Seeing is NOT Believing

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Gulf Air Flight 072

- 23rd August, 2000
- Cairo – Bahrain A320
- Crashed, 143 killed
- 1930 hrs local time
• Auto-pilot off
• VOR/DME approach
• Too high & too fast at 0.9 Nm from runway 12
• Approach aborted
Gulf Air Flight 072

- 250 kts below 10000 ft as per flight manual
- 330 kts, at 2300 feet
- Did not execute missed approach
- 360° left, 500 – 600 ft attempt to land again
Gulf Air Flight 072

- Non standard, involving considerable variations
- Re-intercept with approach
- Overshot runway
Gulf Air Flight 072

- Ignored GPWS warnings
- Misperception of pitch, multiple cockpit distractions
- Spatial disorientation
Spatial Disorientation

- Getting lost not covered by this definition
- Pilot confusion about position, attitude & motion of aircraft
- Rapidly changing, dynamic flight environment
- Degree of freedom, no direct link with Earth
Spatial Orientation

- Natural ability to maintain our body orientation ± posture in relation to the surrounding environment at rest & during motion
Spatial Orientation

- Designed to maintain spatial orientation on the ground
- Hostile flight environment creates conflict & illusions
- 5 – 10% GA accidents due to disorientation
- 90% FATAL
Spatial Orientation

- Ground
- Visual, vestibular, proprioceptive inputs
- Acceleration & gravity changes
- Compared with visual information
Spatial Orientation

- Flight
- Brain – key organ
- Attitude, position & motion
Spatial Orientation #1

- Motion – directional
- Linear, rotational or combination
- No value w/o specific data on direction vector
Spatial Orientation #2

- Information judged according to point of reference
- Intersection of Earth’s surface & vertical vector of gravitational pull
- Earth is left behind in flight
- Gravitational vector may be modified
- Brain continues to interpret body position changes
Spatial Orientation #3

- Reference point may change
- Aerial combat or formation flying
- Cloud top, moon, sun
- If you fly helicopter, beware of cables!
Spatial Orientation #4

- Extrapolates what he feels to what he perceives the aircraft to be doing
- Strong
- Extreme freedom in flight, attitude potentially free to vary
- Confusion, nausea & stress
Spatial Disorientation

- Loss of situational awareness
- Type I: unrecognized – greater flight hazard
- Type II: recognized – discrepancy between pilot & aircraft
Spatial Disorientation

- Pilot preoccupation or distraction
- Failure to respond to warning devices
- Over-reliance on automated systems
- Interpretation errors
- CRM failures
“Coning of Attention”

Eastern Airlines 401 L-1011 (1972). The flight crew became pre-occupied with a faulty landing wheel light indicator and accidentally turned off the autopilot set for 2000 feet. They realised their error too late and were too low to recover, impacting the Florida Everglades.
Vestibular Physiology

- Inner ear
- Organ of equilibrium
- Semicircular canals: angular acceleration
- Otolith organs: linear acceleration & gravity
Vestibular Physiology

- 3 circular canals
- Connected at right angles to one another
Vestibular Physiology

- Corresponds to pitching, rolling & yawing
Vestibular Physiology

Stationary

Angular Acceleration
Vestibular Illusions

- Somatogyral illusions
- Leans
- Graveyard spin
- Graveyard spiral
- Coriolis illusion
The “Leans”

- Most common, clearly identifiable, single
- Type II
- Nuisance
- Sudden return to level flight, following gradual prolonged turn
The “Graveyard Spin”

- Intentional or unintentional spin
- Idle throttle, ailerons neutral
- Apply & hold rudder in opposite direction
- Break stall
- Hold & wait until rotation stops
The “Graveyard Spiral”

- More common
- Return to level flight following intentional or prolonged bank turn
The “Coriolis Illusion”

- Stimulation of 2 semi-circular canals
- Sudden tilting of pilot’s head when aircraft is turning
- Pitching, rolling & yawing at the same time
The Otoliths

- Saccule & utricle
- Right angle to each other
- Utricle: linear acceleration in horizontal
- Saccule: gravity changes in vertical plane
The Otoliths

- Located at base of semicircular canals
- Contain small sacs covered by hair filaments
- Project into gelatinous membrane
The Otoliths

- Weight of organs pulls cupula (gelatinous membrane)
- Hair cells bent
- Signals sent to brain e.g. vertical take-off in helicopter
The Otoliths

- Forward linear acceleration produces backward movement
- Hair cells bent
- Signals sent to brain
- Forward movement
The Otoliths

BACKWARD ACCELERATION

INERTIAL FORCE

LINEAR ACCELERATION
Vestibular Illusions

- Somatogravic illusions
- Unreliable or unavailable external visual cues
- “Inversion” illusion
- “Head-up” illusion
- “Head-down” illusion
The “Inversion Illusion”

- Steep ascent then sudden level flight
- Relative high speed after leveling off
- False sensation of inverted
The “Head-up Illusion”

- Sudden forward linear motion following level flight
- Pitch up
- Push yolk or stick forward
- Night or catapult T/O
The “Head-down Illusion”

- Sudden linear deceleration following level flight
- Pitch down
- Will stall aircraft if try to correct
Prevention

- Spatial disorientation training
- Before flying < 3 miles visibility, training & proficiency in aircraft control w/ reference to instruments
- Maintain night flying currency
- If only VFR qualified, DO NOT t/o in deteriorating weather
ALWAYS TRUST YOUR INSTRUMENTS, SON.
Gulf Air Flight 072

- Somatogravic illusion in total darkness
- False sense of pitching up
- Pilot responded
- Aircraft flew into sea at 280 kts & 6.5° nose down
Central & Visual Forms of Disorientation
Ryanair Flight 9884

- 29th March 2006
- Liverpool to City of Derry
- Maiden City
- Balleykelly Camp
- Army airfield 5 miles away
Ryanair Flight 9884

- Cleared to land by ATC on VFR to Derry
- Mistook airfield
Ryanair Flight 9884

- Steps brought by road for passengers to disembark
- Greeted by soldiers with a laugh!
Vision & Spatial Orientation

• Visual cues
• Important information
• Maintain spatial orientation in flight & on ground
• Especially when in motion
• Birds cannot fly safely w/o visual reference
Vision & Spatial Orientation

- Central or foveal
- Peripheral
Central Vision

- Identification of objects
- Colour perception
- Allows pilots to gather info from instruments during IFR
- Allows pilots to acquire external info to judge distance, speed & depth during VFR
Peripheral Vision

- Ambient vision
- Perception of movement
- Walk & read at the same time!
- Surrounding environment motion can produce self motion
Central Forms of Disorientation

- Coning of attention, task saturation, stress reactions
- Giant hand illusion
- Negative transfer
- Temporal disorientation
- Break-off
Giant Hand Illusion

- Loss of aircraft control to an external force pulling on control column
- Mechanical failure assumed
- Anxiety or over-arousal
- Period of distraction
- Hands occupied
Giant Hand Illusion

- Prior misconception of aircraft attitude
- Change of gravity vector
- Involuntary & unconscious
- Pilot thinks he is pulling back, but really is pushing forward
Negative Transfer Illusion

- When “feel” of aircraft’s controls or instrument display
- Differs from what pilot is used to
Negative Transfer Illusion

• Aircraft type conversion e.g. trainer to strike

• Changing type & role e.g. fixed wing to rotary wing

• Expect trouble if instrument displays are different
Temporal Disorientation

- Occurs in periods of intense stress
- Temporary slowing of perceived passage of time
- Leads to loss of situational awareness
- To eject or not to eject, that is the question
Temporal Disorientation

- Brain unable to accept rapid development of events
- Forced to interpret huge amount in a short period as lengthening of time
- Distortion greatest when perceived dangers are more serious or recognized late
Unusual perception of depersonalization

Sensory input reduced by high altitude

Reduced sensory input or deprivation

Student pilot 1st solo.
Visual Illusions in Flight

- 10  11  12  13  14
- E  D  C  13  A
Visual Illusions in Flight

• Pilot’s visual reference to natural horizon

• When obscured, can be maintained by surface below

• When both obscured, maintained by artificial means viz. instruments

• Smoke, fog, smog, haze, etc
Visual Illusions in Flight

- Normal approach
Visual Illusions in Flight

- Up-sloping runway on FLAT terrain
- High approach
Visual Illusions in Flight

- Down-sloping runway on FLAT terrain
- Low approach
Visual Illusions in Flight

- Flat runway on UPSLOPING terrain
- Low approach
Visual Illusions in Flight

- Flat runway on DOWNSLOPING terrain
- High approach
Visual Illusions in Flight

- Unusually long or narrow runway
- High approach
Visual Illusions in Flight

- Unusually wide
- Low approach
Visual Illusions in Flight

- “Black hole” approach
- No stars or moonlight over water
- Unlit terrain to lit runway
- No peripheral vision
- Runway tilted left & up-sloping
Visual Illusions in Flight

- Visible horizon
- Easily orient w/ central vision
Visual Illusions in Flight

- Hazardous “black hole”
- No lights before runway
- City lights or rising terrain beyond runway
- High approach
Visual Illusions in Flight

- Autokinetic illusion
- Stationary object moving in plane’s path
- Staring a fixed point of light in totally dark & featureless background
- Light on collision course
Summary

- No pilot can fly in IFR conditions without instruments.
- The inner ear can give false positional information unless there is also a visual reference.
- You can literally fly upside down and not know it.
- You can lose orientation in less than 20 seconds if you are in clouds and are not on instruments!
Take off is VOLUNTARY.....

BUT

Landing is MANDATORY