep cycles, body temperature, appetite, etc., and acts as an endocrine gland by producing hormones. It takes into account biological elements such as **body temperature, heart rate and blood pressure** — which affect our level of alertness during the day.

Hazard — Circadian Lows

Human performance degradation at circadian lows is one of the major challenges for the aviation industry.

23.3 24-Hour Circadian Reference

Time	Body Event
00:00	Midnight
02:00	Deepest sleep
04:30	Lowest body temperature
06:45	Sharpest rise in blood pressure
07:30	Melatonin secretion stops
08:30	Bowel movement likely
09:00	Highest testosterone secretion
10:00	High alertness
12:00	Noon
14:30	Best coordination
15:30	Fastest reaction time
17:00	Greatest cardiovascular efficiency and muscle strength
18:30	Highest blood pressure
19:00	Highest body temperature
21:00	Melatonin secretion starts
22:30	Bowel movements suppressed

As we sleep, our heart rate is lowered and hence our level of alertness is reduced. Blood pressure is also often lowered after mealtimes. **Human performance declines at night when the body and mind desire rest.**

23.4 Melatonin — "The Light of Night"

Melatonin is secreted from the **pineal gland** principally at night. The hormone is involved in **sleep regulation**, as well as in a number of other cyclical bodily activities and circadian rhythm in humans.

- Secretion increases soon after the onset of darkness.

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- **Peaks in the middle of the night, between 2 and 4 a.m.**
- Gradually falls during the second half of the night.

This circadian rhythm of secretion plays an important role in its hormonal activity. Melatonin is exclusively involved in signalling the '**time of day**' and '**time of year**' (hence considered to help both clock and calendar functions) to all tissues, and is thus considered to be the body's chronological pacemaker or '**Zeitgeber**'.

23.5 Trans-Meridian Flight — Pilot Considerations

Factor	Value / Rule
Free-running circadian cycle (no time cues)	~ 25 hours
Cycle with normal time cues	~ 24 hours
Stop-over rule	If stop-over > 24 hours → move to new time as soon as possible
Crossing > 3–4 time zones with layover > 24 hours	Keep in swing with rhythm of the departure country for as long as possible; maintain regular living patterns
Re-synchronization rate	1 – 1.5 hours per day
Eastbound adaptation	~ 50 % slower than westbound; 1.5 days per time-zone east
Westbound adaptation	~ 1 day per time-zone
Difficulty	Readjustment after a time shift is normally more difficult with flights towards the East
Sleep duration	Governed primarily by the point within your circadian rhythm at which you try to sleep
Sensorimotor vs intellectual performance	Sensorimotor performance is better in the evening ; intellectual performance is better in the morning

Worked Example — Hyderabad → Berlin Layover

Hyderabad (IST, UTC+5:30) to Berlin (CET, UTC+1) — a westbound trip of about 4.5 time zones with a **22-hour layover**.

- Layover < 24 hours → *do NOT shift to local time*. Stay on departure (IST) rhythm.
- Relevant time measure for your circadian rhythm: **IST (Indian Standard Time)**.

Reason: short layovers do not give the biological clock time to re-synchronize (only 1–1.5 hours/day shift is possible); attempting to shift will degrade alertness on the return leg.

Exam Tip — Eastbound = Worse

Eastbound travel adaptation is **50% slower** than westbound. East → 1.5 days per time-zone; West → 1 day per time-zone. "Lose hours, lose sleep."

24. Sleep — NREM & REM

What this section covers

The two components of sleep, the four NREM stages, REM sleep timing and function, sleep inertia and the implications of sleep loss for pilots.

Sleep is basically divided into **two components**:

- **Rapid Eye Movement (REM) sleep**
- **Non-Rapid Eye Movement (NREM) sleep**

Component	Purpose
NREM sleep	Body restoration — repair tissues, build bone and muscle, strengthen immune system
REM sleep	Brain restoration — strengthening, refreshing and organizing memory

NREM sleep is further divided into **four stages** from lightest to deepest. **Both types of sleep are required to recoup physical and mental energy.**

24.1 NREM Sleep Stages

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Stage	Description	Duration
NREM Stage 1	Transition phase between wakefulness and sleep. Brain activity, eye movement and muscle activity become slower. A person is easily awakened. Waking up in this stage causes a person to feel that he/she has <i>not slept</i> .	10 minutes each time
NREM Stage 2	Light sleep — the first stage of true sleep. Occupies 50 % of the sleep patterns. Brain activity, eye movement become even slower; cardiac activity decreases.	10–25 minutes each time
NREM Stage 3	Beginning of deep sleep — slow-wave delta sleep. Brain activity and eye movement approaching zero. If awoken, the person may feel groggy and disoriented for a few minutes.	—
NREM Stage 4	Deep sleep — slow-wave delta sleep. No eye movement or muscle activity. If awoken, the person may feel groggy or disoriented for a few minutes.	—

24.2 REM Sleep (Paradoxical Sleep)

- Usually occurs **70–90 minutes** into a sleep.
- Happens in cycles lasting for approximately **10 minutes initially to 1 hour**.
- The eye moves rapidly from side to side and the brain wave form is similar to that when a person is awake.
- **Dreams occur.**

As we grow older, the time spent in REM sleep declines from **50 %** of our sleep for infants, to **20 %** of our sleep for adults.

24.3 Sleep Inertia

Definition — Sleep Inertia

Refers to the transitional state between sleep and wake, marked by **impaired performance, reduced vigilance, and a desire to return to sleep.**

24.4 Key Points to Remember

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Sleep — Critical Facts

- The effects of sleep deprivation on performance **increase with altitude and with higher workload**.
- During paradoxical sleep rapid eye movements can be observed.
- The duration of a period of sleep is governed primarily by the point within your circadian rhythm at which you try to sleep.
- **Deep sleep allows for physical recovery and the reconstitution of neuron energy reserves.**
- Lack of sleep increases fatigue, concentration and attention. It has risks of **sensory illusions and mood disorders**. Disruption of sleeping patterns can lead to symptoms of drowsiness, irritability and lack of concentration — making an individual more prone to make errors.
- A person experiencing sleep loss is **unlikely to be aware** of personal performance degradation.
- Performance loss may be present up to **20 minutes** after awaking from a short sleep (nap).
- The sleep cycles repeat during the course of a night's sleep. Each succeeding cycle contains a greater amount of REM sleep. **Frequent interruption of the REM sleep can harm a human being in the long run.** REM sleep is more important for the regeneration of mental and physical functions than all the other sleep stages are.

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flowchart LR
    W[Wakefulness] --> N1[NREM 1]
    N1 --> T[Transition]
    T --> N2[NREM 2]
    N2 --> N3[NREM 3]
    N3 --> N4[NREM 4]
    N4 --> R[REM]
    R --> N2

```

W[Wakefulness] --> N1[NREM 1
~10 min
Transition]
N1 --> N2[NREM 2
10-25 min
50% of sleep]
N2 --> N3[NREM 3
Onset Deep Sleep]
N3 --> N4[NREM 4
Deep Sleep
No eye/muscle activity]
N4 --> R[REM
70-90 min in
Dreams • Brain wave ≈ awake]
R -.cycle repeats with more REM each time.-> N2

25. Mental Health Problems & Disorders

What this section covers

The risk of mental health problems among aviation personnel, the Germanwings 9525 case study, and where preventive efforts should focus.

Mental health problems and disorders among pilots, ATCOs, maintenance and other personnel in aviation may impair performance and therefore be a **threat to flight safety**.

25.1 Case Study — Germanwings Flight 9525

Germanwings 9525 — 24 March 2015

- **Route:** Barcelona–El Prat Airport (Spain) to Düsseldorf Airport (Germany).
- **Aircraft:** Airbus A320.
- **Date:** 24 March 2015.
- **Crash location:** **100 km** north-west of Nice in the French Alps.
- **Casualties:** All **144 passengers** and all **6 crew members** were killed.
- **Cause:** The crash was deliberately caused by the co-pilot, Andreas Lubitz, who had previously been treated for suicidal tendencies and declared unfit to work by his doctor. Lubitz kept this information from his employer and instead reported for duty. Shortly after reaching cruise altitude and while the captain was out of the cockpit, Lubitz locked the cockpit door and initiated a controlled descent that continued until the aircraft hit a mountainside.

25.2 Why Pilots May Not Report Mental Health

There may be many reasons why a pilot may be reluctant to discuss mental health problems with the examining physician during the annual medical assessment, including **fear of losing his or her licence** with both personal and financial costs as a result. This may prevent the pilot from receiving adequate and timely help, and this could potentially make the problems worse and prolong the time for recovery.

Best Practice — Reducing Stigma

More could probably be done to increase knowledge about mental health problems and reduce stigma so that more pilots and other professionals working in aviation report mental health problems, get treatment, and return to work. This would probably increase individual well-being, but also **promote safety**.

25.3 Where to Focus Preventive Efforts

Serious mental health disorders (e.g. *psychosis*) are relatively rare and their onset is difficult to predict. **Preventive efforts should be aimed at more common mental health problems such as:**

- **Depression**
- **Anxiety**
- **Substance misuse**

Master Reference Tables & Mnemonics

Purpose

Every numerical value and key rule from the chapter consolidated for quick exam-night revision.

M-1. Master Numerical Reference

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Topic	Value	Section
Iconic memory duration	0.5 – 1 second	5
Visual channel share of information processing	70 – 80 %	5
Short-term memory duration	10 – 20 seconds	12
Short-term memory capacity	7 ± 2 items	12
Long-term memory capacity	Unlimited (retrieval may fail)	12
Acceptable workload (crew resources)	~ 60 %	11
Human error rate – simple/repetitive	1 in 100	11
Human error rate – after practice	1 in 1,000	11
Startle reflex – motor task recovery	5 – 10 seconds	10
Age-related response slowing	20 – 60 years	14
Anthropometric design population	Central 90 % (disregard 5% lowest & 5% highest)	20
Free-running circadian cycle	~ 25 hours	23
Cued circadian cycle	~ 24 hours	23
Circadian re-sync rate	1 – 1.5 hours/day	23
Eastbound adaptation	~ 1.5 days/time-zone (50% slower than west)	23
Westbound adaptation	~ 1 day/time-zone	23
Stop-over threshold for adjusting to local time	> 24 hours	23
Lowest body temperature time	04:30	23
Highest body temperature time	19:00	23

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Melatonin peak	02:00 – 04:00	23
Melatonin secretion starts	21:00	23
Melatonin secretion stops	07:30	23
NREM Stage 1 duration	10 minutes	24
NREM Stage 2 duration / share	10–25 min / 50 % of sleep	24
REM onset after sleep start	70 – 90 minutes	24
REM cycle duration	10 min → up to 1 hour	24
REM share – infant vs adult	50 % vs 20 %	24
Post-nap performance loss	Up to 20 minutes	24
Life stress scoring – free / normal / high / serious	<60 / 60–80 / 80–100 / >100	22
Germanwings 9525 — date	24 March 2015	25
Germanwings 9525 — crash distance	100 km NW of Nice	25
Germanwings 9525 — casualties	144 pax + 6 crew	25
Cockpit restraint	5-point harness with negative-G strap	20

M-2. Mnemonics & Memory Aids

Concept	Mnemonic
Aviation Psychology aims	D-P-U-I → Describe, Predict, Understand, Influence
Information-processing stages	D-P-D-A-F → Detection, Perception, Decision, Action, Feedback
Workload drivers	DPST → Difficulty, Parallel, Series, Time
Anderson model phases	C-A-A → Cognitive, Associative, Automatic
STM expansion tools	"Chunk & Chain" → Chunking + Association
Long-term memory types	S-E-P → Semantic, Episodic, Procedural
SA-killers	SBF-EPI → Stress, Boredom, Fatigue, Emotional, Poor comm., Interruptions
Decision-making seven steps	R-C-A-D-S-E-F → Recognize, Consider, Analyze, Develop, Select, Execute, Follow-up
Communication barriers	4-A + 2-I-R → Aggressiveness, Arrogance, Anti-authoritarian, (im)Pulsiveness, Invulnerability, Resignation
Human-centred automation qualities	"A-SPA-CFDIE²" → Accountable, Subordinate, Predictable, Adaptable, Comprehensible, Flexible, Dependable, Informative, Error-resistant, Error-tolerant
Control design principles	S-F-S-I-V-S-S-W → Standardization, Frequency, Sequence, Importance, Visual-tactile, Symbolism, Simultaneous, Warnings
Stress observables	"P-FISH-DP-FB" → Perspiration, Flushed Skin, Dilated Pupils, Fast Breathing
Sleep stages	1-2-3-4-R → NREM 1 (transition) → 2 (light, 50%) → 3 (onset deep) → 4 (deep) → REM (dreams)
Jet-lag rule	"East is Least, West is Best" → East 50% slower; 1.5 d/zone east vs 1 d/zone west
Mental health priority targets	D-A-S → Depression, Anxiety, Substance misuse

M-3. Quick Definitions Recall Sheet

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Term	One-Line Definition
Aviation Psychology	Applied psychology focused on human behaviour in aviation systems.
Workload	Mental effort needed to process information.
Perception	Conversion of sensory information into a meaningful structure.
Selective Attention	Continual sampling of inputs to judge relevance.
Divided Attention	Time-sharing of central decision channel between tasks.
Vigilance	Capability of remaining alert above a threshold for a period.
Complacency	Self-satisfaction with one's performance + unawareness of danger.
Motor Programme	Behavioural sub-routine learnt by practice and held in LTM.
Reaction Time	Delay between detection, stimulus and muscle contraction.
Startle Reflex	Reflex-like blink + body jerk to abrupt stimulus.
Human Reliability	Individual functioning in the manner he/she is supposed to.
Hallucination	False perception characterised by distortion of real sensory stimuli.
Cognition	Mental process of acquiring knowledge by reasoning, intuition or perception.
Risk Assessment	Probability of risk × Impact if it occurs.
Situational Awareness	Accurate appraisal of self, environment and own performance.
Automation	Controlling apparatus/process by electronic/mechanical devices replacing the human organism.
Anthropometry	Study of human measurement (static, dynamic, contour-surface).
Eye Datum	Defined eye position around which the cockpit is designed.
Trait Anxiety	Personality trait of high neuroticism (persistent worry).
State Anxiety	Transient anxiety present in anyone at any time.
Arousal	Person's readiness to respond effectively to a stress factor.

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Fatigue	Deep tiredness from cumulative stressful lifestyle/environment.
Zeitgeber	Body's chronological pacemaker — melatonin signals time of day/year.
Sleep Inertia	Transitional state between sleep and wake with impaired performance.

M-4. Risk Formula

Risk Assessment Formula

$\text{Risk} = \text{Probability of Occurrence} \times \text{Impact if it Occurs}$

Variables:

- *Probability* — likelihood the hazard manifests (low / medium / high).
- *Impact* — severity of consequence (minor / major / catastrophic).

Worked example — Marginal weather decision:

Probability of icing on route = High (forecast supports it).

Impact if encountered without anti-ice = Catastrophic.

→ Risk = High × Catastrophic = **Unacceptable**. Decision: **Don't fly**, or re-route below freezing level / with active anti-ice.

M-5. Final Quick-Revision Summary Box

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Exam-Night One-Page Recap

Memory: Iconic 0.5–1 s · STM 10–20 s, 7 ± 2 · LTM unlimited.

Workload: Acceptable $\approx 60\%$ · DPST drivers · symptoms = funneling, regression, mental blocking, panic.

Error rate: 1/100 raw $\rightarrow$ 1/1,000 after practice. Errors are cumulative.

Startle: Motor task back to normal in 5–10 s. Fear potentiates.

Anderson Skill: Cognitive $\rightarrow$ Associative $\rightarrow$ Automatic.

Anthropometry: central 90 %, discard top & bottom 5 %.

Restraint: 5-point harness + negative-G strap.

Display rule: Digital for quantitative · Analogue for qualitative. Standardization is the #1 design rule.

Three-pointer altimeter: more misreads than single-pointer.

Stress observables: perspiration, flushed skin, dilated pupils, fast breathing.

Life stress: <60 free · 60–80 normal · 80–100 high · >100 serious. Spouse death = 100.

Circadian: Free-running 25 h · cued 24 h · Lowest body temp 04:30 · Highest 19:00 · Melatonin peak 02–04 · Zeitgeber = Melatonin (pineal gland).

Jet-lag: 1–1.5 h/day re-sync · East 1.5 d/zone (50% slower) · West 1 d/zone · >24 h stopover $\rightarrow$ shift; <24 h $\rightarrow$ stay on departure rhythm.

Sleep: NREM 1 = 10 min · NREM 2 = 10–25 min, 50% · REM at 70–90 min · REM 50% infant $\rightarrow$ 20% adult · Post-nap loss up to 20 min.

Mental health priority: Depression, Anxiety, Substance misuse. Germanwings 9525 (24 Mar 2015, A320, 100 km NW Nice, 144 pax + 6 crew).

Communication barriers: Aggressiveness, Arrogance, Anti-authoritarian, Impulsiveness, Invulnerability, Resignation.

Murphy's Law: if it can be operated wrongly, sooner or later it will be.

Golden Maxim: A superior pilot uses his superior judgment to avoid situations that would require his superior skills.

— End of DGCA Study Notes — Aviation Psychology & Human Factors —
Compiled by **Ghost Aviator** | Source: Chapter 25 (pages 615–652)