

I HAVE SEEN THE EYES OF DEATH* and

By John Albrecht

Introduction

December 6, 2000, Tofino Airport, B.C. - The scene was set.

Weather was brilliant sunshine with a cloudless sky and a light westerly sea breeze. In the unseasonably warm conditions, the mechanics and pilots of Tofino Airlines had moved a floatplane out of the hangar to carry out scheduled maintenance. On the adjacent apron, a middle aged American businessman was loading and pre-flighting his immaculate Cessna 182 for the return flight to his home base in Oregon. He was completing his solo cross-country trip as a student pilot. Well known to the Tofino Airlines employees, they had complimented his adventuresome spirit in making a cross-border flight.

The serenity of the morning was broken by the faint forlorn moan of the Leonard Island foghorn. With disbelief and apprehension for the rookie pilot, a quick telephone call confirmed that indeed a fogbank was moving in from the Pacific. A glance to the west revealed a thin white line on the horizon. The student's preflight seemed to take forever. At last he strapped in and fired up. With increasing alarm the onlookers realized that he was taxiing for runway 28 - a westbound departure into a light wind. Another observation noted that the gray wall had reached the golf course at the western boundary of the airport and was advancing in leaps and bounds! Sensing trouble, one of the pilots jumped into the silent Beaver, hit the master switch and transmitted a brief warning "Dave, don't take off that way!" By this time, the Skylane was positioned on the threshold of 28 for the take-off roll.

The pilot transmitted back - "I check that".

Almost simultaneously the throttle was closed and the aircraft began to accelerate. Initial relief turned to horror as the huddled group realized that this action was not a high speed taxi but commitment to take-off. The 182 broke ground and had climbed to 250 feet AGL when it entered the fog bank at mid field - the right wing had already dropped as it was engulfed.

Out of sight the engine sounds gave testimony to the remainder of the flight. For several seconds they were normal and then rapidly increased into a shrill crescendo, a brief flutter followed by the final impact. Then silence. The flight had been just under one minute in duration! One of the veteran pilots dejectedly confirmed what the rest feared ...

"He's just killed himself."

A brief search in the mist located the burnt wreckage just a quarter mile north of the departure runway. The pilot's wife and teenage daughters had difficulty comprehending how a beautiful day could turn into tragedy.

Personal Encounters

As a family physician, aviation medical examiner and active pilot with 28 years of flying experience, I have some understanding of the factors involved in this preventable accident. A review of my of log books brings to vivid recall my four encounters with the terrifying condition that resulted in this crash:

1. February 26, 1975 - Student pilot. Entered snow squall with instrument conditions east of Pitt Meadows Airport. Solo, 30 hours total time, instrument time - nil. Inexperience with deterioration from VFR to IFR conditions.
2. August 21, 1977 - Private pilot. Encountered instrument conditions in heavy rain east of Denman Island on flight from Comox to Pitt Meadows. 320 hours total time, instrument time - 13 hours (Hood). Wife and two daughters. "Gethomeitis" with rental aircraft. Marginal VFR

3. July 17, 1978 - Private pilot. Inadvertently entered cloud over Bowen Island in VFR conditions on flight from Pitt Meadows to Comox. 390 hours total time, instrument time -24 hours (Hood). Wife and two daughters. Visual illusion of cloud proximity. Wife did not fly with me for the next 20 years!
4. August 6, 1982 - Commercial pilot. **Flew into a fogbank** departing Ocean Shores, WA, for Newport, OR. 790 hours total time, instrument -32 hours (Hood). Flying partner with one child each. "Gethomeitis".

In three of these situations, VFR conditions were forecast when IMC was encountered. After which aircraft control was in doubt if it existed at all. There is only one reason that I am on this side of the twilight zone to take pen to paper - blind unmitigated LUCK. I hope that other pilots can learn from my past errors as they may not get four kicks at the cat. — The American student had less than one.

Definition and Impact

Each of the above scenarios has a common flight phenomenon - SPATIAL DISORIENTATION.

Disorient means to mix up; confuse; to cause to lose one's sense of direction, perspective or time. Spatial disorientation is the loss of position sense in relation to the earth's surface. In the aviation environment, the ultimate consequence is loss of control with the terminal maneuver being a spiral dive - often vertical or inverted! To the accident investigator, the telltale signs of a disorientation accident site are obvious - one of high speed impact with or without control or in-flight structural failure. (Illustration 1).



1. Twin Otter – Controlled Flight into Terrain (C.F.I.T)

The fatality rate for a disorientation mishap is 90% or greater. As a physician this is similar odds to giving a patient a positive HIV laboratory result or biopsy for carcinoma of the pancreas or ovary. The difference being the time to the terminal event and that with understanding and insight, the disorientation accident is preventable. **No pilot, student, private, commercial, instrument, float, aerobatic, military or air transport rated is immune to this deadly phenomenon!** It is difficult for the landlubber or uninitiated aviator to comprehend the danger of pressing on from visual to instrument conditions.

The Transport Canada Safety Bulletin - Take Five for Safety, entitled "178 Seconds" describes the typical scenario of scud running. It refers to the University of Illinois research project set up to determine how long non-instrument rated pilots take to lose control of their aircraft in simulated instrument conditions. The range was 20 to 480 seconds with an average of 178 seconds! Once in instrument conditions their average lifespan was just under three minutes - of the 20 students all eventually lost control.

Several years ago on an instructor re-ride, Roy Israel gave me an in-flight demonstration that is nauseatingly vivid to this day. He mimicked the flight control inputs and gyrations of a recent commercial pilot candidate flying straight and level under the hood. The initial transgression was a gentle right spiral dive, then a brief correction to straight and level. Next the nose came up and we rolled left and into a spiral dive that was near vertical with alarming speed. It was all we could do to throttle back and recover before the engine redlined. My mouth was dry and heart raced as my mind drifted back to 1978 and Bowen Island ...

The weather for this flight from Pitt Meadows to Comox Airbase was VFR as forecast with residual cumulus over Howe Sound and the North Shore mountains. The trip was uneventful as we droned westward toward Bowen Island. A cloud bank over the mainland did not appear to be a problem.

POOF! Instant gray, uniform and everywhere. No horizon, mouth dry, fast pulse. Wife, stone silent. Oldest daughter in the rear seat, a seasoned aviator “Daddy, it’s foggy outside.” A quick look left then right, still no horizon. A swivel over both shoulders and still no outside reference. The engine droned on but my brain says we’re suspended in time and space. A voice inside my head shrills “Jack, you are in deep shit!”. Check the flight instruments. Impossible! We entered this mess straight and level and my mind and body feel the same, but the airspeed indicator is unwinding through 50 knots and the attitude indicator shows the little aircraft profile in a nose up and right bank attitude. Unusual attitude with a stall seconds away! Recover, nose down and level the wings. Turn to reciprocal heading and wait and wait and...Time stands still, loses all meaning. Then POOF! English Bay, anchored freighters and a natural horizon! The rest of the flight was uneventful.

This brief insightful encounter with disorientation made me an instant believer of its deadly peril. I was astounded by the rapid transition from controlled flight to an unusual attitude in mere seconds. Contributing factors included surprise, distraction and the surreal world of instrument conditions. Under these conditions, 24 hours of hood time was almost not enough to survive. There is no doubt that in cloud experience is invaluable. The importance of recognizing and recovering from unusual attitudes was driven home as was the pre take-off setting of the heading indicator for the reciprocal turn. In retrospect, I did commit two errors: The turn, rather than rate one (3° per second), was a steep aerobatic fighter pilot variety and to the right towards the concealed peak of Bowen Island. I will never know how close we came to terrain and I don’t care to. There was a touch of panic and the adrenalin was flowing hot. But we survived to fly another day!

It is difficult to describe the emotional and physical reactions in this situation. During my lifetime, I have encountered several life-threatening crises. These include personal health (subarachnoid hemorrhage), fishing, logging and aviation adventures. In aviation, a close encounter with another aircraft always results in a strange metallic taste in my mouth — The taste of raw adrenalin. However, the absolute dysphoria and terror of spatial disorientation is by far the worst and for many pilots the last they will experience. One of my sage flying instructors, John Brongers, put this into perspective after I recounted to him my Bowen Island fiasco –

“Jack” he asked, “If I was sitting in the right hand seat, instrument rated, and told you I could fly you out of this mess, would you sign this blank cheque?” I responded “Yes, immediately!” The amount was immaterial and the recipient could have been the devil himself. I call this “Lotto Equivalent” dysphoria. It is hard to convey to the non-aviator the intensity of the mental anguish.

Orientation Senses

Understanding disorientation and the human frailties that contribute to this seductive siren are essential to a pilot’s longevity. God graced us with legs to travel the earth’s surface. He did not fit us with wings for good reason. Three senses interact to keep us upright, feet firmly planted on terra firma - vision (eyes), proprioception (“seat of

the pants”, pressure sensing organs in the skin and joints), and vestibular (balance apparatus in the inner ear called the semicircular canals). Blindness is a disability but not incapacitating as the remaining two senses compensate with the aid of touch and hearing.

Once airborne the rules change dramatically with the two fallible senses, proprioception and vestibular being negated. **Vision rules supreme as the only reliable orientation sense once the aircraft abandons the earth’s surface.** Remove the natural horizon, ignore attitude instruments and your lifespan is reduced to an average of three terror filled minutes!

There are certain natural phenomena and emergency situations which may deprive a pilot of his/her vision. The brilliance of the low setting sun can temporarily blind a pilot as he/she flares to land. A windscreen covered with ice or oil from a failed engine can severely restrict visibility. Smoke in the cockpit from a combusting bird’s nest or an oil starved engine can have serious consequences. On one occasion a combination of sweat and suntan lotion led to my temporary visual loss while taking off a Super Cub on floats from Powell Lake. I was fortunate to stagger into the air without digging a float or striking surface debris. Had I been unsuccessful, accident investigators would never have deduced the cause of the accident A direct bird strike on the windscreen can result in catastrophic visual impairment with plexiglass fragments, blood and feathers. Chick Childerhose in his book “Wild Blue” recounts Syd Burrows’ encounter with a bird while flying a Sabre jet. He was awarded the Air Force Cross for getting this aircraft back to base despite serious orbital trauma. To date I have not heard of an accident resulting from inadvertent release of bear spray in the cockpit of a floatplane or helicopter. Hopefully wise cargo storage will prevent such a disaster. Vision and aircraft control go hand in hand.

Pilots should be aware that spatial disorientation can be one of three distinct types — each just as seductive and deadly.

Type I Disorientation - Unrecognized

Unrecognized spatial disorientation (Type I) describes a situation wherein the pilot is disoriented but is **unaware** and controls his/her aircraft using false sensory information. This may occur in visual or instrument conditions. There is little room for humour in dealing with this topic but the attached cartoon gives some insight into the mindset of disbelief when one is confronted with the stark reality of nature’s deceptive ways. The vultures anticipate lunch while the flight crew motors on unaware. They will not walk away from their controlled flight into terrain (CFIT).(Illustrations 2)

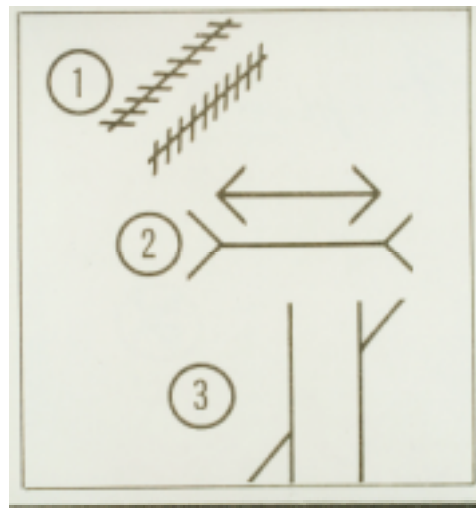


2. Avoid Marginal VFR

As an Aviation Medical Examiner, I am very much aware of the importance of vision in pilot fitness. The medical examination includes distant, near, colour and peripheral vision testing as well as eye movements. The results tell me if a pilot can assimilate information from his/her environment and charts to navigate and avoid other aircraft on a collision course. It does not tell me his/her ability to correctly interpret what is seen. Perfect vision is not infallible. Visual illusions are the most common factor contributing to Type I accidents. The pilot misinterprets what his/her eyes see often with deadly consequences.

Many of us have experienced visual illusions while driving our automobiles. Driving in a mountain pass I have been puzzled by the unexplained deceleration as I am descending. The reality is I am climbing a grade. At an intersection I have jammed on the brakes as my vehicle starts to roll backward. The reality is the adjacent car is edging forward. My interpretation and reaction are in error. In a car wash the sensation is one of a stationary vehicle and moving brushes when the reverse is true. I always experience a sense of uneasiness as reality is declared and my mind and body reorient.

If you have not experienced the above and believe you are infallible, here are several textbook examples to play with: the first diagram (Illustration 3) has three figures that demonstrate how easy it is to deceive our eyes. The first two lines are parallel (1), the second two are equal in length (2), and the last two are in alignment with each other.



3. Illusions – 3 Classical

The next figure (Illustration 4) is a vase or two opposing facial silhouettes. Then there is the etching of the lady, young or elderly (Illustration 5) – both are looking to the left. The nose of the old lady is the cheek of the younger.



4. Illusion – Vase/Two Face Profiles
Psychology Today-An Introduction
- Author: R. Bootzin



5. Illusion – Old Lady/Young Lady
Psychology Today-An Introduction
- Author: R. Bootzin

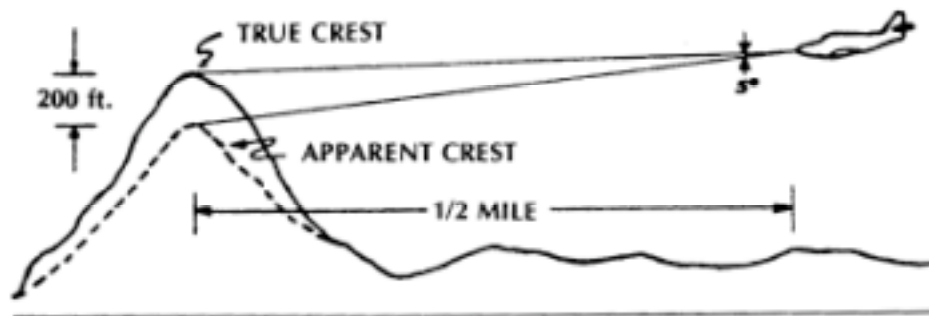
The next example is a bit more challenging (Illustration 6). There is a Dalmatian dog facing left and sniffing the ground, or is it a snowfield with rocks exposed? This brings to mind an experience I encountered while driving in Cypress Bowl with my family on a Sunday afternoon. Rounding a corner we were mesmerized by a half dozen skydivers silhouetted by snow and clouds. I pulled to the side of the road to observe their descent. The moment the car stopped, reality hit home. The parachutists were bare rocks in a snowfield. We had been deceived by a complex visual illusion of snow and rock with the motion of cloud and vehicle. In an aircraft there would have been time to bank and avoid a skydiver and fly headlong into an invisible snowbank!



6. Illusion - Sniffing Dalmatian
Psychology Today-An Introduction - Author: R. Bootzin
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Visual illusions encountered in flight deserve special consideration to increase awareness and avoidance of Type I disorientation. There are many variations of these themes and some quite likely unreported as the pilots involved did not survive to share their experience. Their last voiced words would have been “That’s bizarre!” or “What the” Here are some well described variations.

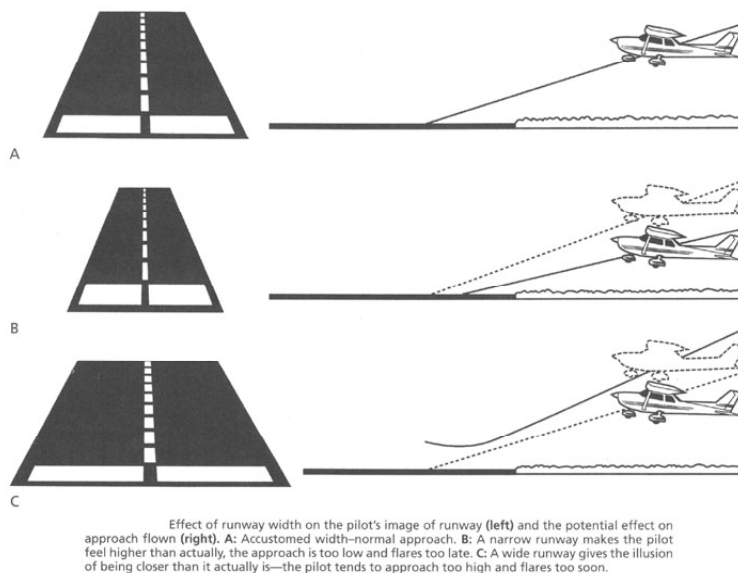
Heavy rain causes light refraction (Illustration 7). This can lead to approaching obstacles appearing lower than they actually are. The potential risk is a C.F.I.T. accident or undershooting the approach in a heavy rain shower.



7. Hazards of Flight in Rain

Relative motion of the aircraft over the earth's surface can be misleading when strong winds are encountered while maneuvering at low altitude. All pilots should have had this demonstration as students with Exercise 20 - **Illusions Created by Drift and Low Flying**. The danger is twofold -first with a strong tailwind comes an inherent tendency to throttle back to compensate for the increased ground speed. The illusion comes with the pilot's brain equating ground speed and air speed. Low air speed and altitude leave little room above the stall for gusts and distraction. The second set up comes with course reversal from into to downwind. In the coordinated turn there is the illusion of a slip. The tendency is to skid with uncoordinated rudder. A tried and true "method" for inducing an incipient or full spin - not a healthy low level maneuver!

Runway size, slope and approach environment can add some interesting twists. A shorter narrower runway than the pilot is accustomed to can result in a higher than standard approach illusion resulting in an undershoot (Illustration 8b)The converse situation, with a longer wider runway (Illustration 8c) gives a lower than standard approach illusion leading to an overshoot or high flare in the landing configuration. During daylight the pilot has other visual cues to alert him/her to overcome the dangers of these illusions. Night flying has its perks but the risk of disorientation with these illusions is much greater.



8. Runway Width Illusions Courtesy of Allen J. Parmet, M.D.

My introduction to visual illusions came on my first dual night cross-country trip from Pitt Meadows (runway dimensions 75' x 2500') to Victoria (runway dimensions 200' x 9000'). A flawless flight came off the tracks with a touch and go approach to runway 27 at Victoria. Throttled back I gradually raised the nose of Fleet Canuck CF-HHE to a perfect three point landing - in my mind's eye. In the right seat hovered Jim Hora, my cheerful and resourceful instructor. I was puzzled by his increasing agitation. Unable to restrain himself any further, he leaned over and shouted in my ear

“Jack, are you trying to kill us? We are 50 feet in the air!”

So we were and on the verge of a power off stall to boot. With judicious power and lowering the nose, the landing, HHE's bungee cords and my crumbling ego were salvaged. Lesson learned, stored and remembered.



**9. C-FIKO Pitt Meadows – Night CFIT
South View from Float Dock**



**10. C-FIKO Pitt Meadows – Night CFIT
North View to Threshold Rwy 36**

The sensation of landing on a lit runway at night has been compared to landing in a **black box**. This is especially true when there are no approach lights or vertical approach slope indicator lights (VASI) to guide the unwary pilot to the threshold. These conditions existed one night when a pilot approached over the Fraser River to land on runway 36 at Pitt Meadows. The accompanying photos (Illustrations 9 & 10) indicate that the flight terminated in an abrupt undershoot. The distant photograph (Illustration 9) shows a slash in the tree line just left of centre. Collision with treetops resulted in abrupt loss of control and impact with a stationary log boom. The pilot survived without serious injury to be rescued by a passing tugboat several hours later. One of the 10% or less to walk away or be carried alive from the scene of a disorientation accident.

The crews of two Canadian Forces C-130 Hercules aircraft were less fortunate. The first came to grief on January 29, 1989 at Fort Wainwright, Alaska. During a stabilized night Ground Controlled Approach (GCA) in ice fog the crew encountered the black hole phenomena on short final and descended below the descent profile. Illustration 11 indicates that the aircraft was too low to initiate the landing flare as evidenced by the foreground impact print. The veteran flight crew survived and was incredulous that its senses had been deceived.

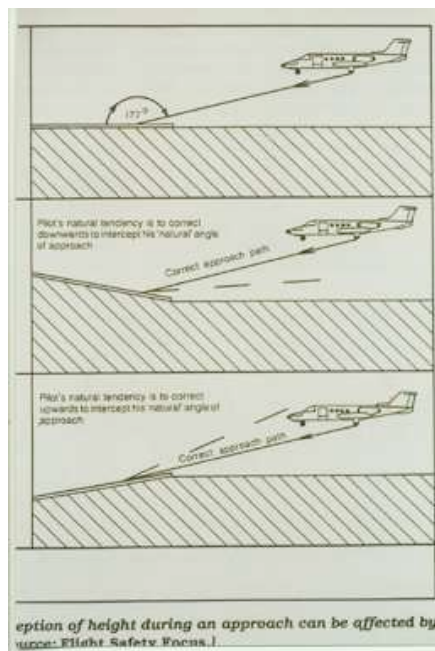
The second accident occurred on January 31, 1991 during a night visual approach into Alert, NWT. A combination of loss of situational awareness and black hole phenomena resulted in terrain contact within sight of the airfield. The tragedy of this accident and the heroic rescue are chronicled in Robert Mason Lee's 'Death and Deliverance'.

When flying at night the pilot should be aware that when flying towards lights they should always become brighter and clearer. Fading or flickering lights should raise the alarm of trouble ahead. This is an indication of deteriorating weather or obstacles such as hills, trees, or wires on the flight path between the touchdown point and the aircraft. This calls for an immediate full power climb and/or course reversal. Keep in mind that clouds at night may be invisible until you find yourself in sudden unexpected IMC!



11. C-130 Hercules – Black Hole Phenomena

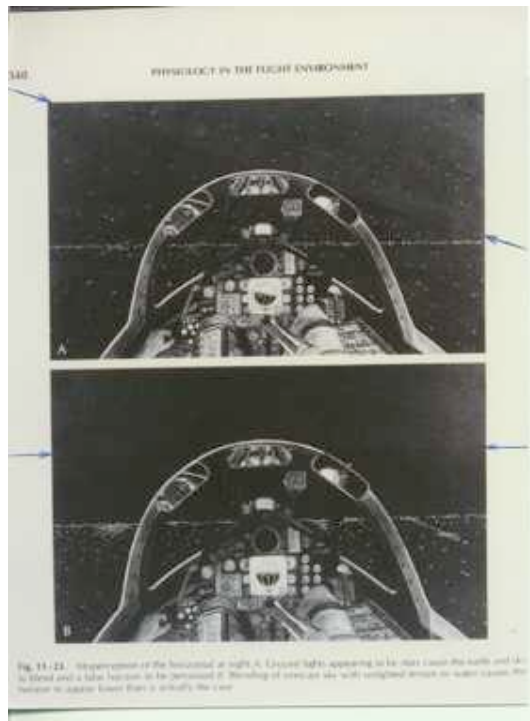
Landing on a sloping runway can also lead to dangerous illusions. The pilot attempts to maintain **the same approach angle** as with a level runway surface. With the downsloping runway this leads to a steeper approach angle and increased airspeed leading to an overshoot or runway overrun (Illustration 12)



12. Sloping Runway Illusions

The upsloping runway leads to decreased airspeed and undershoot tendency. The latter scenario is double jeopardy at night if the runway lacks VASI. The first indication the pilot may have that something is amiss is that unsuspected jolt of initial contact with trees or turf. GOTCHA....

Stars and ground lights at night can lead to a myriad of illusions that can seduce the unwary pilot caught ignoring his/her flight instruments. The attached illustrations give two such examples (Illustration 13) The upper pilot's mental image is one of straight and level flight – but he/she has substituted the real horizon with a lit street. A look over the shoulder at the attitude indicator reveals an insidious left spiral dive (arrows mark the real horizon). Without recognition and prompt recovery, impact would occur shortly after passing the street. The lower pilot is wings level but in a descent as he/she is oriented with a lit shoreline and not the natural horizon. Past the shoreline his/her lifespan will be reduced to seconds unless a quick glance inside the cockpit reveals the crazy unwinding altimeter.



13. Stars and Groundlights Illusions, Arrows Indicate Real Horizon
Courtesy of Allen J. Parmet, M.D.

Float flying has always been one of my aviation passions (Illustration 14). The natural beauty and solitude are unparalleled. But it can be risky business as the scarcity of rental floatplanes and exorbitant insurance rates attest to. One of the reasons for this is the alluring tranquillity of **glassy water** conditions. Every float plane student receives special instruction on the landing techniques to minimize the risk of this treacherous set up. Despite this, the following accident description occurs with undue frequency: Sea plane approaches to land, fails to flare, digs float tips or nose, flips inverted and sinks to the float bottoms. Pilot and passengers often succumb to impact injuries, drowning or hypothermia attempting to reach shore *sans* life jacket.



14. Super Cub – Chilliwack Lake

How can this be possible? The answer is spatial disorientation due to visual illusion. If you have ever walked nose first into a spotless plate glass door or window, you have experienced the shock and unpredictability of glassy water. The two pictures of a Supercub on Clowholm Lake give some idea of the ambiguity of glassy water (Illustration 15a & 15b). Photo 15a is reality while photo 15b is the same picture inverted. Under these conditions the ability to judge height for the touchdown is virtually impossible.



15a. Super Cub – Clowholm Lake- Reality



15b. Super Cub - Clowholm Lake-“Inverted Flight”

One afternoon while daydreaming on our sundeck, comprehension hit me: why birds fly into windows and float pilots succumb to glassy water. Different lighting conditions produced totally different pictures (Illustrations 16 & 17). In one, the light penetration was complete, revealing the house interior or the equivalent lake bottom. The other had almost complete reflection of light, giving a near perfect mirror image of trees or sky. In each picture, the deadly interface is invisible – for the birds: the glass pane, for the pilot: the glassy water surface.



16. Living Room I (Interior)



17. Living Room II (Reflection)

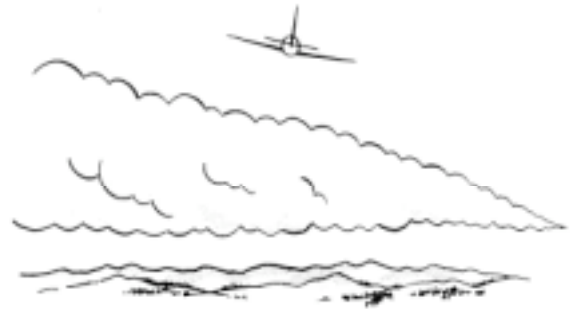
The words of wisdom of my flamboyant float instructor, Jean Marc Ranger, to tackle this hazard will always be

with me - flare at a set altitude over the shoreline, power-assisted descent in the landing attitude, focus on the distant horizon for reference, and **never never** look down until the floats are solidly on the water surface.

Sloping cloud layers can be a source of disorientation for pilots VFR on top or in IMC between layers (Illustration 18a and 18b). The tendency is to align the wings “level” with the **false horizon**. The risk of losing control increases when cloud is entered in a banked attitude. Any attempt to stop descent by pitching the nose up will progress insidiously into a spiral dive.



18a. False Horizon-Pilot's Perception



18b. False Horizon - Reality

Under certain conditions of diverse light refraction and terrain absorption, IFR conditions prevail even though ceiling and visibilities are well in the VFR domain. The result is an indiscernible horizon and/or lack of ground shadows or contrast. This condition may be described as **whiteout**, **greyout** or in one case I have encountered – **blueout** (Illustration 19).



**19. Lake Manitoba, Blueout with smoke
Horizon Mid Strut**

Accidents are often of the C.F.I.T. variety and have involved highly experienced Air Transport crews. For example, the Air New Zealand DC 10 crash in Antarctica. In this condition, the pilot has difficulty judging distance for obstacle clearance or height to assess the landing flare. In Illustrations 20 and 21 some insight is gained in the difficulty of judging distance when flying into white out conditions.



20. Super Cub - Whiteout



21. Cessna 206 - Whiteout

The two views of Manila Harbour contrast safe VFR and risky greyout conditions. (Illustrations 22 and 23)
 In the first picture the horizon is obvious. In the second, the breakwater on the right will be the pilot's last contact with reality. For the VFR pilot, survival comes with course reversal before passing the last visual reference and plunging into the gray void beyond. The alternate accident scenario for this condition is loss of control when course reversal is made in IMC. In the turn the VFR pilot is distracted from instrument indications of a descent while struggling to regain outside visual reference. Unexpectedly, the low wing contacts invisible terrain and the aircraft cartwheels. Survival comes with avoiding this hazardous gold fish bowl with early course reversal or an instrument monitored rate one turn to a reciprocal heading if it is unexpectedly encountered.



22. Manila Harbour I, VFR with Horizon



**23. Manila Harbour II,
Marginal VFR to Breakwater, IFR beyond**

A relatively new visual illusion was described by a S.A.R. helicopter crew that was investigating the crash of a S.A.R. Twin Otter that had impacted a sheer mountain face while involved in a search for a lost aircraft. When simulating the flight path of the Twin Otter in identical weather conditions, the helicopter crew observed the illusion of an empty valley ahead. The sun was low behind them creating a **mirror effect** with the sheer face. Low airspeed and greater maneuverability saved them from a similar fate. This condition could be considered the wheel pilot's glassy water equivalent. It is quite likely that many other undescribed visual phenomena exist but as yet have not been described as there were no survivors from the resulting accidents. Dead men tell no tales!

Type II Disorientation – Recognized

Type II or recognized spatial disorientation is most often associated with the accidents that inevitably occur when

the VFR pilot pushes his luck into the subtle but deadly I.F.R. environment. The pilot is disoriented and **aware** of the fact, but for reason of lack of instrument proficiency or vestibular (inner ear) or proprioceptive (seat of the pants) illusions is unable to believe the attitude instruments. Loss of control is inevitable. - 178 seconds and counting!

The non-aviator may have experienced similar sensations while driving a vehicle in heavy drifting snow or operating a boat in fog. Time and distance are distorted. There is the option of stopping at the curb or dropping the anchor to await improving weather conditions. The aviation equivalents include cloud, fog, starless night, whiteout or grayout - unfortunately there is no easy out other than a personal or ballistic parachute and often insufficient time or presence of mind to activate the device.

Once in instrument conditions the VFR pilot does not have the training or discipline to cope with loss of the natural horizon. Smooth transition to instrument flight is most unlikely. Visual input is rapidly overcome by illusions of vestibular or proprioceptive organs. A gentle yaw or roll below the threshold of these organs leads to an unperceived bank and an insidious spiral dive develops. Back pressure on the control column mimics gravity in the pilot's buttocks. His brain interprets an illusion of pitching up the nose in relation to the natural horizon. Reality is steepening of the spiral with rapid progression to inverted flight and vertical descent!

It is difficult to accept that without visual reference to the natural or instrument horizon, the other two senses cannot be trusted to maintain orientation. Acceleration without monitoring the attitude instruments gives an illusion of the nose pitching up. The pilot compensates by pitching the nose down. - a dangerous reaction when taking off on a dark featureless night. The end result is an unexplained accident with the aircraft impacting terrain on take-off.

With deceleration the process is reversed with the illusion of the nose pitching down and the pilot reacting by raising the nose of an already slowing aircraft. A setup for a stall and spin in IMC.

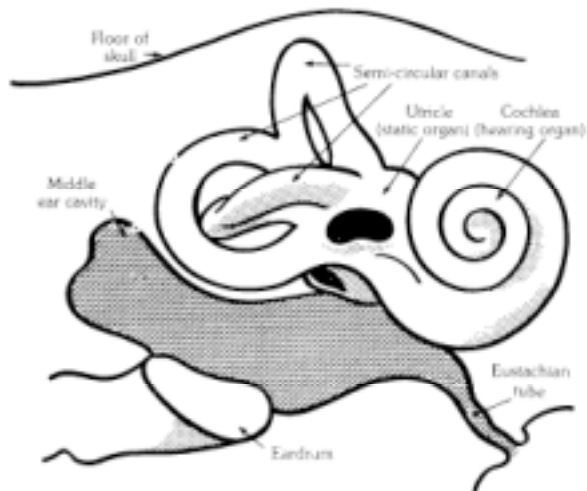
The proprioception and vestibular organs are sensitive to initial linear acceleration or deceleration and angular acceleration (turning). For example, they would be stimulated with the spin entry. However, once a stabilized state is established in the spin after several rotations they signal the brain that all is well. - i.e. straight and level flight. This is hard to believe but air transport pilots have spun into the ground while debating instrument discrepancies. To convince yourself, try this with another pilot flying at a safe altitude. Look down at the floor prior to spin entry or close your eyes. After several revolutions you will have no sensation of spinning. It can be quite shocking when you look up or open your eyes. Have a barf bag ready just in case!

When descending out of a cloud in a spin, the visual shock may be overpowering and prevent the pilot from regaining control of the aircraft.

Type III Disorientation – Vestibulo-ocular Disorganization/Incapacitating

Fortunately Type III spatial disorientation or vestibulo-ocular disorganization is a rare variation. In this type, the pilot is **aware** that he/she is disoriented and is **unable to control the aircraft** because **reflex eye movements prevent instrument interpretation**. My nickname for this is “Tits up” disorientation - chances of survival are remote with salvation being an ejection seat or a deep belief in the Lord! The sensations of this type can be mimicked by rolling down a grassy hill. The resulting intense vertigo (spinning) makes walking a straight line impossible. Controlling an aircraft would be out of the question! Viral infection of the inner ear organ (labyrinthitis) can also result in vertigo with associated nausea. This condition can complicate a viral upper respiratory infection (common cold), one of the reasons for grounding yourself until fully recovered.

Type III spatial disorientation can also be induced by the pilot in-flight. This condition is called the **coriolis effect**. It results from simultaneous stimulation of two or more of the semicircular canals in the inner ear (Illustration 24) This can occur in IMC when the pilot initiates a turn and simultaneously looks up or down with head movement. The stimuli to the brain are overpowering and produce a tumbling sensation. Rapid reflex movements of the eyes (nystagmus) makes instrument interpretation and aircraft control impossible. Prevention comes with a disciplined instrument scan - eye movement only. By holding the head still, only one set of semicircular canals is stimulated by the rolling movement of the aircraft - Vertigo and nystagmus are averted.



24. Vestibular Apparatus of the Inner Ear with 3 Semicircular Canals

It is quite possible that more than one type of disorientation may come into play in an accident. A pilot suffering from unrecognized spatial disorientation (Type I) may receive an altitude alert from a vigilant air traffic controller. Distraction or fixation may result in progression to recognized (Type II) disorientation as instrument skill deteriorates. Over-controlling the aircraft and sudden head movement in search for the elusive runway environment may induce the coriolis effect (Type III). The odds of survival in this escalating scenario would be close to nil!

Contributing Factors and Prevention

Several factors can contribute to the likelihood of a pilot becoming spatially disoriented. There is usually an element of surprise and unpreparedness as the VFR pilot stumbles into instrument conditions. Fatigue and distraction will render him/her less vigilant to external visual cues of deteriorating conditions. Anxiety can rapidly escalate to a panic state when the outside world disappears. With panic goes any semblance of problem solving - key to survival. Alcohol consumption is still found as a culprit after the dust and smoke have settled. It impairs judgement, concentration and coordination required to maintain aircraft control in IMC. Even the hangover state can last several days after binge drinking with impairment of the vestibular apparatus, resulting in unpredictable vertigo, nausea and vomiting. Several years ago one of my favourite Fleet Canucks, CF-DPN, was lost along with the lives of a young student pilot and his friend. The accident occurred at night with low ceiling and visibility. In their car was found a partially consumed bottle of hard liquor! The student had ceased training due to a medical condition. The aircraft was removed without permission and one of the occupants was not wearing a seat belt or it failed on impact - a stacked deck with disorientation holding the "winning hand".

The common cold or upper respiratory tract infection can lead to distraction with pain from pressure changes in the middle ear or sinuses. The unpredictable onset of intense vertigo with inner ear involvement would result in instantaneous incapacitation (Type III spatial disorientation). Lack of current instrument training may lead to a false sense of security when instrument conditions are encountered. In these conditions, the VFR pilot struggles to maintain control. The current IFR pilot has demonstrated his/her ability to maintain control, recover from unusual attitudes, navigate, communicate, deal with instrument failures, aircraft emergencies, enter and fly a holding pattern, maneuver to minimums on an instrument approach, and fly to an alternate airport in IMC. Without currency training, these skills rapidly deteriorate.

With a flight condition having such a high fatality rate, insight, avoidance and prevention are key to longevity in aviation as a recreational pastime or career. Weather smarts with sound decision-making in the go/no go scenario are critical survival tools. The accident chain is broken when the decision to abort or divert a flight is made before IMC is encountered. A VFR pilot receiving a briefing of marginal VFR or IFR conditions for the intended route or an en route update of unforecasted deterioration at destination, is well advised to stay on the ground or press plan B into action. Every airborne pilot should have a plan B. Keep in mind it is always safer to land an aircraft under some semblance of control. The picture of the Cessna 172 on the Hope-Princeton Highway epitomizes the off airport landing. (Illustration 25 & 26). Caught between cloud layers just east of the Hope Slide, the pilot made the best of a tough situation landing under control on the highway. The flashing lights of the RCMP cruiser and illuminated navigation lights and anti-collision beacon are indicative of the adrenalin levels involved. The other photo shows that the pilot would have been playing Russian Roulette with mountainous terrain, in a 360 degree radius, had he pressed on.



**25. Cessna 172, Hope-Princeton Highway –
The Ultimate VFR – Off Airport Landing**



**26. Hope-Princeton Highway, Same View
- 360 deg. Of mountainous Terrain**

“Gethomeitis” is a term that often comes into play with spatial disorientation accidents. It refers to the psychological pressure perceived by the pilot. It may be externally or internally applied. Whenever there is an urgency to complete a flight for personal or business reasons, and you start to lower your personal weather limitations - beware! The next link in the accident chain is this statement, “Let’s take off and have a look, we can always come back to the airport” - CLANG - the trap is set! Once airborne, IMC may be encountered in the climb out and the safe sanctuary of the departure runway vanishes. I refer to this mind-set as the Horniness Index or the Testosterone Factor. For some reason, this accident sequence is more prevalent in young male pilots. Remember it is always safer to be on the ground wishing you were in the air than vice-versa.

If at all possible, fly towards a confirmed natural horizon, avoiding cloud banks, mountains and water surfaces with indefinite horizons or surface features. Visual illusions may lead to inadvertent cloud penetration or a C.F.I.T. accident. If in doubt of visual clues, resort to the “180° Rule” and reverse course to better weather and positive visual references. This is much safer than pushing on until outside reference is lost.

When I obtained my private pilot’s license instrument flying was not included in the syllabus. Now it is, as well as with the night rating and commercial license. This experience provides the pilot with the ability to fly straight and level, recover from unusual attitudes, turn 180° and perhaps penetrate a thin cloud layer - that’s it! This skill is maximal at the time of the flight test and rapidly deteriorates thereafter if not practiced. During my early instrument training I was not introduced to the helpless sensation of spatial disorientation. On a recent IFR training flight, my keen young instructor, Andrew Soltau, provided two graphic demonstrations. After one hour of hood time flying approaches into Abbotsford, he informed me that we were going to do something different. The medical resident plugged into the back seat intercom was witness to my performance. The first demonstration was for me to fly straight and level with the hood on while looking at the cockpit floor. Using the sunlight and other senses I did

quite well. After several minutes Andrew told me to look up and reorient myself. Not bad, down several hundred feet and 20 degrees off my original heading. My bubble burst when Andrew informed me that I had completed a 380 degree turn. Incredible, but the grinning resident in the back seat affirmed Andrew. The second demonstration was more graphic and came to a rapid conclusion. Andrew's instructions were simple. - With the hood off, close your eyes and open them when you know you have lost control. My estimate was 15 seconds before the engine's shrill pitch and air frame vibration signaled the increasing spiral dive. Opening my eyes I saw only earth - no sky, no horizon. After recovery there was no need to glance back at the resident. I would recommend these humbling demonstrations to any candidate – **student to IFR**, who has not experienced the sensation of spatial disorientation. It goes without saying that a safety pilot or instructor is essential!

A current instrument rating is good insurance against a disorientation accident but not a guarantee. Several scenarios come to mind of IFR drivers coming to grief. A typical example is a non-precision approach with circling procedure. During the circle to land visual reference is lost but the pilot pushes on in low level I.M.C. rather than carrying out the missed approach procedure. The fatal Metroliner accident in Terrace, BC highlights the risk involved. During night operations, the risk of circling procedures goes up almost exponentially! IFR pilots are also prone to C.F.I.T.(Type I) accidents. The cause may be a simple oversight such as failing to set the altimeter before commencing the approach or identify a navigational aid. The former resulted in the loss of a Medevac Lear jet in the chilly waters near Massett, BC. There were no survivors among the flight crew or medical personnel . On an IFR flight test there are several critical safety checks which if omitted will result in automatic failure. In the real world of IMC similar omissions can have dire consequences! Since obtaining an IFR rating in 1989 I have managed to minimize the adrenaline rush experiences of spatial disorientation. My personal limits are well above those in the Canada Air Pilot and I have a total aversion to freezing rain and thunderstorms.

Survival Strategy

If a VFR pilot follows all of the preventative guidelines but still finds him/herself up to his/her neck in instrument conditions, is there any hope of survival? During my years as an Aviation Medical Examiner, I have heard some fascinating anecdotes. One private pilot en route to Tofino inadvertently entered a band of cumulus clouds near Nanaimo. After a roller coaster ride of terror lasting close to 45 minutes he and his passengers were spit out near Courtenay - a little older and infinitely wiser!

The real champion was a student pilot flying out of Bellingham, Washington. He was climbing out on a solo VFR flight to Oregon. Just above circuit altitude he entered cloud. Aware of the risk of adjacent hills he elected to climb. At 4000 feet he broke out into brilliant sunshine, in an extreme banked attitude. After regaining control and his composure he notified Bellingham Tower of his predicament. - Cloud below as far as the eye could see!

After orbiting for several minutes he was handed off to Vancouver ATC. A calm voice provided radar vectors northward along the invisible coastline. At a break in the cloud he transmitted his intention to descend but was advised against this by ATC as airliners were passing below cloaked in cloud. Eventually he was guided to a cloud break over Georgia Straits and authorized to shuttle down below the overcast. He then navigated VFR back to Bellingham for an uneventful landing and the undeserved wrath of his instructor.

Survival is possible as demonstrated by this fortunate young pilot. He did everything right and did not lose control of his aircraft despite a prolonged climb in total instrument conditions.

The first hurdle will most likely be recovery from an unusual attitude - Spiral dive, departure stall or even a full spin. Next will be your total trust in the visual interpretation of the flight instruments. If there is a discrepancy, revert to the most trustworthy limited panel (turn and bank indicator, altimeter, airspeed indicator, vertical speed indicator and magnetic compass). If there is risk of icing turn on the pitot heat and activate the alternate static source. Scan with your eyes and avoid sudden head movements (coriolis effect). Unless turning, keep the wings absolutely level. (no bank, no spiral dive). Maintain directional control with gentle rudder adjustments. Trim for level flight and use the control column as little as possible. Declare an emergency! You need all the help you can get, but you have to fly and maintain control of the aircraft. That is your key to survival. ATC can provide vectors to VFR conditions or an airport with Precision Approach Radar. They cannot climb aboard and fly for you. If time permits, slip in a short prayer - it can never hurt.

Thus ends my Personal Survival Kit for Spatial Disorientation. During the writing of this article, a Cessna 182 was lost with four souls near the Coquihalla toll booth. Another VFR flight pushed into IMC! I can only hope that this

information will save some aspiring aviators from a similar fate. As the old adage goes - Learn from the mistakes of others, for you will not live long enough to make them all yourself.

..... THEY BLINKED*

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ILLUSTRATIONS AND PHOTOGRAPH CREDITS & SUBTITLES

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2. Avoid Marginal VFR – By H.L. Townsend, Aviation Safety Officer (February 1992)
3. Illusions – 3 Classical – Aviation Safety Letter (Canada Issue No. 5/86)
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5. Illusion – Old Lady/Young Lady – Psychology Today, an Introduction(3rd Edition, 1975), Reproduced with Permission of The McGraw-Hill Companies Inc.
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REFERENCES

- 1. Armour, Major J. Director of Flight Safety DND, DVD Night Visual Illusions
- 2. Childerhose, Chick. Wild Blue(1978), pp 180-182
- * 3. Coulson, Barry. The Logger's Digest, Vol. 1, pp 17-23
- 4. DeHart, Roy L., Davis, Jeffrey R., Fundamentals of Aerospace Medicine, Third Edition
- 5. Hansen, Bryce W., Flying is Safe – Are You?, Aeromedical Handbook(1980)
- 6. Lee, Robert Mason, Death and Deliverance(1992)
- 7. Lavella, Stoffer, Survival Sense for Pilots and Passengers(1980)
- 8. Psychology Today – An Introduction, Third Edition(1975)