Savannah River Remediation
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HISTORY OF CAUSAL ANALYSIS – TWO AVIATION CASE STUDIES

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Safety SRR Integrity SRR Ownership SRR Teamwork SRR Continuous Improvement

Investigation Agencies

Investigation and Causal Analysis
1952 -present

Question

When You Fly

- **Do you shop for**
  - Cost
  - Schedule

  OR

  - Carrier
  - Manufacturer

  WHY?

The Wars Never End

- **1943 – Before D-Day and the push into Germany, Churchill started to prepare for a post war future.**
- **All passenger planes prop-engine to date.**
- **America had the market cornered (90% DC-3).**
- **Churchill directed the study of jet engines for application in commercial passenger air service in anticipation of intercontinental air travel.**
  - Developed in secrecy, bad designs let out to confuse competitors
- **1949 – Maiden Voyage of the De Havilland Comet**

Beautiful Aircraft

First Commercial Flight With a Jet Airplane

Advertising – Once Upon a Time

Quiet, Smooth, Fast

- **40,000 ft**
  - Fly high enough to get over storms – smooth
  - Pressurized Cabin
- **Quiet**
- **600 mph (about twice as fast as a prop)**

Square Windows

Rough Start

- Oct 26, 1952 – Rome, Italy
- March 3, 1953 - Karachi, Pakistan
- May 2, 1953 – Calcutta, India
- January 10, 1954 – Rome, Italy
- April 8, 1954 – Stromboli, Italy – certificate of airworthiness revoked.

What's Causing This?

- **According to the manufacturer**
  - Manufacturer insist Pilot error
  - Although some design changes were made
- **After 5th incident, Churchill called in the royal airforce investigators to determine the problem**
- **De Havilland obstructed and worked closely with Italian government to delay release of an information or physical evidence**
- **Caused well over a year in delay of investigation of the causes**

Pressure Tests

Reconstructing the Fusalage

Royal Aeronautical Establishment Investigation

- 1st reconstruction of aircraft and stress tests
- Full-scale cyclic internal pressurization test of the fuselage in a water tank of the aircraft G-ALYU removed from service for this purpose
- 1221 internal pressurization cycles in service and after a further 1836 cycles in the water tank the cabin ripped open.
- Evidence of fatigue cracking was found in the aft lower corner of the forward escape hatch and from the right-hand aft corners of the windows.
- Viewing windows are no longer designed square but with rounded edges to reduce any stress concentrations.
- Crack-stoppers are now placed between frame-cutouts that take the shape of circumferential stiffeners that break-up the fuselage into multiple sections and thus prevent the crack from propagating from one window to the next.

Issue Investigation Matters

- In the end, because of investigation obstruction and insistence that the issues were human error and not design flaws (also a form of human error) the US cornered the market.
- This is why you fly Boeing and not De Havilland.
- Boeing and Douglas both said they would have made the same mistake were it not for the DeHaveland investigation.

Investigation and causal analysis matter and help, rather than hinder, business in safety critical industries

Gimli's Glider

- Fast Forward to July 23, 1983
- Another new jet has been commissioned – The Boeing 767 – several aircraft newly acquired by Air Canada and have been in the air only 2 months.
- First Aircraft to use the metric system
- First flight crew without the third person on crew – flight engineer
- Flight from Montreal to Edmonton
- Stopover in Ottawa – dipstick test determined no refueling needed

Boeing 767


Air Canada
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Gimli's Glider - What Happened

- Fuel gauges inoperable due to electronic fault - known to pilots
- Both engines cease operation at 41,000 feet
- Cockpit went black – lost all instruments, lights and hydraulics
- Aircraft is dark and quiet – no power
- Descending at 2,500 meters per minute
- Power and hydraulic systems ran on power generated from Rapid Air Turbine – power was reduced as aircraft speed slowed
- Headed aircraft toward Winnipeg, couldn't make it
- Co-pilot had been in Royal Canadian Airforce stationed at Gimli
- Diverted to Abandoned Royal Canadian Airforce base - Gimli

Landing At Gimli

- Nothing in the procedures on how to land with no engines or power
- Approaching Gimli, they are going to fast
- Captain Pearson had been a glider pilot and decides to “slip” the aircraft to reduce speed
- Front landing gear doesn’t lock in – First Officer decides not to tell Captain as it’s too late, and he has enough on his mind
- Gimli has been turned into a raceway and the runway is a dragstrip with cars and day camping all along the runway
- Kids riding bike on the runway
- Barrier in middle of runway

Long Way Down

On the Ground

Captain Pearson

Peddle Fast

Gimli's Glider - Why

- Used wrong conversion factor when fueling.
- First plane to feature kilograms and liters.
- Ground crews and pilots not trained in metric conversion
- First air crew of only two people – pilot and co-pilot. All other flights had flight engineer who usually did fuel calculation.
- Digital processors to calculate fuel not working so fuel gauges not working. Tagged out one processor, flight allowed, but dip tests required.

I'm Going to Say It Again

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When You Fly

- **You Shop For**
  - Cost
  - Schedule

  And Not
  - Carrier (unless a carrier annoyed you because of schedule or service)
  - Manufacturer