SPATIAL DISORIENTATION

Dr Musa Ndukuya

OBJECTIVES

- DEFINITION
- CAUSES
- SENSES OF ORIENTATION AND HOW THEY ARE AFFECTED
- TYPES OF SDO
- VESTIBULAR ILLUSIONS
- PREVENTION AND RECOVERY

DEFINITION

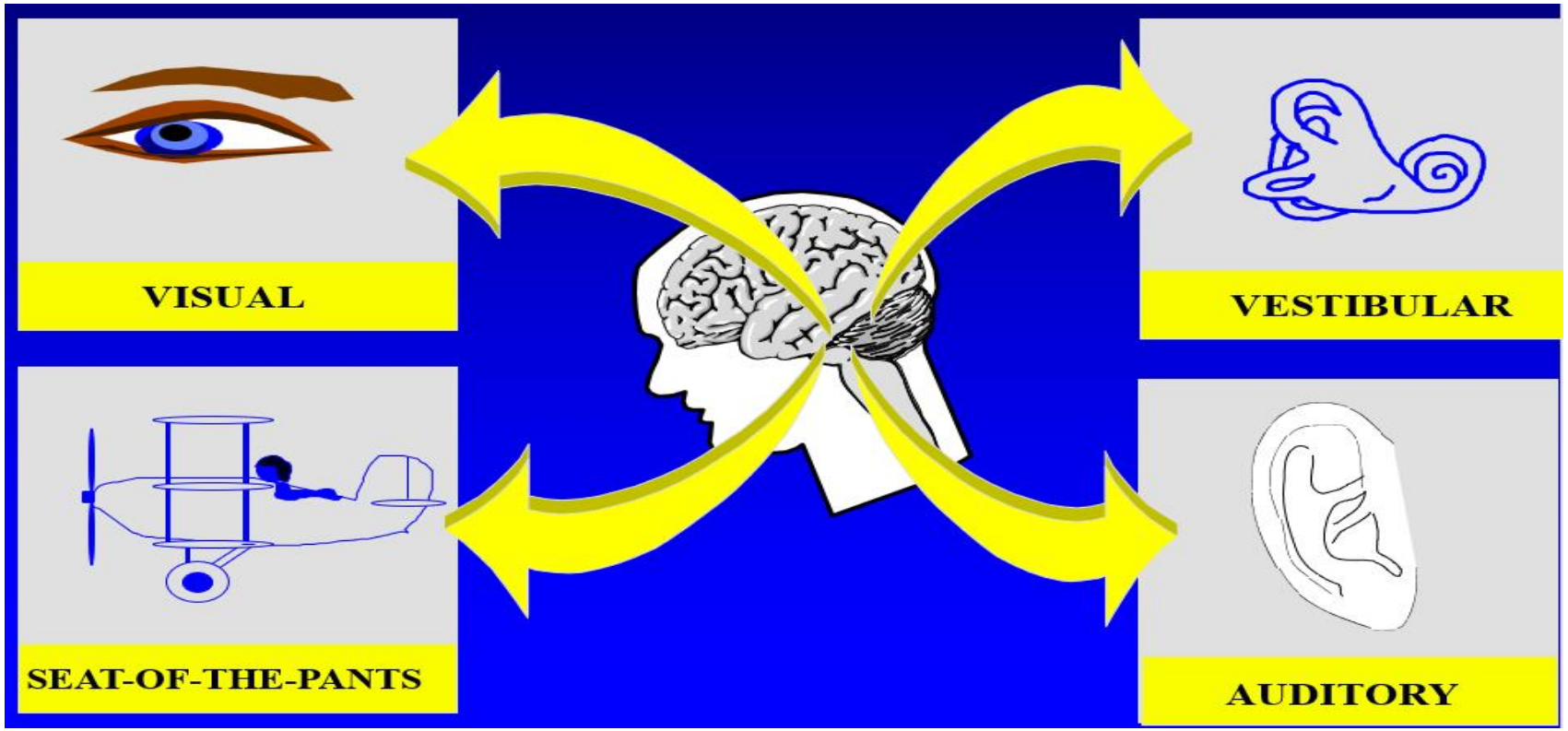
Spatial disorientation is a term used to describe a variety of incidents occurring in flight where the pilot fails to sense the position, motion or attitude of his aircraft or himself relative to the earth.

A state characterized by a pilot's erroneous perception of the magnitude of an aircraft control or performance parameter

CAUSES OF SPATIAL DISORIENTATION

- LACK OF VISUAL CUES, CLOUD FLYING ETC.
- NIGHT FLYING.
- INATTENTION.
- INEXPERIENCE.
- HYPOXIA, COLD, ALCOHOL AND DRUG.
- VIOLENT MANEUVERS.
- UNNECESSARY HEAD MOVEMENT
- FATIGUE.
- ANXIETY, PREOCCUPATION AND EMOTIONAL STRESSES.
- GLARE AND DAZZLE.
- INADEQUATE CUES FROM VESTIBULAR AND OTHER MECHANORECEPTOR.
- DISEASES AFFECTING VESTIBULAR SYSTEM.

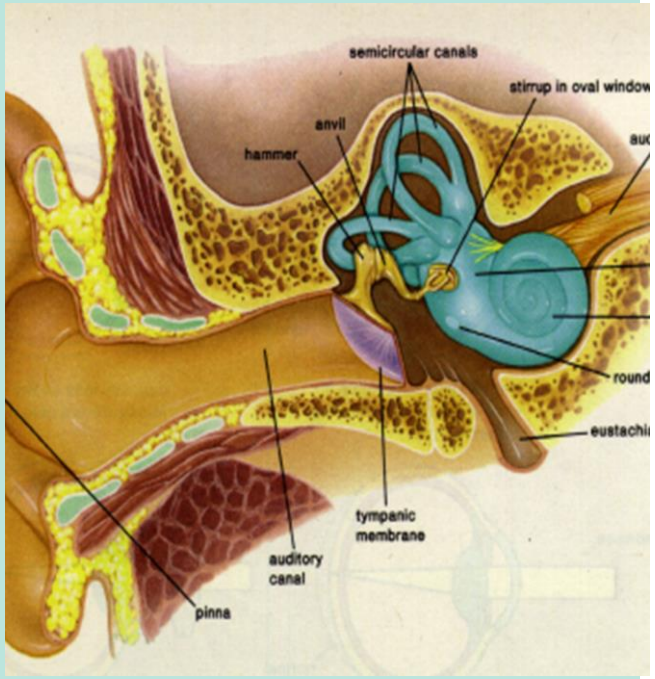
WHAT SENSES ARE USED DURING FLIGHT?



VISION

- THE MOST IMPORTANT SENSE FOR ORIENTATION
- MOTION, OBJECTS, REFERENCES, FLIGHT INSTRUMENTS

VESTIBULAR APPARATUS

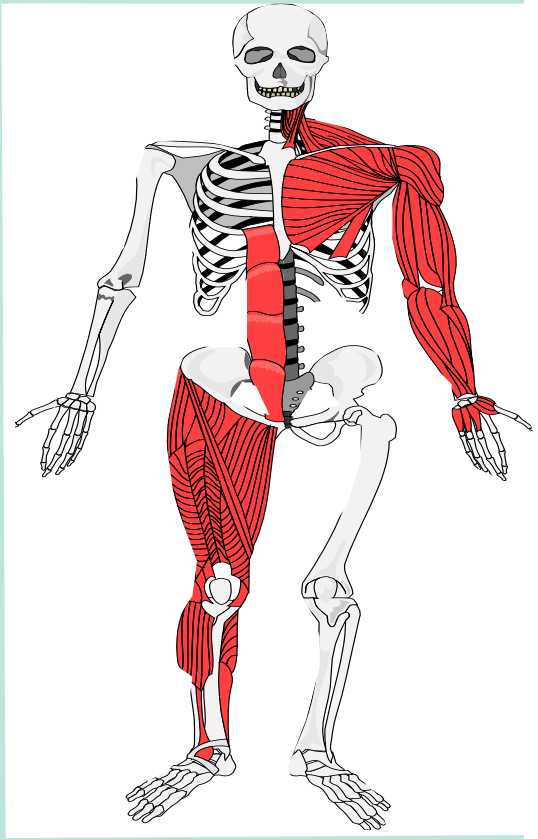


SEMICIRCULAR CANALS

- MONITORS ANGULAR ACCELERATIONS
- THREE LOCATED IN EACH EAR - YAW, PITCH & ROLL AXIS
- LOCATED IN THE BONY LABYRINTH

OTOLITH ORGANS

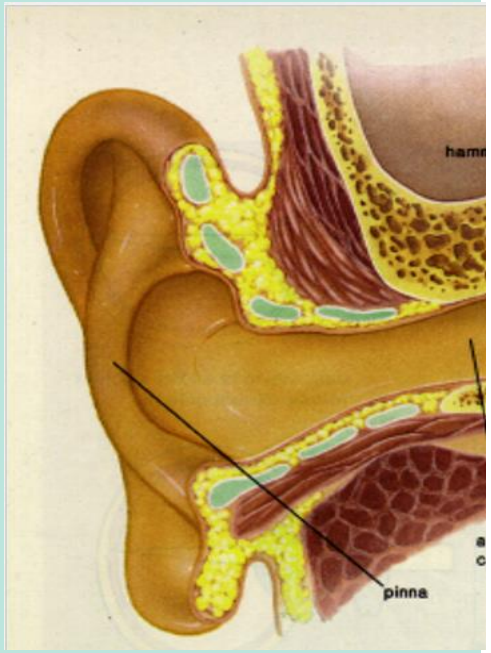
- MONITOR LINEAR ACCELERATIONS AND GRAVITY
- ALSO LOCATED IN THE BONY LABYRINTH
- CONTAIN SMALL SENSORY HAIRS WHICH PROJECT INTO A THIN MEMBRANE



PROPRIOCEPTIVE INPUT: SEAT OF THE PANTS

- STRETCH RECEPTORS
- MUSCULOTENDINOUS TENSION
- PRESSURE
- JOINT ANGULAR MOTION
- INPUT FROM BODY'S PRESSURE RECEPTORS
- MONITOR LINEAR ACCELERATION

AUDITORY CUES



- ENGINE NOISE
- CONFIGURATION CHANGES
- SLIPSTREAM NOISE
- AFFECTS SITUATIONAL AWARENESS

TYPES OF SPATIAL DISORIENTATION

- **TYPE-I:** THIS IS UNRECOGNIZED SD. HERE PILOT GET DISORIENTED, BUT DOES NOT RECOGNIZE IT AS SUCH LEADING TO WRONG DECISION AND ACCIDENT
- **TYPE-II:** RECOGNIZED SD. HERE PILOT KNOWS THAT HE IS DISORIENTED AND TAKES CORRECTIVE ACTION.
- **TYPE-III:** IS CALLED RECOGNIZED BUT INCAPACITATED TO TAKE ANY CORRECTIVE ACTION. INCAPACITATION MAY BE PSYCHOLOGICAL, PHYSIOLOGICAL OR PHYSICAL IN NATURE.

UNRECOGNIZED

- OCCURS WHEN A PILOT IS UNAWARE, THEY ARE EXPERIENCING DISORIENTATION DUE TO A MISMATCH BETWEEN THEIR VISUAL, VESTIBULAR (INNER EAR), AND PROPRIOCEPTIVE (BODY POSITION) SENSORY INPUTS
- OFTEN CAUSED BY FACTORS LIKE POOR VISIBILITY, RAPID MOVEMENTS, OR ILLUSIONS IN SPECIFIC SITUATIONS
- OCCURS WHEN PILOT IS BUSY, PRESSED, STRESSED, PREOCCUPIED, OR DISTRACTED

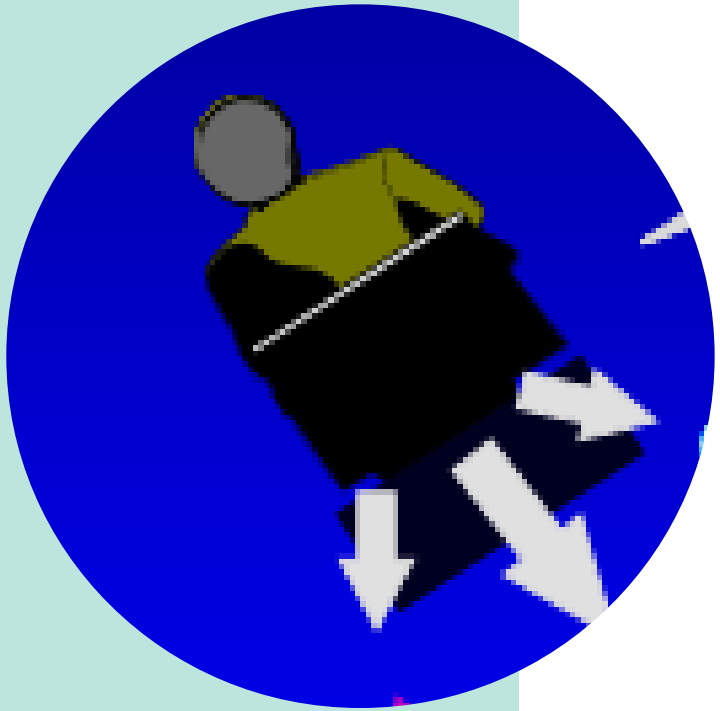
RECOGNIZED

- OCCURS FREQUENTLY, BUT IS USUALLY BRIEF
- SENSORY CONFLICT IS RESOLVED BY PERFORMING AN INSTRUMENT CROSS-CHECK AND BELIEVING THE INSTRUMENTS

INCAPACITATING

- SIGNIFICANT DISORIENTATION (SEVERE)
- THINKING PROCESS BREAKS DOWN, RATIONAL THOUGHT PROCESSES CEASE, AIRCREW MAY FREEZE OR PANIC
- NYSTAGMUS
- VERTIGO

VESTIBULAR ILLUSIONS



THE LEANS

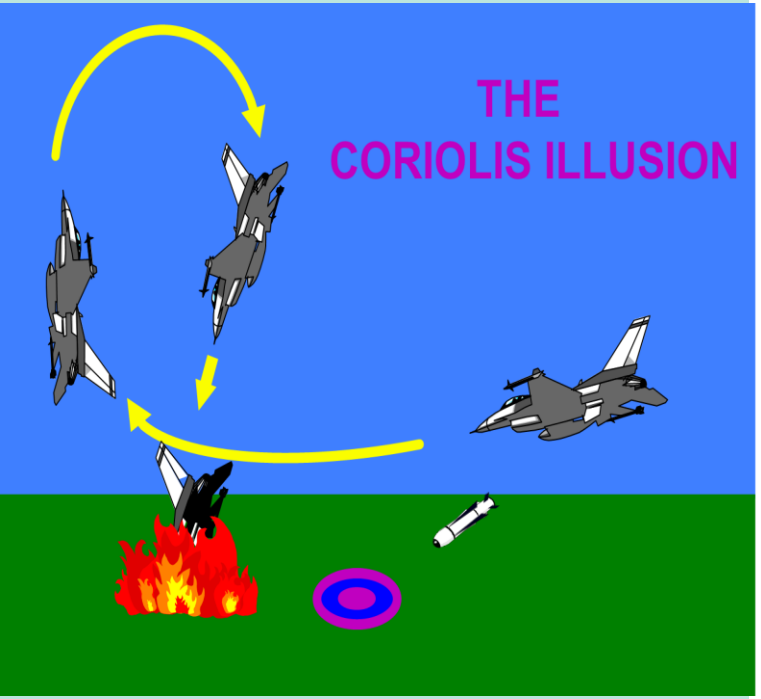
- MOST COMMON SENSORY ILLUSION
- AFTER A SLOW OR PROLONGED ROLL
- ROLL OUT PERCEIVED AS ROLL IN OPPOSITE DIRECTION
- CORRECTION INTO THE ORIGINAL TURN
- **FIX IT**: TRUST YOUR INSTRUMENTS, NOT YOUR BODY

VESTIBULAR ILLUSIONS

SOMATOGYRAL ILLUSIONS

GRAVEYARD SPIN AND SPIRAL

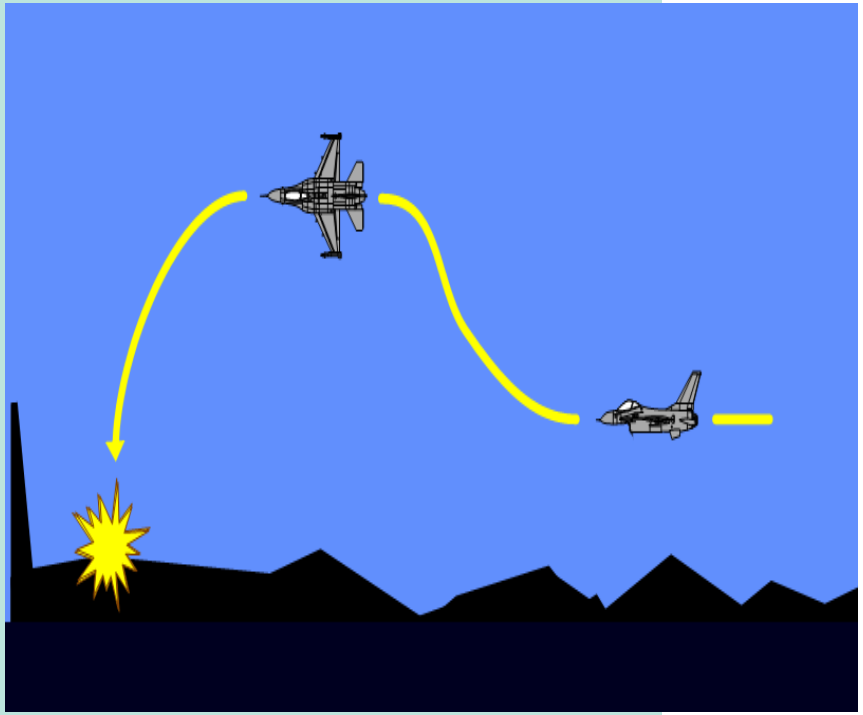
- THIS HAPPENS WHEN YOU FALL FOR THE LEANS
- SPIN OR SPIRAL GREATER THAN 20 SECONDS
- **FIX IT**: WATCH YOUR INSTRUMENTS TO STOP THE SPIRAL



VESTIBULAR ILLUSIONS

SOMATOGYRAL CORIOLIS ILLUSION

- MOST DANGEROUS OF VESTIBULAR ILLUSIONS
- OVERWHELMING DISORIENTATION
- OCCURS DURING CONSTANT TURN AND QUICK HEAD MOVEMENT
- GIVES ILLUSION OF A ROTATION PLANE MOVEMENT WHEN IT DOES NOT EXIST
- PREVENTION IS THE BEST: NO SUDDEN HEAD MOVEMENTS DURING TURNS

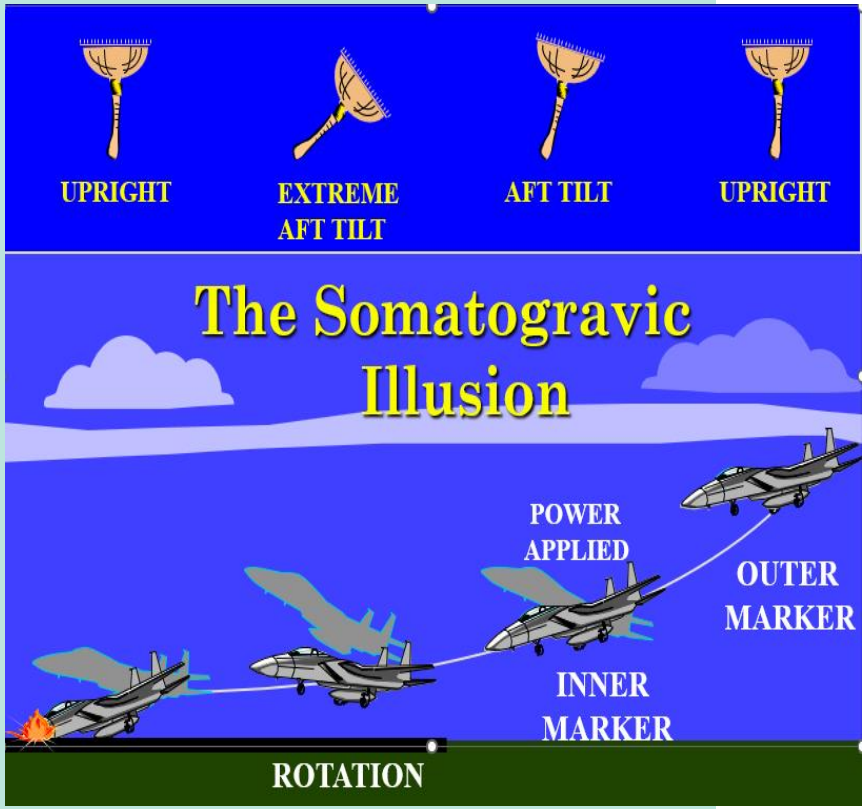


VESTIBULAR ILLUSIONS

GIANT HAND PHENOMENON

- OCCURS AFTER A STEEP BANKED TURN OR CORIOLIS ILLUSION
- AIRCRAFT IS IN SOME ATTITUDE OTHER THAN PLANNED
- ATTEMPTS TO CORRECT DON'T WORK BECAUSE HAND IS SUBCONSCIOUSLY MAKING THE INPUTS
- USUALLY OCCURS DURING INSTRUMENT CONDITIONS

VESTIBULAR ILLUSIONS



SOMATOGRAVIC ILLUSION

- FALSE SENSATION OF NOSE-HIGH PITCH ATTITUDE
- OCCURS DURING TAKE-OFFS OR MISSED APPROACHES WITHOUT EXTERNAL VISUAL REFERENCE

AERIAL PERCEPTION ILLUSIONS

RUNWAY WIDTH ILLUSION

WIDE RUNWAY: FEELS LOWER THAN YOU ARE, CAUSING YOU TO PITCH UP AND RISK STALLING

NARROW RUNWAY: FEELS HIGHER THAN YOU ARE, LEADING TO A STEEP DESCENT AND FASTER LANDING

SLOPING RUNWAY ILLUSION

UPSLOPING RUNWAY: FEELS HIGH, CAUSING A LOW APPROACH AND RISK OF TERRAIN COLLISION.

DOWN SLOPING RUNWAY: FEELS LOW, LEADING TO A HIGH APPROACH AND POSSIBLE MISSED LANDING OR STALL.

AERIAL PERCEPTION ILLUSIONS

SLOPING TERRAIN ILLUSION

- **UPSLOPING TERRAIN:** FEELS HIGH, RISKING A SHORT LANDING OR EARLY FLARE.
- **DOWN SLOPING TERRAIN**: FEELS LOW, CAUSING YOU TO OVERSHOOT THE LANDING SPOT.

BLACK-HOLE APPROACH

- AT NIGHT, A WELL-LIT RUNWAY SURROUNDED BY DARKNESS CAN FEEL HIGHER THAN IT IS, LEADING TO A DANGEROUSLY LOW APPROACH.

OTHER ILLUSIONS

AUTOKINETIC ILLUSION

- STARING AT A STATIONARY LIGHT IN THE DARK CAN MAKE IT SEEM LIKE THE LIGHT IS MOVING.
- **FIX IT:** DON'T FIXATE ON ONE LIGHT—KEEP SCANNING.

FALSE HORIZON ILLUSION

- IN LOW VISIBILITY, YOU MIGHT ALIGN WITH A FALSE HORIZON, LIKE CITY LIGHTS OR BANKED CLOUDS, CAUSING ALTITUDE LOSS OR A STALL.
- **FIX IT:** TRUST YOUR INSTRUMENTS, ESPECIALLY OVER FEATURELESS TERRAIN OR AT NIGHT.

HOW TO AVOID THESE ILLUSIONS

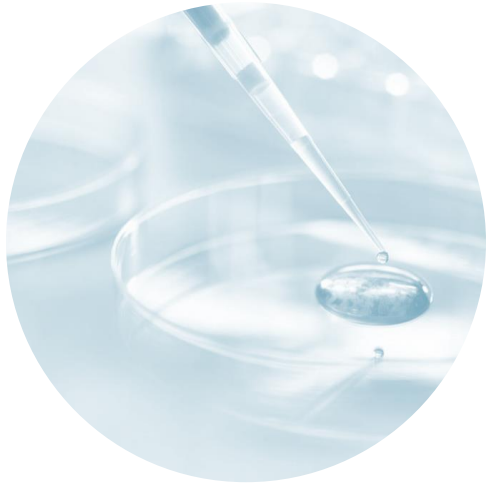
- USE VISUAL AIDS LIKE VASIS AND PAPIS TO GUIDE YOUR APPROACH.
- CROSS-CHECK YOUR INSTRUMENTS TO STAY ON A STABLE PATH.
- STUDY RUNWAY AND TERRAIN DETAILS DURING FLIGHT PLANNING

PREVENTION OF SD

- TRAINING AND PROFESSIONAL KNOWLEDGE OF PROBLEMS
- EXPERIENCE
- OBTAINED RELIABLE VISUAL REFERENCES
- MINIMIZED HEAD MOVEMENTS
- FLY STRAIGHT AND LEVEL
- PROPER MISSION PREPARATION
- COMMUNICATE YOUR PROBLEM
- SIT-DOWN AND HOLD-ON

WHEN SPATIAL DISORIENTATION STRIKES:

- MAKE A POSITIVE EFFORT OT REDIRECT TO INSTRUMENT.
- BELIEVE IN YOUR INSTRUMENTS.
- DO NOT TRY TO ANALYZE THE SITUATION, THIS WASTES VALUABLE TIME, TRY TO MAKE YOUR INSTRUMENT READ RIGHT.
- MAINTAIN INSTRUMENT SCAN PATTERN.
- DO NOT ATTEMPT TO MIX INSTRUMENT FLYING AND FLYING BY VISUAL REFERENCE ONLY.
- HAND OVER CONTROL TO CO-PILOT IF AVAILABLE.
- TALK. TELL SOMEONE THAT YOU ARE DISORIENTED.
- ENGAGE AUTOPILOT.



THANK YOU