Alaskan Aviation
Fall Safety Seminar
Anchorage
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Flying at Night
Don’t Get Caught in the Dark!

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Eastern Air Lines Flight 401, Lockheed L-1011, Dec 1972

American Airlines Flight 965, B-757, Dec 1995
• National Safety Council motor-vehicle fatality rate three times higher at night than during the day.

• 3X to 4X times higher at night

• NTSB Safety Alerts 2008 and 2013
Flying at Night:
Don’t be Caught in the Dark!

- Ground Operations
- Takeoff & Climb
- Enroute/Cruise
- Approach & Landing

--Landing Illusions
Flying at Night: Don’t be Caught in the Dark!

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Ground Operations

- Reduced Taxi Speed Illusion
  - early B747 incidents
  - reduced “optic flow” at night
Ground Operations

† Geographic Disorientation

• getting “lost” easier at unfamiliar airport
• “sea-of-blue” effect †
Ground Operations

✈ U.S. Runway Incursion Accidents 1990s

• 5/6 major RIs after dark (dusk) in VFR Wx
• 1991 USAir B737 on landing collided with Metro

- 34 people died (worst in US to date)
Ground Operations

Runway Incursion Accidents

• all of these occurred at night in good VFR conditions!

• RI accidents occur in impoverished visual conditions - fog, night, or both

• NTSB’s “Ten Most Wanted” list 1990-2013
Flying at Night: Don’t be Caught in the Dark!

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---Landing Illusions
Lining Up

- Comair CRJ Flight 5191, 2006 Blue Gras AP, KY
Lining Up

• 116 reports 20-year period of pilots taking off from wrong runway

• B737 reached 60 knots on taxiway FOXTROT before RTO at Phoenix Sky Harbor airport

• MD-80 initially attempted takeoff in Las Vegas using runway edge lights as centerline lights!
Takeoff & Climb

✈️ Takeoff into “Black Hole”

• no lights ahead of you - pitch black
  - moonless and/or overcast sky

• 78% fatal night takeoff accidents occur on “dark nights”
Takeoff & Climb

→ False Climb (Somatogravic) Illusion

• somatosensory/vestibular senses give nose-high illusion

- leads to nose-down response →
Somatogravic Illusion

Constant speed

Gravity

Inertia

Accelerating

Resultant

Gravity

Correct Perception of Level attitude

Level attitude

Nose-high Illusion

Level attitude
Takeoff & Climb

The “Dark-Night Takeoff Accident”

- 1996 Part 135 cargo C-402 collided with ground
- 1995 Beech 58 flew into dark water of Lake Erie
- 2003 Cessna 340 in Bishop, CA
- all occurred in VMC on “dark nights”
- known of this for at least 50 years, yet still occurs
Flying at night is no different than flying in the day.

..*except you can’t see anything!*
Flying at Night: Don’t be Caught in the Dark!

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--Landing Illusions
Enroute/Cruise

✈ Weather Detection

- 35% of VFR-into-IMC accidents at night (vs. 10% VFR GA activity)
- Almost 90% fatal yet <20% of all accidents fatal
Enroute/Cruise

Terrain Detection

- 1972, EAL L-1011, Florida Everglades
- 1995, AA B-757, Cali Columbia
- 1991 near San Diego, Reba McEntire’s HS 125
- 2004 air ambulance Learjet

• Darkness one link in causal chain
Night Light Illusions

- Ground lights seen as stars and vice-versa
False horizons

Actual Horizon

Apparent Horizon
Autokinetic illusion

- False perception of a fixed object moving
  - Common with stars

Air Canada B767 pilot mistook the planet Venus for Cargo plane
Enroute/Cruise

✈ Geographic Disorientation

• GA “landing at wrong airport” incidents

  25% at night

• >150 airline flights since early 90s landed or attempted to, at wrong airport
Flying at Night: Don’t be Caught in the Dark!

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- Enroute/Cruise
- Approach & Landing

--Landing Illusions
Fatal Accidents and Onboard Fatalities by Phase of Flight
Worldwide Commercial Jet Fleet | 2004 through 2013

Percentage of fatal accidents and onboard fatalities

<table>
<thead>
<tr>
<th>Phase of Flight</th>
<th>Fatal accidents</th>
<th>Onboard fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxi, load/unload, parked, tow</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Takeoff</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Initial climb</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td>Climb (flaps up)</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Cruise</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Descent</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Initial approach</td>
<td>8%</td>
<td>15%</td>
</tr>
<tr>
<td>Final approach</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>Final approach fix</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>Landing</td>
<td>25%</td>
<td>18%</td>
</tr>
</tbody>
</table>

Exposure (Percentage of flight time estimated for a 1.5 hour flight)

- Taxi, load/unload, parked, tow: 1%
- Takeoff: 1%
- Initial climb: 14%
- Climb (flaps up): 57%
- Cruise: 1%
- Descent: 1%
- Initial approach fix: 11%
- Final approach fix: 12%
- Final approach: 3%
- Landing: 1%

Note: Percentages may not sum precisely due to numerical rounding.
<table>
<thead>
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<th>Final approach</th>
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<td>Initial approach fix</td>
<td>3%</td>
<td>8%</td>
<td>22%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>15%</td>
<td>22%</td>
<td>18%</td>
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</tbody>
</table>

47%

Initial approach fix
11%

Final approach fix
12%

3%

1%
• 39% U.K. fatal approach/landing accidents at night
  – nighttime rate 3X that for day
• US Navy/Marine Corps significantly greater incidence of landing mishaps during evening/night
• ½ of world’s CFIT accidents occur at night
  – 70% of during approach-to-landing phase
Approach & Landing

Runway Identification

• 1992 DC-8 mistook army barrack lights for runway
• Same mistake made by B707 crew 9 mos later
• China Northern MD80 mistook highway for runway

• All these occurred in clear Wx at night!
Visual Illusions on Approach and Landing

A visual Illusion is a misperception of visual reality

What you see is NOT always what you get!
Expectancy

- Sometimes we see what we want to see.
- USAF pilots shoot down 2 of their own helicopters.
- German pilot bombs its own ship.
Geometric Illusions
Many catalogued by artists & physiologists a century ago
Muller-Lyer Illusion. Which line is longer—AB or CD?
Poggendorf Illusion
Is the diagonal line straight?
Ponzo Illusion.
Which horizontal line is longer—top or bottom?
Visual Illusions

- Illusions trick us into seeing something that isn’t there
- Flight illusions occur relatively infrequently but consequences often fatal—by definition they . . .

\textit{deceive} us into believing everything looks fine
Landing Illusions

1. Runway Slope/Dimensions
2. Atmospheric & Runway Lighting Conditions
3. Black-Hole Conditions
Sloped Runways

- Pilots judge approach angle by familiar trapezoidal shape the runway image casts upon their retina
• **Illusion:** low approach

• **Result:** you adjust approach angle to see normal approach image you’re used to

• **Result:** high approach, go-around or long landing & overrun or even stall above runway
• **Illusion:** *high approach*

• **Result:** *you adjust approach angle to see normal approach image you’re used to*

• **Result:** *low approach, premature hard landing or CFIT accident short of runway*
Upsloped Runways

- Deceives both novice and expert pilots

- CAI B767 crew fooled by upsloping runway in Halifax (0.77% upslope) despite mostly red PAPI lights!
Runway Dimensions

- *Relative size*

- object of known size casts a smaller image on our retina, we rightly perceive it as further away *not* shrinking in size
Same runway but smaller retinal image on right. Right one further away.
Runway Dimensions

• Problems occur when not aware of actual size
• High rear-end accident rate for smaller foreign cars when first introduced
  – Drivers mistook them for larger cars that were further away
• Same illusion with varying-sized runways
• Illusion strengthened when L/W ratio same as runway pilot is accustomed to
Two different runways, same proportions (L/W)

- Smaller than accustomed to runway (same L/W)
  - illusion of being further away
  - if perceived as higher, a low approach &/or late (low) flare-out and premature hard landing may result

- Larger than accustomed to runway (same L/W)
  - illusion of being closer
  - if perceived as lower, a high approach & long landing and/or high flare out & possible stall above runway may result

200' x 5,000'
L/W = 25/1

100' x 2,500'
L/W = 25/1
Runway Dimensions

• Factors which strengthen distance illusion
  – Same L/W ratio (proportions)
  – Little or no surrounding context (terrain, man-made features, etc) such as occurs at night
  – The *home-drome syndrome*
Which looks like you are higher?
High approach illusion on runway with greater “L/W ratio” than pilot used to. L/W ratio increases with longer +/- or narrower runways.

Student pilot accustomed to L/W of about 30, hit truck on L/W 70 runway at Sylvania Airport, Wisconsin.
2. Atmospheric Conditions

• *Aerial (Atmospheric) Perspective*

  – Extremely clear air creates illusion of being closer (cold, dry, winter, high mountains)

  – Poor visibility & hazy air creates illusion of being further away ➔
Hazy days can lead a pilot to overestimate a runway’s distance which could result in a higher or lower approach, depending on how this distance illusion is perceived by the pilot.

Extremely clear air (especially at night) can create illusion of closeness leading pilot to underestimate distance. Could result in a higher or lower approach, depending on how this is perceived by pilot.
Brighter-than-normal runway lights look **clearer**, **larger** and **closer** creating illusion of being close.
Dimmer-than-normal runway lights look darker, smaller and further away creating illusion of being further away
3. Black Hole Approach

- *Dark nights* (moonless +/- or overcast sky condition) when little or no surface lights between aircraft and runway environment
- Results in dangerously low approach and has claimed the lives of many pilots
Black Hole Approach

– Sabreliner corporate jet on a visual approach to Kaunakakai Airport in Hawaii

– Part 135 C402 flew into water 3 miles short St. Thomas Airport U.S. Virgin Islands

– Both highly experienced pilots (ATP-rated) > 12,000 hours each
FEDEX Blackhole Approach

July 26, 2002, Boeing 727 struck trees on short final and crashed short of runway 9 at Tallahassee Regional Airport, Florida.
Black Hole Approach

- Kraft and Elworths’ Boeing simulator studies in 1960’s
  - In absence of a horizon at night, pilots tend to fly curved approach in attempt to keep a constant *visual angle* between the threshold lights and surface lights beyond the airport →
Same Approach Angle = Increasing “Visual Angle”
Kraft and Elworths’
Constant Visual Angle Hypothesis

Constant Visual Angle = Curved Approach
• Strengthened by upsloped runway
  – Hawaiian Saberliner and B767 tail strike in Halifax involved upsloped runway in black-hole conditions
  – A *high approach* retinal image adds to black hole phenomenon
• Boeing instructor pilots conducted entirely visual approaches to upsloping runway in black-hole conditions without aid of ILS or altimeter
  – eleven of the twelve crashed short of the runway!
Most visual illusions are **not** due to the physiological limitations inherent in the human eye. *The image on the retina doesn’t lie, but the perceptual interpretation of it does.*
How many cubes?
How many on this one?
Do you see the white triangle?
How about the white square?
Which way is Cube oriented?

Ambiguous visual stimuli *at night*
Which way is the cube oriented?

Our brains try to impose order by trying to match a pattern that it is familiar with.
**Probability**

- “dark night” takeoffs
- VFR-into-IMC+/or terrain at night
- “black hole” approaches
- fatal approach and landing accidents 4X greater risk at night

**Consequences**

- “dark night” takeoffs
- majority of VFR-into-IMC & CFIT fatal
- consequences of engine failure in SE airplane
Strategies to Help You Avoid Falling Victim to Landing Illusions

• Believe they exist & can deceive you into fine
  -- that is why they are called illusions!

• **ALL** of us are subject to illusions

• Understand the nature of these illusions

• Knowing about them isn’t enough
  – CFI in tree-strike incident well aware of the black hole illusion—that is why he elected to fly the approach!
  – As he hit the trees he was “consciously aware of the illusion and trying to correct for it”

• Don’t completely trust your senses—double check your own perception
Strategies to Avoid Falling Victim

**Departure**

- Allow enough time to dark-adapt (avoid bright lights)
- Don’t stare at taxiway centerline when taxiing
- Use A/P taxi diagram (consider progressive taxi instructions)
- Perform “compass check” on every takeoff
- Depart over well-lit terrain
- Use instruments until outside visual cues established
**En Route/Cruise**

- Fly over well-lit terrain (cultural or natural)
- Fly at minimum safe altitudes (MEF, min IFR altitudes)
- Don’t fly in the mountains
Approach & Landing

• Determine beforehand if airport conducive to landing illusions
  – Consult A/FD, NOTAMS, other pilots, to ascertain presence of irregular-shaped runways, sloped runways or terrain, or runways conducive to black-hole conditions
Strategies to Avoid Falling Victim

• Get instruction at airports conducive to illusions (experience reduces home-drome syndrome)

• Avoid long straight-in approaches
  – almost always result in a premature decent, especially at night
  – consider overflying airport before conducting an approach
Strategies to Avoid Falling Victim

- Use runway approach slope indicator aids—especially at night
  - VASI, PLASI, PAPI, T-VASI, etc.
  - visible ≥ 20 miles, safe obstruction clearance only up to +/-10° of extended centerline to 4 NM from threshold
Red over White - You're all right
PAPI: A Pilot's eye view

On Glide Path

Too High
Slightly High
On Glide Path
Slightly Low
Too Low
• Supplement outside visual cues with cockpit aids to vision

  – *Glide path information such as an ILS or DME/Altimeter*

  – 3° glide slope ~300’ AGL / NM from threshold
  – 4° glide slope ~400’ AGL / NM from threshold
  – 5° glide slope ~500’ AGL / NM from threshold

  – a 300, 400, or 500 feet per minute descent at 60-knot groundspeed yields a 3°, 4° or 5° glide slope
PRINCIPLE
1 mile out on final
500' above threshold
60 kts. airspeed
full flaps
14 inches man. press.
500 ft/min descent

1 mile out
500' above threshold is 1900'

1/2 mile out
250' above threshold is 1650'

Runway threshold 1400'

5°

1 mile out
Runway
Visual illusions have duped too many pilots

“Seeing can indeed be Deceiving”

Learning all you can about landing illusions and the steps necessary to correct for them will keep you from being fooled
CATS CAN SEE IN THE DARK...

YOU CAN’T

BE AWARE OF THE HAZARDS OF NIGHT FLYING
Chap 7 “Don’t Be Caught in the Dark”
Chap 8 “What You See Is Not Always What You Get”
Thank You!

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