Dynamic Non-Events

Adrian Cockcroft
VP Cloud Architecture Strategy, AWS
@adrianco

“Work in complex systems is bounded by three types of constraints. Economic, workload and safety.”

- Jens Rasmussen

How did we all non-eventfully manage to get to this talk?

(Survivor bias accounts for those that didn’t...)

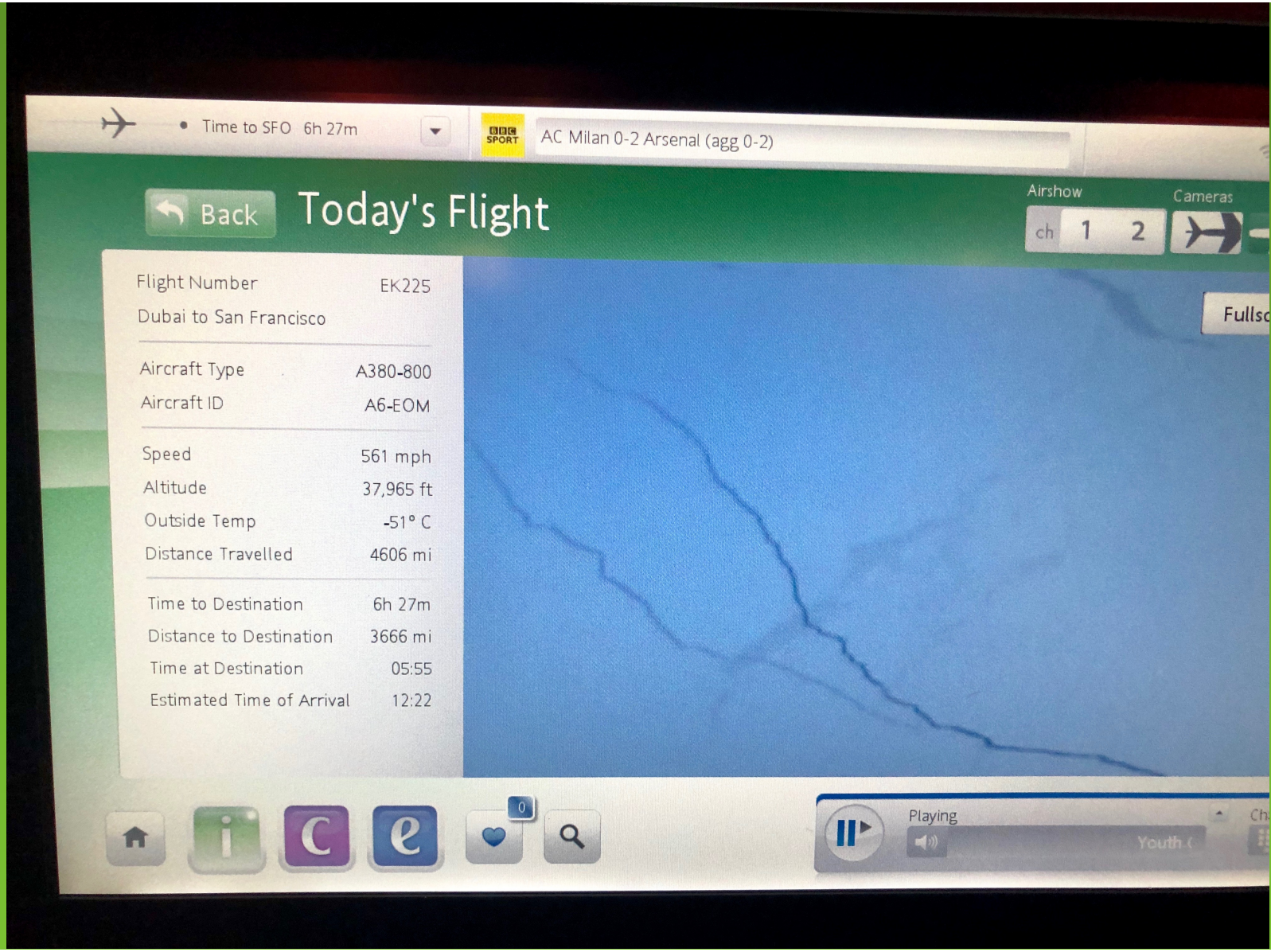

thwest
st.com

First US airline casualty since 2009

Why is flying so safe?

My Visit to the North Pole

My Visit to the North Pole

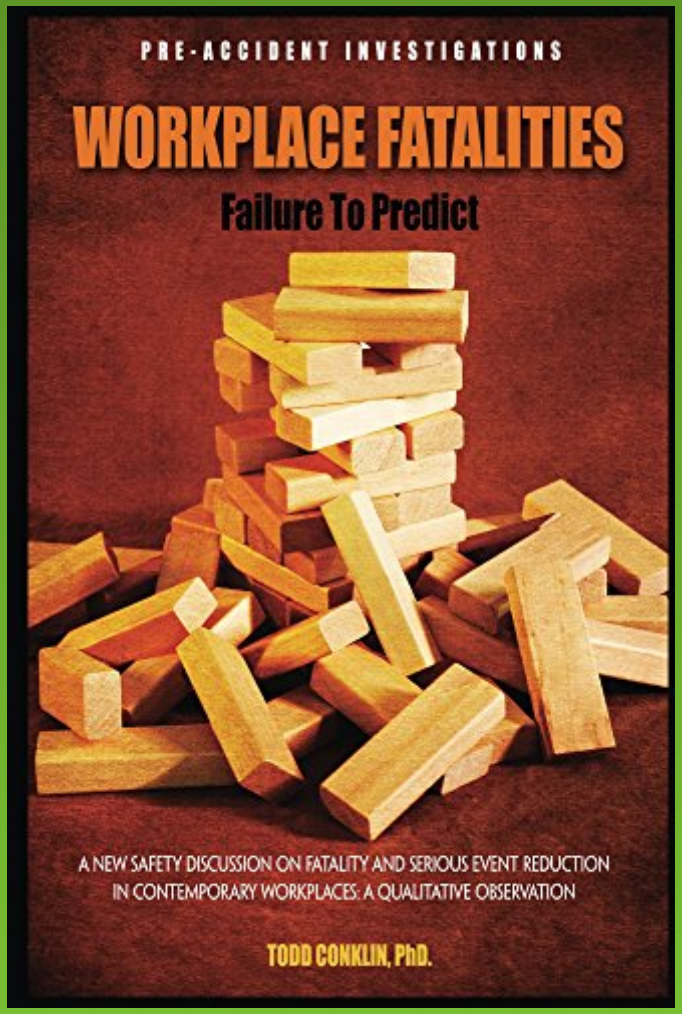


My Visit to the North Pole

Workplace Fatalities
Todd Conklin

Airlines with the fewest incidents have the highest passenger mortality risk

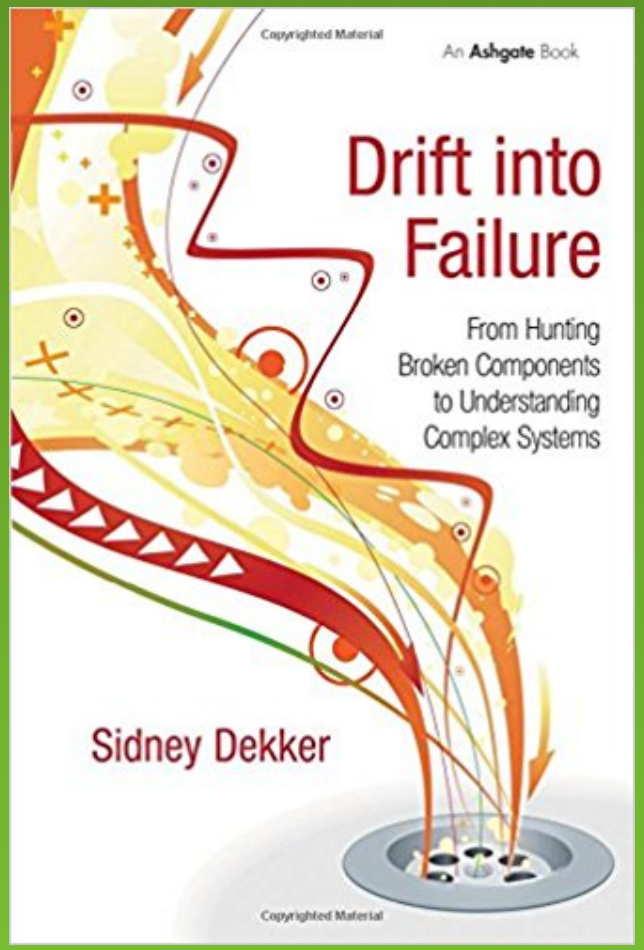
(Barnett & Wang, 2000)



Drift into Failure

Sidney Dekker

Chapter 2



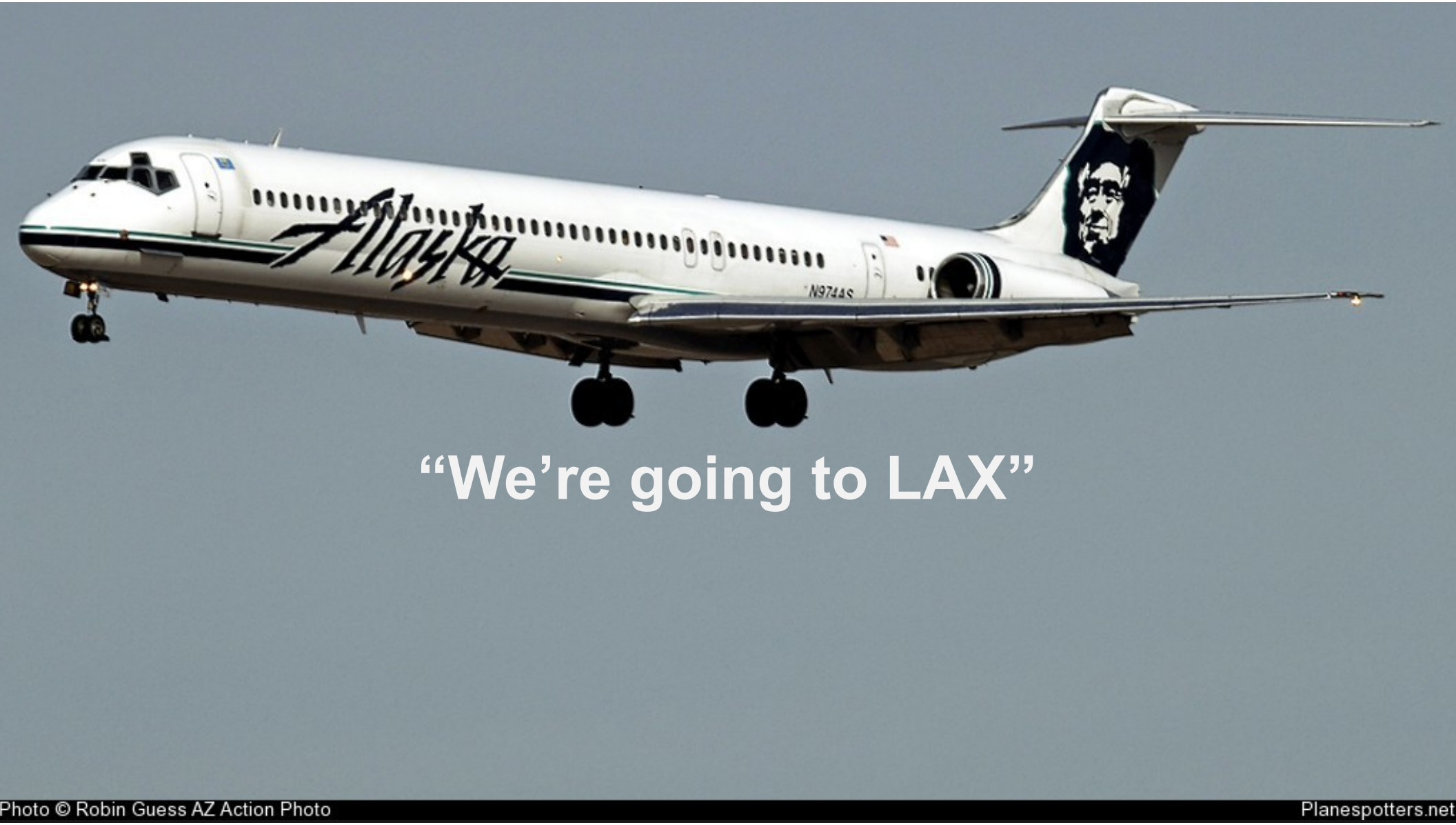
DC-9, MD-80, MD-90, 717

January 31st, 2000

Alaska Airlines 261

Mexico to Seattle


Alaska
N974AS
“Horizontal stabilizer appears to be jammed...”
Photo © Robin Guess AZ Action Photo
Planespotters.net


Alaska
N974AS
“We’re going to LAX”
Photo © Robin Guess AZ Action Photo
Planespotters.net


Alaska
N974AS
Disengage autopilot
Photo © Robin Guess AZ Action Photo
Planespotters.net

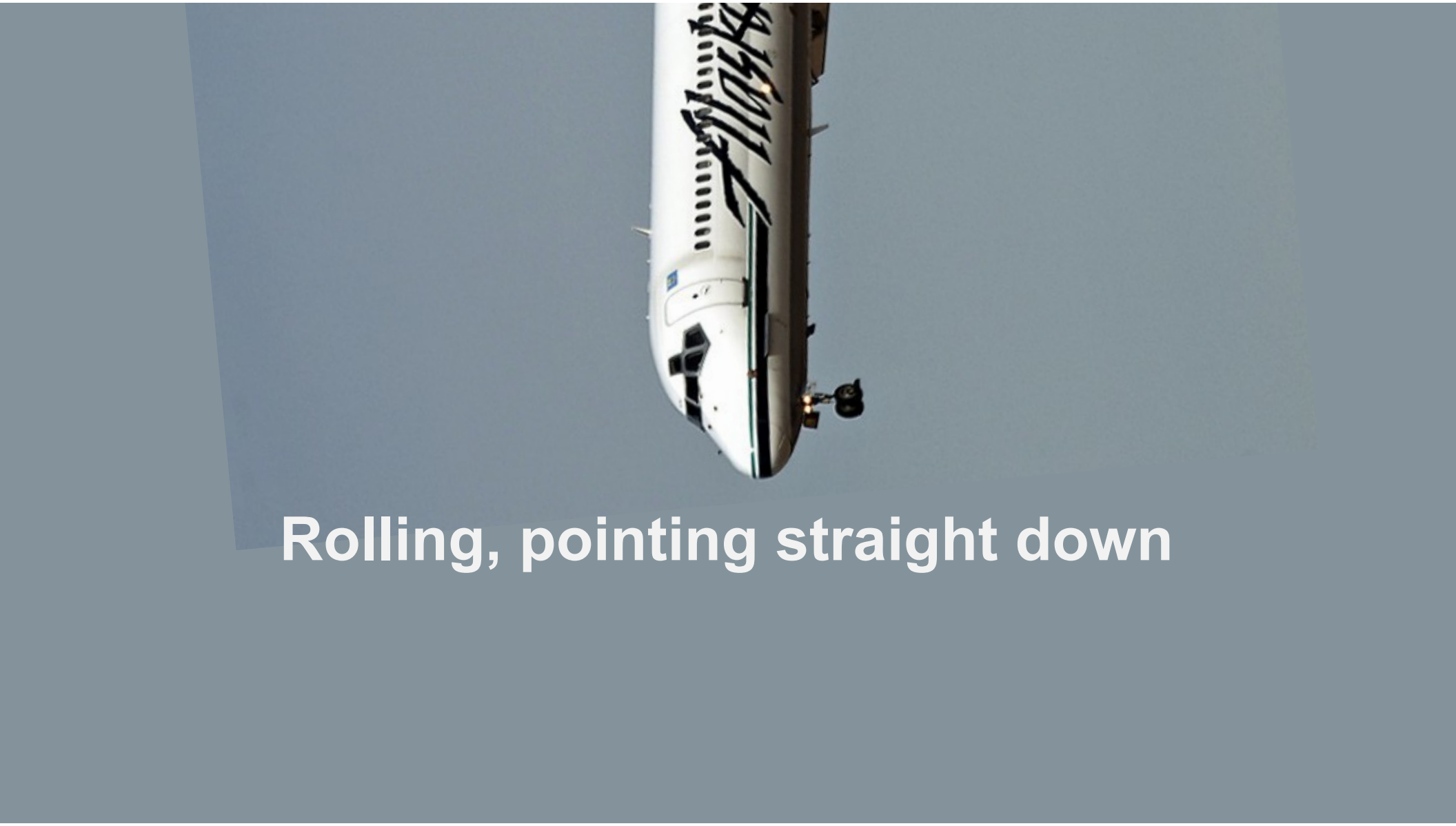
Aircraft nose pitched down, dived from 31,000 to 23,000ft


Alaska
N974AS
Pulled out of dive, pulling hard
to hold it level.
Photo © Robin Guess AZ Action Photo
Planespotters.net


Alaska
N974AS
Reduced speed, flaps deployed
17,000ft, over the ocean.
Photo © Robin Guess AZ Action Photo
Planespotters.net

Thumps heard,
then a loud noise

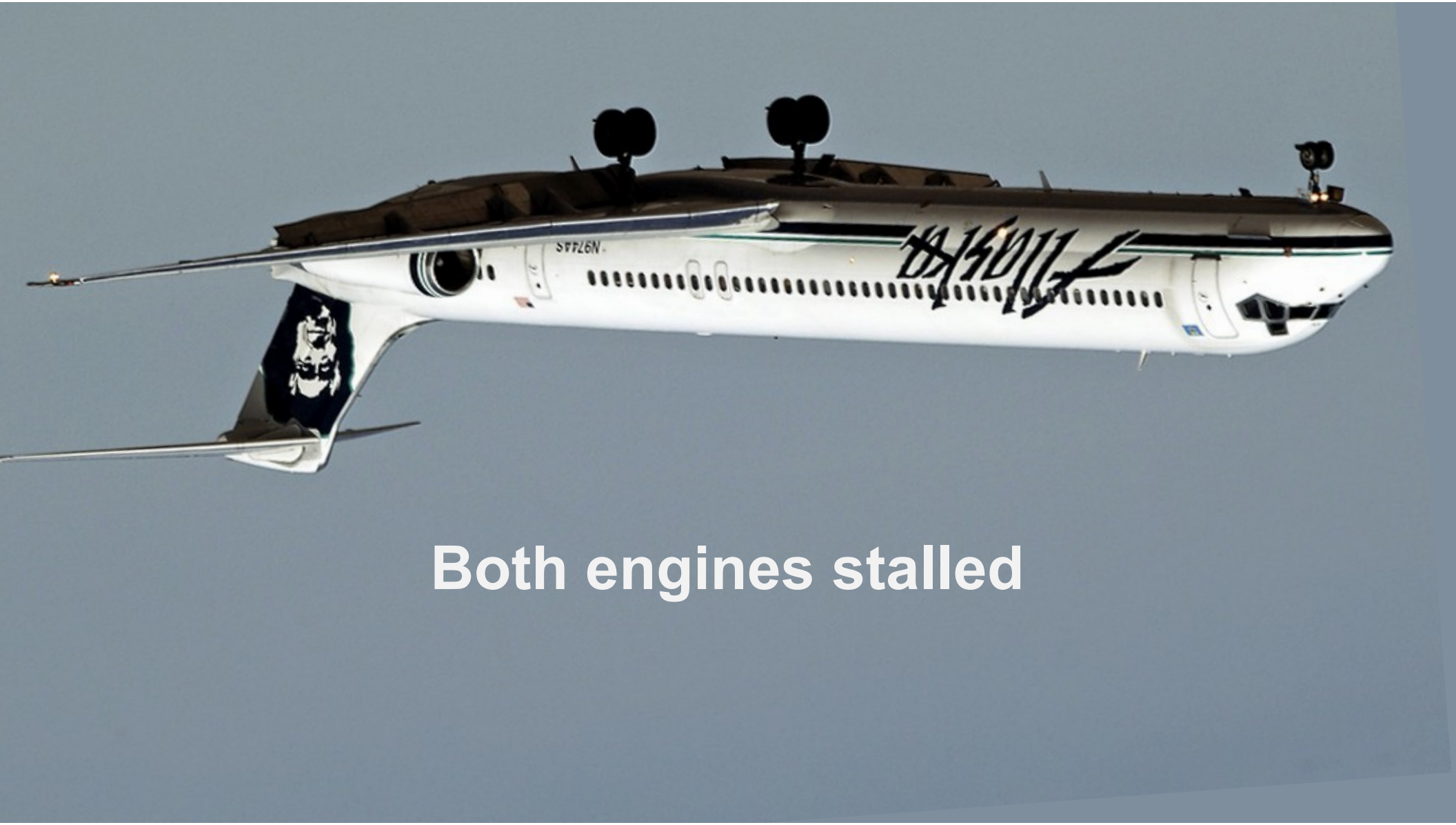
Nose pitched down,
25° per second



Rolling, pointing straight down

Inverted


Pilot tried to roll back upright


Both engines stalled


No recovery possible

Hit the ocean, destroyed

Two pilots, three cabin crew
83 passengers died

What went wrong?

2,300 similar aircraft delivered
95 million flight hours

This problem had never been seen before

95 million non-eventful hours

What went right?

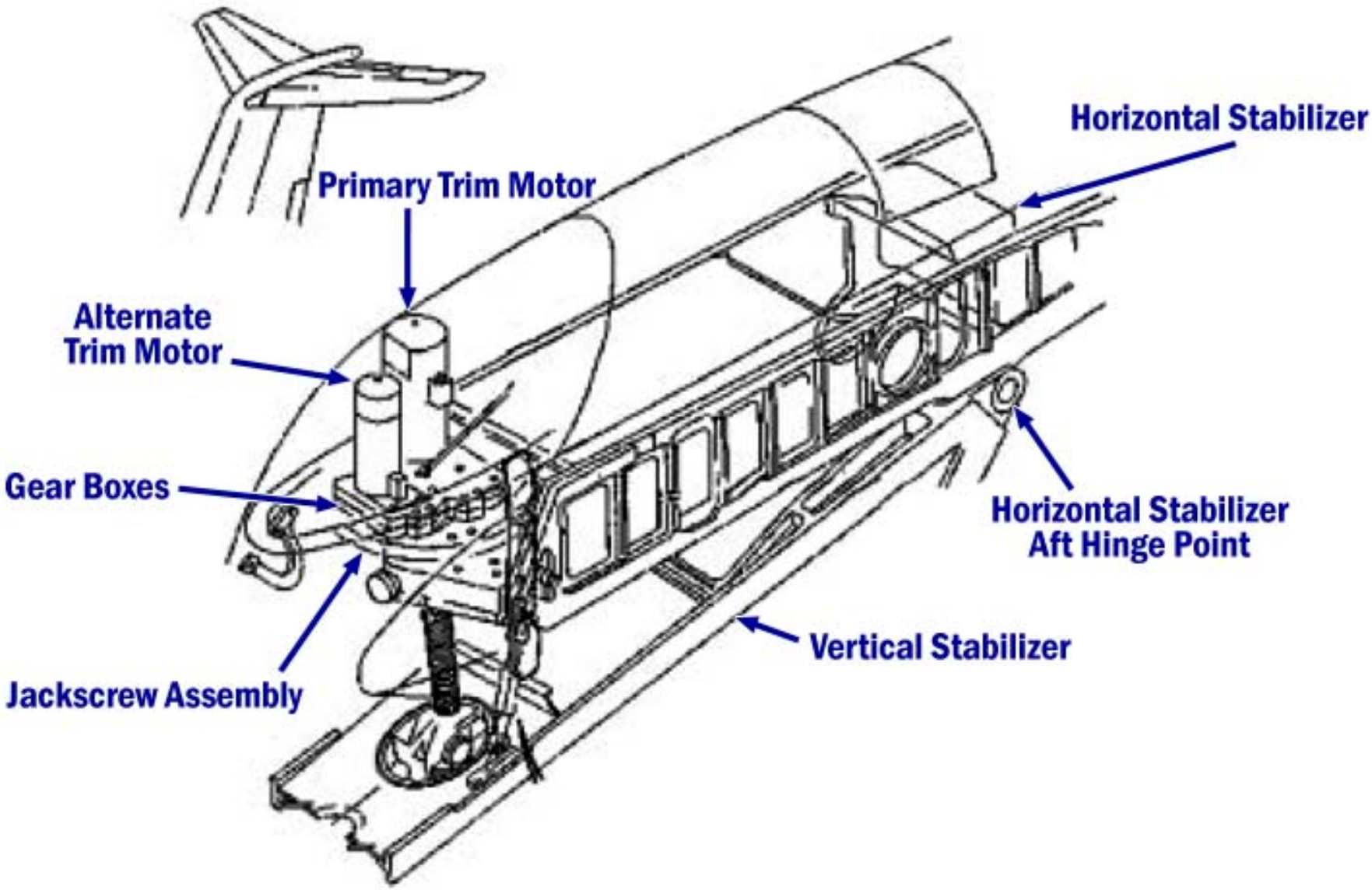
In a dynamic real-world stressed environment, what causes non-events?

Redundancy

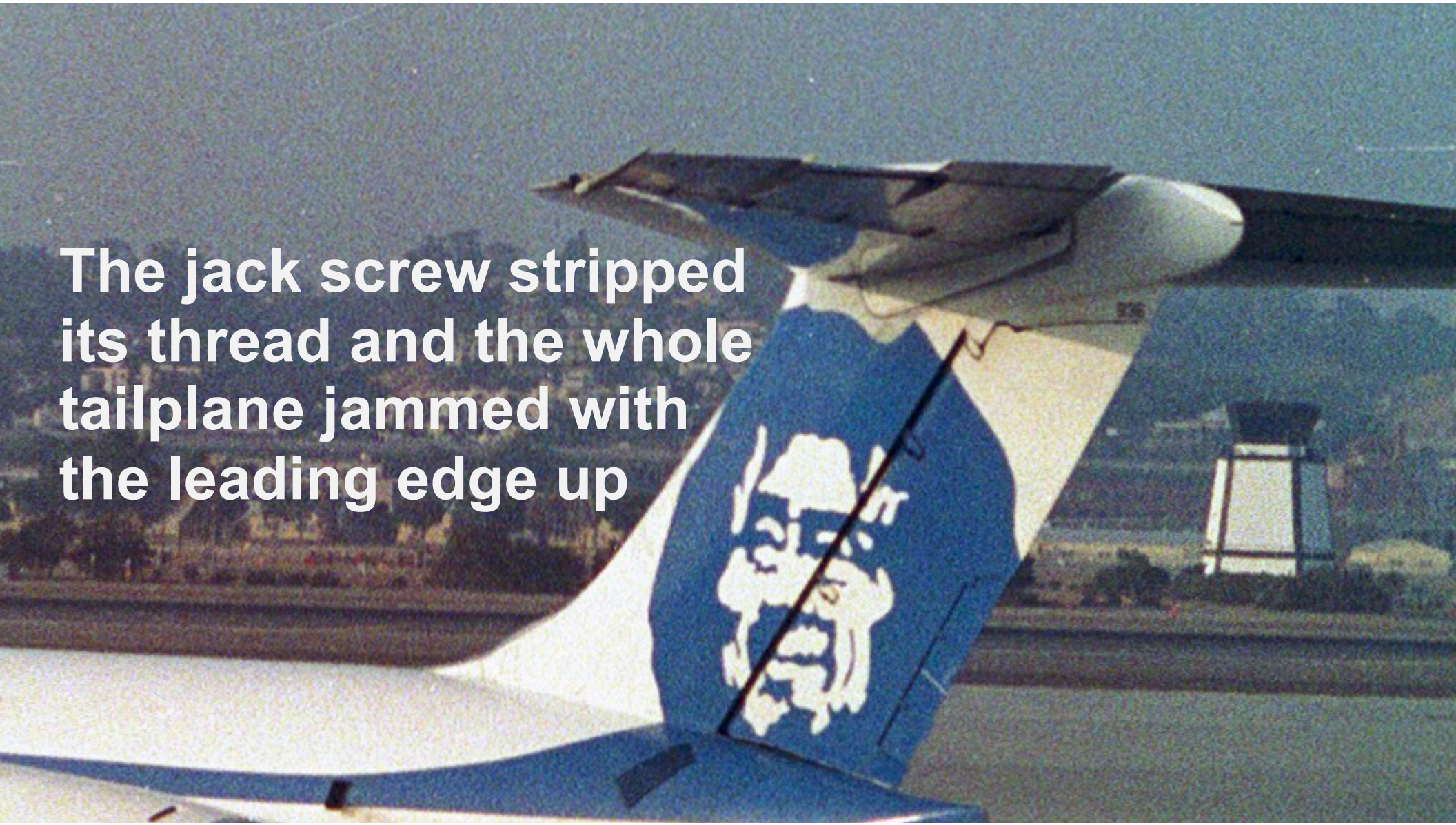
Safety Margins

Inspections and Maintenance


MD-80 Tailplane has
one jack-screw to
adjust its angle


Horizontal Stabilizer
Primary Trim Motor
Alternate
Trim Motor
Gear Boxes
Horizontal Stabilizer
Aft Hinge Point
Vertical Stabilizer
Jackscrew Assembly


Maintenance, inspection
and lubrication are the
compensating controls


The jack screw stripped
its thread and the whole
tailplane jammed with
the leading edge up

At first launch of DC-9 in 1965 recommendation to lubricate every 300-350 flight hours

Committees, reports, analysis supported economic push to longer intervals

Lubrication Interval
1965 every 350 flight hrs ~2 weeks
1985 Air industry deregulation
1985 every 700 flight hrs
1987 every 1000 flight hrs
1988 every 1250 flight hrs
1991 every 1600 flight hrs
1996 every 8 months ~2550 flight hrs

Parts recovered from flight 261 showed no signs of lubrication in the last ~5000 flight hrs.

Maintenance inspection check

Inspection Interval
1965 30,000 flight hrs design life
1967 problems found, 3600 hrs
1985 air industry deregulation
1985 inspection every 5000 flight hrs
1988 inspection every 26 months
1996 inspection every 30 months
1996 30 months ~9,550 flight hrs

Inspection tolerance

At the last inspection in 1997
wear was at limit

Re-tested a few shifts later, just under limit

No maintenance action

“Maintenance often performed at night, in the basket of a lift truck, even in the rain, through two tiny access panels with hardly room for a human hand.”

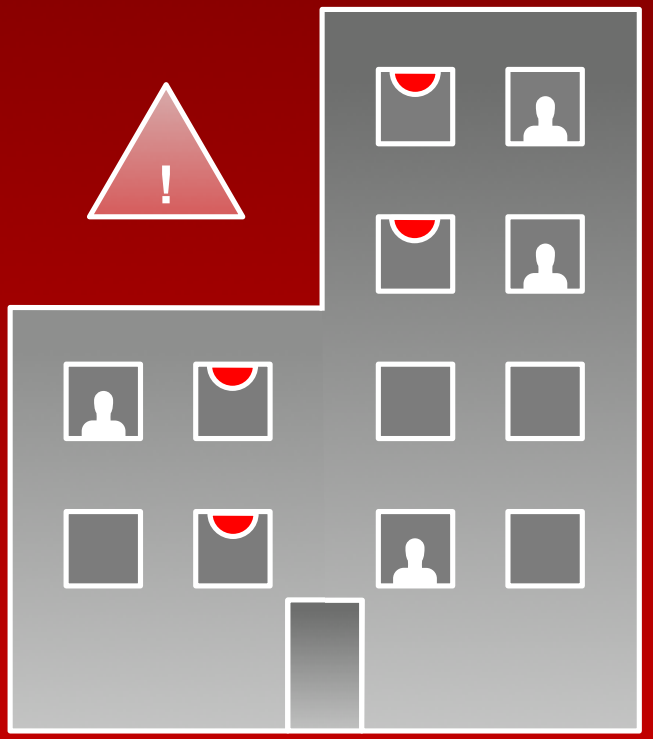
“Using a wear measurement tool that was not calibrated to manufacturer guidelines.”

With a reporting and learning culture, humans use intuition and judgement, see things, fix things, perhaps report things that might be wrong

Humans cause the non-events that keep things safely working most of the time

People Training

A fire drill is a boring routine where we make everyone take the stairs and assemble in the parking lot



People Training

Fire drills save lives in the event of a real fire, because people are trained how to react

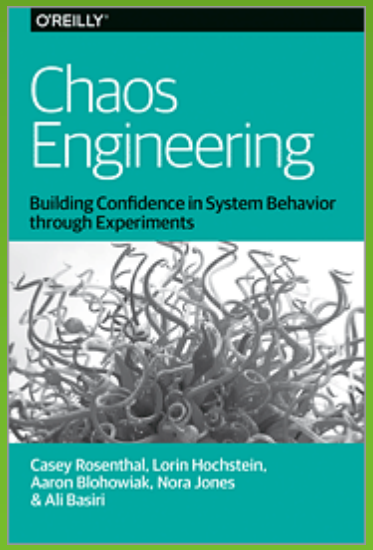
Who runs the “fire drill” for I.T.?

People

Application

Switching

Infrastructure



Chaos Engineering Team

People

Application

Switching

Infrastructure

Safety is a dynamic non-event

To make systems safe, we need to instrument and study the non-events

Look for near-misses and outliers

Beware of drift, from economic and workload pressure, into unsafe territory

Forgot to renew domain name…	SaaS vendor
Didn’t update security certificate and it expired…	Entertainment site
Datacenter flooded in hurricane Sandy…	Finance company, Jersey City
Whoops!	**YOU, tomorrow**

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