Flight Crew Decision Making
Capt. Phillip Graves
Why Study Decision Making?
The Goal

Awareness – Airmanship
Resilience
Introductions

- Name
- Position
- Aircraft type
- Previous experience
- What do you hope to accomplish?
Day 1

- Introduction
- Overview of CRM and Decision Making
- DM Studies and models
  - Thinking Fast, Thinking Slow
  - Natural Decision Making
- Lunch
- Case Studies
- Discussion
Day 2

- Recap of Day 1
- Integration of DM with line training
  - Simulation exercises
- Case Studies
  - Discussion
- Lunch
- Open Forum: The Way Forward?
  - Working Groups
- Wrap up and Summary
## Accident Review and Trends

2014
21 Accidents
990 Fatalities

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<tr>
<th>Date</th>
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Accident Review and Trends
The way forward?

Uncertainty avoidance shows to what level a person requires rules, regulations and guidance to avoid a sense of uncertainty.

Countries with high levels of uncertainty avoidance maintain rigid codes of behaviour and are intolerant of new ideas.
Safe Skies?

- According to the Aviation Safety Network
  - 21 Accidents in Nepal since 2000
  - 13 Fatal Accidents
- Primary Factors
  - Controlled Flight into Terrain
  - Weather - VFR in IFR
  - Runway Loss of Control
- A pilots decision to continue
Safety Comparison

- Alaska Aviation Safety Study (Bensyl et al 2001)
  - Unique terrain, climate
  - Weather unpredictable, lack of reporting
  - Few roads, high demand on aviation services
  - Pilots Had 100 times higher fatality rate than other occupations
Safety Comparison

• Aircraft Pilots in Alaska
  • 5 times higher fatality than rest of USA
  • Leading Causes: VFR departure, pilot decision to continue into IFR conditions, leading to CFIT in rugged terrain (NTSB Report)
The Way Forward?

- Local pilots and those with over 5000 hours had twice the survival rate
- Modern avionics and GPS navigation equipment initiative
- Remote airfield weather reporting improvements needed
- Pilot training to include mentoring, CRM, and Sim training for CFIT, decision making and off airport ops
Working Together

- FAA provided funding
- Alaska Air Carriers Assn
  - Formed non profit organization
- Medallion Foundation
  - Pro active detection of safety trends
  - Establish higher safety standards
  - Voluntary participation
  - Pilot CRM/DM Training

9 years later: 57% fewer air carrier accidents
Safety vs. Efficiency

• Pilots must decide
  ◦ More safety today?
  ◦ Sacrifice safety for time?
• Dynamic environment
  ◦ Trajectory of decisions
• Quality based on outcome
Summary

- Accident Overview
- Evidence of DM work still needed
- Comparison with Alaska Flying
- Safety vs. Efficiency

Airmanship – Awareness Resilience
Crew Decision Making

- CRM and HF
- Decision Making models
- Academic research in DM
- Reliable vs. Resilient
- Case study
Technology and Design

(Chapanis, 1999)
The Start of CRM

Ca: One eighty.
FO: We did something to the altitude.
Ca: What?
FO: We're still at two thousand right?
Ca: Hey, what's happening here?

FO: God, look at that thing. That don't seem right, does it? Uh, that's not right.
CA: Yes it is, there's eighty.
FO: Naw, I don't think that's right. Ah, maybe it is.
CA: Hundred and twenty.
FO: I don't know.

CA: Why?
FO: We're losing an engine.
CA: Why?
FO: We're going to lose an engine, buddy.
CA: Why?
FO: We're losing an engine.
CA: Why?
FO: Is he not off, the Pan American? (Is he not off, the Pan American?)
CA: Jawel. (Oh yes.)
Accident Warning Flags

- 1994 NTSB study
- Review of 37 fatal accidents (Period 1979-1990)
- Nine warning flags for all accidents
Accident Warning Flags

- Captain flying
- Experience gradient
- First duty day
- Time since awake
- Operational stress

Threats!

- Procedural error
- Poor tactical decision
- Monitor/challenge
- Checklist use

Errors!

(NTSB, 1994)
Decisions & Outcomes

- How good are we at assessing probability?
- How good are we at assessing outcomes?
What do we use to make decisions?

Experience!

• Our Good Experiences
  • Many but mild
• The Bad Experiences
  • Few but strong
• Other peoples Stories!
Decisions

The quality of a decision can be judged on:

The Outcome
Some typical crew decisions ... 

- PF – PNF
- MEL
- Fuel
- Late passengers
- Go – No Go
- Aborting take-off
- Weather diversion
- Go around
- System malfunction

Is it safe, legal and is there a good reason?
Normal Decision Making

1. Situation Assessment
2. Grab a Solution
3. Implement Solution
Some Decision Threats

- Poor SA
- Limited options
- Not reviewing decision
- Confirmation bias
What is the critical factor in Decision-making?

Time
Time and Decisions

For the correct strategy we need to decide:

Whether the situation is…

TIME CRITICAL?

…or if there is a specific amount of…

TIME AVAILABLE?

…or do we need to…

MAKE TIME?
Assessing Time Available

- Startle Factor
- Phase of Flight
- Maintain Aircraft Control
Assess

- First:
  - Aviate
  - Navigate
  - Communicate

*Always protect these tasks!*

- Understand the problem
- Look at as many different options as possible
- Do not rush
Action

- Keep your partner in the loop
- Implement your decision
- If you need to - stop the checklist
Manage

Address the needs of:

- Task
- Group
- Individual

- Use NITS to brief Cabin Crew

Re-assess your decision,
look for something telling you,
that your decision was wrong!
Stay below the line!

Solution

Problem

Problem
Boeing Non Normal Guidelines

- Recognize malfunction
  - Call out clearly and precisely
- Maintain Aircraft Control
  - PF – Fly! PM – NNC and Scan!
  - Automation – Reduce workload
- Analyze the Situation
  - Identify, Prioritize, then NNC
- Take Proper Action
  - Communicate – Pace and accuracy
- Evaluate the Need to Land
  - Land at nearest “suitable” airport? Continue toward the destination?
Decision making and Time

- TCAS
- GPWS
- Wind shear

- All other decisions

- Fuel
- Weather
- Medical

- Split-second
- Seconds
- Minutes
- Hours

- Conditioned reaction

- Natural decision making

- Rational decision making
Conditioned Reaction

Typical conditions:

• Clear trigger(s)
• Time is a critical factor
• No competing/complex information available
• The aim is for reaction to be correct and fast
Rational Decision making

Typical conditions:

• Clear and specific goals
• Minimal time constraints
• Complete and correct info
• The aim is an optimal decision
Naturalistic Decision Making (NDM) is based on how experienced professionals make decisions under conditions of time pressure, with uncertain information, competing or changing goals and high risk.
Natural Decision making

Typical conditions:

• Unclear goals (+ risk)
• Available time is minimal
• Incomplete/incorrect info and changing situation
• The aim is a decision that is “good enough”
Steps involved:

• Situation recognition
  (Based on cues from the situation)

• Serial option evaluation
  (Until get to “good enough” option)

• Mental simulation
  (To test option and have a plan)
Uncertainty avoidance shows to what level a person requires rules, regulations and guidance to avoid a sense of uncertainty.

Countries with high levels of uncertainty avoidance maintain rigid codes of behaviour and are intolerant of new ideas.

The way forward?
Learning from When Things Go Right

300

30

1

4 300 000

43 000

(Heinrich, 1931; Hollnagel, 2014)
Improving Monitoring Skills

- Brief what you want to look for
- Identify threats per phase of flight
- Mini Briefs - to maintain shared SA
- Clarify what you want to see
- Look out for and note subtle changes

*Maintain vigilance – be suspicious!*
Problem Solving Exercise

- A bat and a ball cost $1.10
- The bat costs $1.00 more than the ball
- How much does the ball cost?
Another problem

- A pond had lily pads that double every day
- They will cover the pond in 40 days
- How long will it take to cover half the pond?
Thinking Fast Thinking Slow

- The brain takes energy to think
- Human Nature tries to conserve energy
- Calculation takes more effort
Exercise

- Work in groups
- You are flying from DXB to FRA
- After top of climb the cockpit begins filling with smoke
- The nearest airport is 12 min but has crosswinds and is at CAT 1 min Wx
- Your Departure airport is 17 min away and is CAVOK
- You have 5 min to discuss a plan
15:12 UTC – Fire Bell Alarm

15:15 UTC – 2nd Fire Bell Alarm. Crew put on oxygen and goggles

15:17 UTC – Cockpit “full of smoke”

15:19 UTC – Capt declares lack of oxygen supply and leaves seat

15:21 UTC – PF advises will stay on Bahrain frequency as not possible to see radios

15:26 UTC – PF asks for radar guidance due to difficulty viewing instruments

15:38 UTC – Landing gear selected down but not functioning

15:40 UTC – Aircraft advised to turn left for Sharjah on 095°, PF acknowledges but selects 195° on MCP. Autopilot disconnected. Aircraft enters descending turn to right

15:41 UTC – Radar contact lost

Not to Scale
Reliability vs. Resilience

Comparison of Risk in Health Care With Other Industries

- HIGH RISK (>1/1000)
- MODERATE RISK
- MINIMAL RISK (<1/100,000)

- HEALTH CARE
  - Bungee jumping
- Driving
- Chemical Manufacturing
- Commercial Aviation
- Nuclear Power

Modified from R. Amaberti and L. Leape
Reliability

- Standard Operating Procedures
- Technical Knowledge
- Handling Skills
- Safety Management Systems
- Flight Standards
Resilience

- Situational Awareness
- Communication
- Decision Making
- Workload Management
- Leadership
Modifying the Book

- Engine fire after takeoff
  - SOP? Prioritize
- Time assessment
  - Risk analysis
- Plan for the worst
- Ready to adapt
Adapt the plan

- Establish "gates"
- Contained fire - Plan x
- Uncontained – Plan y
- Communicate plan
- Discipline to execute
Situational Awareness is having an active attitude that seeks out information to build a current mental picture of the flight.