Human Factors and Helicopter Safety 2009 - 2016

Patrick Hudson
Leiden University
Delft Technical University
Introduction

• What is the problem?
• What are the proposed solutions?
• Why might these not be enough?
• SMS and Safety Culture
• A Human Factors tool
• Conclusion
Improvements in Safety Performance
Where are Helicopters now?

- Engineering
- Equipment
- Safety
- Compliance

- Integrating HSE
- Certification
- Competence
- Risk Assessment

- Behaviours
- Leadership
- Accountability
- Attitudes
- HSE as a profit centre
Factors That Will Lead To Breakthroughs in Helicopter Accident Rates Since 2005

- IHST Formed
- Introduction of a scalable SMS tool?
- Insurers participate in targeted Safety investment?
- Widespread use of SVS?
- Cockpit imaging systems?

The data indicates opportunities abound.
How do accidents happen?

• The ‘Old’ model
• Human Factors in the simple model
• The systems approach
• Human Factors in the Systems approach
• What is the problem with helicopters?
The ‘Old’ Approach

- Classical model has accidents caused by immediate causes
  - The model is one of a chain of events
  - The assumption is that breaking the chain anywhere will produce safe outcomes
- Technical failures
  - Things break
  - Design parameters are exceeded
- Human errors
  - People do what they should not have done
  - People do not do what they should have done
- If people only did what they *should* do, we wouldn’t have a problem
- Hindsight is a wonderful thing
  - People could have seen the problem coming
  - They should have known it would be dangerous
  - They didn’t try to prevent it . . . . .
Hindsight Bias

Before the Accident

Surgeon at the time

Hindsight Bias

After the Accident

Lawyer after the event
Human Factors in the Old Model

• Vigilance
  – Sleeping on the job
  – Not looking out for the obvious dangers

• Competence
  – Not being good enough to perform the task
  – Not trying hard enough

• The solution to these problems are simple
  – Training
  – Procedures

• If I see these as solutions being proposed I immediately suspect the use of the classical model
Herald of Free Enterprise, Zeebrugge, Belgium, 1987
193 dead

UNDERLYING WEAKNESSES:
- inadequate supervision
- ambiguous safety procedures
- poor communication
Assistant bosun asleep
From Error to Underlying Cause

- Active Errors
  - Unsafe Acts
  - Unintended Actions
    - Slips
    - Lapses
    - Mistakes
    - Violations
  - Intended Actions
- Latent Conditions
  - Planning Design Procedures
  - Decisions
    - Training Planning Communication Accountability
  - Latent Conditions
Boeing 757 Start Sequence
Altimeters

The perceptual discrimination difficulty makes errors more likely (10,000 foot errors)
Accident Causation Model implemented in HFACS

- Fallible Decisions
- Latent Conditions
- Preconditions
- Unsafe Acts
- Defences

Local triggers
Environmental conditions

Accident
The Systems Approach

• End of the 80’s it became clear that accidents were caused by people in situations that were not always of their own making
• Problems were lying around waiting to catch people
• The critical factors are not usually determined by those performing the task
  – Who decides how much training to give people?
  – Who writes the procedures?
  – Who says “get the job done”?
• Accidents are multi-causal – the individual at the sharp end may be victim as well as final cause
• Removing one failure leaves all the others
Reason’s Swiss cheese model of accident causation

- Some holes due to active failures
- Other holes due to latent conditions
- Hazards
- Successive layers of defences, barriers, & safeguards
- Losses
Identifying Slices of Cheese

• How do we know which barriers are in place?
• Why do they have holes?
• Did the holes cause the accident?

• The Bow Tie technique allows us to identify all the slices = barriers or controls
• We get the added benefit of identifying preventative and mitigation controls
Bow-tie Concept

Events and Circumstances

Harm to people and damage to assets or environment

HAZARD

BARRIERS

Undesirable event with potential for harm or damage

CONSEQUENCES

Engineering activities
Maintenance activities
Operations activities
Level 0 Threats and Consequences

- Inadequate design of plant
- Improper construction of plant
- Improper operation of plant
- Injected Chemical over-temperature
- Incorrect Chemical specification
- Temperature Excursion in Process
- 5.4.4.1 Heating Chemicals in the Catalyst Heater
- Chemical Site: Overheated Catalyst
- Enhanced combustion within gas cloud (contained onsite)
- Projectile damage to product bulk storage
- Unignited pressure burst causing spread of hot liquid and gaseous product
- Building damage, possibly extending offsite
Level 1 Immediate Barriers
Bow-tie Concept

Events and Circumstances

Harm to people and damage to assets or environment

Undesirable event with potential for harm or damage

Engineering activities
Maintenance activities
Operations activities
Why were there holes in the cheese?

• A Level 0 description is **What** happened
• The Level 1 description is **How** the accident happened
• The actors in Level 1 are all immediate and close to hand
  – Pilots
  – Surgeons
  – Engineers
• There is no explanation of **Why**
• Level 2 requires understanding the systems that should put barriers in place
• Level 3 describes why those systems might not be taken seriously
Level 2 Escalation Factors
Level 2

- Level 2 explains why an incident happened, referring to organisational failures
- Level 1 may be a competence failure
  - This is what training should have delivered
- Level 2 may be a failure to deliver an adequate training
  - Pilots receive training, they don’t fund it, design it or test its adequacy
- A Level 3 analysis describes why the failure at Level 2 was allowed to happen
Level 3 Organisational Culture and Regulation
Factors contributing to incident causation

Corporate Culture & Regulation
- conflicting objectives
- unclear priorities
- unclear expectations
- focus on commercial targets
- loose culture
- condone non-compliance
- lack of consequent management
- focus on cost reduction
- inadequate control of business processes
- uncontrolled change management
- not open for ‘bad’ news
- scorecard driven
- focus on slips, trips & falls (TRCF)

Organisation & systems
- inadequate standards & procedures
- lack of resources
- poor audits and reviews
- time pressure
- inadequate HEMP process
- workload
- maintenance back-log
- lack of competence
- inadequate design
- Inadequate monitoring & corrective action
- Pushing operating window
- unclear roles & responsibilities
- inadequate ER system
- production pressure
- lack of supervision
- human error
- poor communication and hand-over
- pushing operating window
- no intervention
- equipment failure
- non-compliance
- acceptance of high risks
- lack of hazard awareness
- Incident
SPS Analyses EHEST & JHSAT

Percent of Accidents in which Top 5 SPS category (level 1) was identified at least once
EHEST data versus US JHSAT data

- Pilot judgment & actions
- Safety Culture/Management
- Pilot situation awareness
- Data issues
- Ground Duties

US JHSAT data vs EHEST data

Percentage %

0 10 20 30 40 50 60 70 80
EHEST Recommendations

Intervention Recommendation Categories – All Accidents

- Training/Instructional: 307
- Flight Ops & Safety Management/Culture: 252
- Regulatory: 169
- Data/Information Issues: 70
- Maintenance: 58
- Aircraft System/Equipment Design: 40
- Aircraft Design: 19
- Manufacturing: 15
- Research: 11
- Infrastructure (aerodrome, heliport, ATC, ...): 4
The problem

• Analyses show human factors issues
  – Pilots keep making errors of judgement
  – The culture is *can-do*
  – Situation awareness is lacking in dangerous situations

• The problem is  - The Helicopter
• We can use helicopters to do things we can’t with anything else
• All levels are involved
  – Clients
  – Operators
  – Pilots
  – Engineers
The Solutions

- Safety Management Systems
- Safety Culture
- The two can be brought together
- This will work for commercial organisations, but will be more difficult for private individuals and small GA operations
The HSSE Culture Ladder

GENERATIVE  (High Reliability Orgs)
HSE is how we do business round here

PROACTIVE
Safety leadership and values drive continuous improvement

CALCULATIVE
We have systems in place to manage all hazards

REACTIVE
Safety is important, we do a lot every time we have an accident

PATHOLOGICAL
Who cares as long as we're not caught
Safety Culture indicators

**GENERATIVE**
- chronic unease
- safety seen as a profit centre
- new ideas are welcomed

**PROACTIVE**
- resources are available to fix things before an accident
- management is open but still obsessed with statistics
- procedures are “owned” by the workforce
- we cracked it!
- lots and lots of audits
- HSE advisers chasing statistics

**CALCULATIVE**
- we are serious, but why don’t they do what they’re told?
- endless discussions to re-classify accidents
- Safety is high on the agenda after an accident

**REACTIVE**
- the lawyers said it was OK
- of course we have accidents, it’s a dangerous business
- sack the idiot who had the accident
Going up the ladder - how do we get there?

- We need to develop good safety habits
- Organizations should concentrate on doing things rather than just trying to have better attitudes. i.e. implementing SMS
- There is a progression up the ladder
  - In place (→ Reactive)
  - In operation (→ Calculative)
  - Effective (→ Proactive)
  - Permanent and continuously improving (→ Generative)
The HSSE Culture Ladder

- **CALCULATIVE**: We have systems in place to manage all hazards
- **PROACTIVE**: Safety leadership and values drive continuous improvement
- **REACTIVE**: Safety is important, we do a lot every time we have an accident
- **PATHOLOGICAL**: Who cares as long as we're not caught
- **GENERATIVE** (High Reliability Orgs): HSE is how we do business round here

Increasingly Informed → Increasing Trust and Accountability

In Place → In Operation → Permanent

Effective
Which drivers for which culture?

- **Pathological** respond to regulation
  - They don’t know the rest or it won’t happen anyway
  - They may be shifted if they are confronted with the costs

- **Reactive** respond to ethics, laws, regulation and accident costs (everything!)

- **Calculative** respond to regulation
  - They may be ethical but regulations and systems are the way they succeed

- **Proactive** respond to costs (as lost benefits)
  - Regulations are seen as defining minimum requirements

- **Generative** respond to benefits and self-image
  - They see it as strange if you don’t have HSE as a priority
Problems with management

- Management are the single biggest obstacle to improvement – their culture is critical
- *Reactive* organisations demand instant success
- *Calculative* organisations require proven success (elsewhere)
- *Proactive* organisations think they can do it on their own
- *Generative* organisations are there anyway but need to be constantly aware of the possibility of back-sliding

- *Pathological* organisations don’t need to do this anyway
  - “We’ve got better things to do, shareholder value is all that counts.”
  - “All this safety stuff just costs money” and
  - “We can’t be responsible if the workforce doesn’t do what they’re told”
- SMS compliance may be seen to be sufficient
  - “Now we can get back to the real business” is a real indicator that there is a long way to go
Conclusion

• Accidents are caused in complex ways, not just a straight chain that can be broken
• Cultural and regulatory failures have the greatest impact – through the effective implementation of SMS
• The exact nature of the accident depends on circumstances, which can be hard to manage
• The helicopter itself is a major source of circumstances
• The industry needs to develop a common culture, one of discipline in operations
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Patrick Hudson
Leiden University
Delft Technical University
The Rule of Three
• Normally Safe
• Near the limits
• On the edge
Why didn’t they stop?

An Incident occurs when 2-4 of the signs meet.
TRIMMING PROBLEM
MANAGEMENT
NO CHECKING SYSTEM
15 MINUTES EARLIER
5 MINUTES LATE
ACCELERATION
CHIEF OFFICER LEAVES G-DECK
MASTER ASSUMES SHIP READY
DOORS OPEN
BOSUN
ASSISTANT BOSUN ASLEEP
NO INDICATION

Herald of Free Enterprise
What is it?

• How did we get into this mess?
  – Accidents are made more likely by indirect causes, not just the obvious ones
  – We want to minimise regret, which includes not missing opportunities

• Why Three?
  – British Airways study showed decreasing resilience with increased number of oranges

• How is it meant to be used? (My ideas)
  – Move decisions from argument to process
  – Manage into the Green before it goes wrong
  – Use as near miss information system
Empirical support - Why Three?

- AAIB accident re-analysis (David Stephens)
- BA incident study - no accidents was a problem (Herman Jonker)
- New Zealand analysis and experimental study (Koen v d Merwe)
- Experiments found flight performance influenced by knowledge that next sector would be difficult
Dimensions Used in BA study

- Weather
- Crew experience
- Commercial setting
- Short term variation /day-night/ shifts
- Equipment
- Task
- Plan
- Destination/ Location
- Maintenance/ Checks

- Most of this information is missing in incident reports
Accident studies for Rule of Three

- Stephens found 4.4 oranges in major accidents with aircraft > 2000 kg, fewer in lighter aircraft
- Jonker used British Airways BASIS data for one year (No accidents)
- Four potential categories
  - Did the Right Thing 34 0.5
  - Screwed up but Recovered 8 1.5
  - Screwed up but Got Lucky 0 ?
  - Screwed up and Didn’t Get Lucky 0 ?
- Suggests Got Lucky = 2.5, Didn’t get lucky = 3.5
Analysis study 100 incidents

- Outcomes: Incident | Accident
- N of oranges: 0 | 3 | 1
- 1/2 | 13 | 7
- 3+ | 3 | 10
- Transition point between incident and accident at 2.32 oranges (sensitivity 59%)
- Transition point for pilot impairment was 3.07
- Evidence suggests that beyond 2.5 pilots are impaired and accidents become much more likely
The Edge

Inherently Safe

Normally Safe

No need

Return on Capital Invested

HSE Management Systems

HSE Culture