Human Performance in Maintenance

A CASE STUDY

"Death of an Airline"

DC-8-61

Jeddah, Saudi Araba

At the time of the accident, this airline was growing fast with a fleet of 16 aircraft comprised of 5 B-747s, 9 DC-8s and 2 B-757s. They employed about 1,200 people yet less than a year after the accident, they became part of history.

Read how a simple maintenance error was the “active” failure at the end of a series of “latent” failures. Safety nets, which are the last defence, were not in place or had holes in them, the end result was a terrible accident.

Eleven of the dirty dozen are known to have contributed to the "error in judgment." See if you can recognize them as you read.

Also, what safety nets can we put in place to help ensure this kind of tragedy is never repeated ?

We must learn from the mistakes of others,
as we’ll never live long enough to make them all ourselves

The following case study is part of the video “Death of an Airline” produced and distributed by
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Death of an Airline

SYNOPSIS

The aircraft took off from Runway 34L at Jeddah, Saudi Arabia with 247 passengers and 14 crew members on board.

During the take-off roll, the front tires, then the front wheels failed on the main undercarriage and remnants of the failed tires were burning when the landing gear was retracted after take-off.

A fire developed within the main gear wheel wells causing loss of pressurization, loss of hydraulics, structural damage and finally loss of control.

During the final stages of the approach to runway 34C, witnesses reported a significant increase of fire and smoke and the aircraft dived and rolled to crash 2,875 meters short of the runway threshold.

History of Deployment

July 3: The aircraft arrived at Jeddah with a group of personnel consisting of 3 complete flight and cabin crews, three mechanics and a project manager for a 21-day deployment to carry out a series of charter flights for pilgrims from Jeddah to various African countries.
July 4, 5 and 6: The aircraft made three trips to Conakry, Guinea. It was then flown to Accra, Ghana where it was grounded for 36 hours for a repair to the radar system. During this down time, while waiting for parts, the 125 hour "A" check was begun (32.5 hours before it was due) and the recorded tire pressures indicated two(#1 & #4) were low.
July 8: The aircraft flew to Jeddah to pick up a load of pilgrims.
July 9: The aircraft flew one of two loads of pilgrims to Accra.
July 10: The aircraft landed at Accra with the second load at 0450. A planned four hour maintenance stop is commenced which called for changing 5 tires. But the aircraft was called back to Jeddah by the project manager, the tires were loaded into the aircraft at 0730 local time and it was flown to Jeddah arriving at 1400 local time. Routine post-flight maintenance was carried out and the maintenance crew retired to the hotel at about 1700. The entire crew, except for the captain, went shopping and returned at about 2300.
July 11: The crew was awakened at 0300 and arrived at the airport at 0500. The lead mechanic, who would be going with the aircraft in the cockpit jump seat, carried out a pre-flight check and at 0755, 20 minutes before departure, with passengers on the aircraft, requested nitrogen for a low tire. The request was made to a support facility who informed them that the nitrogen bottles were empty.

Death of an Airline (Continued)

Thus he would have to go to Saudi Airlines to arrange the loan of their equipment. The project manager was heard to say *"forget it."* The lead mechanic and project manager boarded the aircraft and the flight engineer signed the pre-flight check as having been completed on the maintenance release.

The Final 30 Minutes

The engines were started and the aircraft was pushed back at 0810. The outside temperature was 29C as they began to taxi to the runway six 90 degree turns and 17,061 ft. away. Eleven minutes later they were lined up for take-off on Runway 34L. The first officer was given control as they began their take-off run at 0827. Within 15 sec, at a speed of 50 kts, an oscillating sound was heard. The flight engineer said, *"What's that?"* The first officer replied, *"We gotta flat tire, you figure?"* The captain responded, *"You're not leaning on the brakes, eh?"* The first officer answered, *"No I'm not, I got my feet on the bottom of the rudder."* The captain said, *"OK."* The captain called, *"V1"* and two seconds later the first officer observed, *"Sort of a shimmy like if you're riding on one of those ah thingamajigs."* At 51 sec the Captain called, *"Rotate"* and nine seconds later reported, *"Positive rate."* The FO called for *"Gear up"* and the aircraft climbed away.

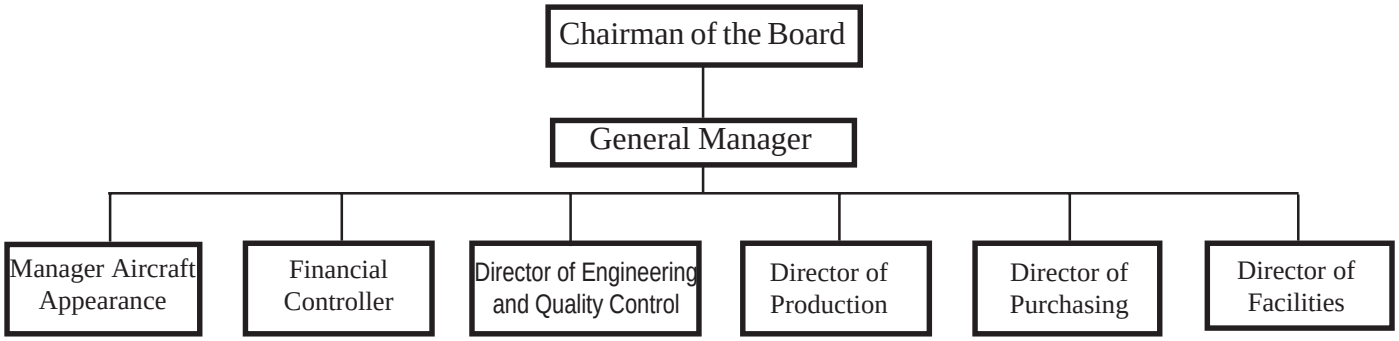
Two minutes and 16 seconds from brake release, climbing through 1,600 ft. the flight engineer reported, *"You've got four low pressure lights"* (said twice). The captain's only response was, *"Yeah."* 12 seconds later the flight engineer stated, *"losing pressurisation."* The first officer requested, *"Flaps ten"* twice. The captain called the tower to inform them that, *"we're having a slight pressurisation problem."* The tower mistook them for a Saudi Boeing 737 which was returning with a pressurisation problem. The first officer then informed the captain, *"I got a spoiler light." "Gear unsafe light." "OK, I thought I blew a tire." "Flap up."* (Second time) "*We're losing hydraulics here"*
"Flaps" (third time) The captain then responded, *"The airbrake thing just broke."* The captain was doing all the radio transmissions and was not using the aircraft callsign. As more problems cropped up, the flight director came into the cockpit and reported *"...smoke in the back ... real bad."* The captain acknowledged: *"Yeah, we're going back, we've got blown tires...and we got a hydraulic problem Faye, yeah just tell them we'll be returning to ah Jeddah."* Meanwhile the controller twice reissued their departure clearance. The first officer reported, *"I've got no ailerons,"* and the captain responded, *"OK, hang on, I've got it."* The controller once more called the aircraft and the captain responded. When given his departure clearance once more he responded, *"OK sir I cannot climb, I cannot climb. We are at two thousand feet now declaring an emergency, we have flight control problems."*

Death of an Airline (Continued)

The controller finally realized that the DC8 and not the B737 was in an emergency situation and gave a heading to intercept the final approach. At about 11 miles from the airport the first of a number of casualties fell from the aircraft at an altitude of 2,200 feet. During the final approach, with pieces of aircraft and bodies falling from it, the weakened empennage failed, the aircraft pitched nose down and from an altitude of 400 ft. dived at a 70 degree angle into the desert at a speed in excess of 240 kts. The disintegrating fuselage pitched over the nose and fragmented in the ensuing fireball. The wreckage trail spread 1,300 feet long and 650 feet wide with some debris carried over 3,600 feet from the initial impact. There were no survivors.

The Company

The company began operations about eight years prior to the accident and rapidly expanded, mostly in the charter operations. The maintenance on the company aircraft was carried out by a separate company which was owned by the same person. Their Company Organization Chart:



Excerpts from Position Descriptions

The **General Manager** is responsible to the Chairman of the Board for the development of a Department capable of efficient and economic accomplishment of all Maintenance Functions and to provide airworthy, reliable and clean aircraft in a timely fashion to (airline name) and other Customers at a minimum cost.

The **Director of Production** is directly responsible to the General Manager for the efficient Maintenance, Repair and On-Schedule performance.... Organize, direct and control (company name) Maintenance Operations in the production of on-schedule, safe, clean, aircraft....

The **Director of Engineering and Quality Assurance** is responsible to the General Manager for the efficient and economical performance of the Quality Department and for the quality of all Maintenance performed on...

Death of an Airline (Continued)

The Deployment Maintenance Team

The Maintenance team for the deployment was selected by the lead mechanic and consisted of himself, an avionics specialist and an A&P mechanic. While all three were experienced on aircraft, none were holders of a Aircraft Maintenance Engineers's (AME) license.
The flight engineers on the aircraft were holders of AME licenses, endorsed on type and were responsible for certifying the aircraft as airworthy. The flight engineers did not oversee or do any of the maintenance.

The Lead Mechanic

The 38 year old lead mechanic had been trained in France and had worked for a number of years in West Africa. While he had worked on DC8s in the past and was considered a capable mechanic, his knowledge of the DC8 was considered very limited. His knowledge of English was also very limited and his French was considered very Parisian.

The company arranged his emigration in order for him to work for them as a senior mechanic two years previous but he quit after 14 days. He was rehired as a foreman in training five months before the accident. This training was on the job training and he received no formal training from the company. As a condition of employment he was to obtain his AME license within six months of being hired.
He was chosen for the Jeddah deployment because of his past experience in West Africa. Those who worked under him indicated he was disorganized, unfamiliar with the DC8 and the company's maintenance procedures. He indicated to the mechanics on the deployment that he did not want maintenance operations to cause any flight delays.

It is said that he had a steady girlfriend and indicated a strong desire to settle down and move up in the company.

He was responsible directly to the Director of Production but tended to report to the General Manager. He made daily calls to the company and never reported any problems. The aircraft and operation were perfect. Persons who knew him indicated that he was quite intelligent but sometimes came across as arrogant

He was responsible for the coordination, accomplishment and recording of all work done but the certification was done by the flight engineer.

Death of an Airline (Continued)

The Project Manager

The 41 year old project manager, like the lead mechanic, was a new employee with an extensive background in passenger services. His duties were to ensure the smooth flow of passengers for the flights. He reported to Planning Department.

The Operations Officer

The operations officer was also a spare pilot who looked after the operational decisions (flight crew scheduling etc) . He reported to the Operations Department.

The Captain

The 47 year old captain spent 28 years in the military; 21 of them as a pilot. He had joined the company two years earlier as a first officer on the DC8 and after one year he became captain on the DC8. He had 10,700 hours flying time, 1,000 of which were on the DC8.

He was noted as having a strong personality and went by the book. It was said that he often lacked confidence in others ability and did not delegate duties well. Some crew preferred not to fly with him as he had a tendency to nit-pick and argue about procedures.

During the 11 minute final flight he took back control of the aircraft as soon as the first officer indicated he had lost aileron control. He also made 10 radio calls and received 14. He often made no response or reaction to information given to him.

The First officer

The 36 year old first officer had about 8,000 flying hours, 550 of which were in the DC8. He had obtained his early flying in the bush and had flown 1,200 hours as a first officer in the Airbus 310 prior to joining the company about one year previous.

He was noted as being a well liked, out going person with a forceful personality. He was knowledgeable about the aircraft and confident but did not take criticism well. It was reported that he did not like flying with the captain and had decided to just let him do his thing.

Death of an Airline (Continued)

The Flight Engineer

The 46 year old flight engineer held a flight engineer's license as well as an Aircraft Maintenance Engineer's license. He had served in the military for 24 years, the last 14 as a flight engineer. He had worked for the company for about two years.

He was described as a quiet, easy-going person with a conscientious and level-headed approach to his work. He was very knowledgeable about the aircraft systems and was considered a professional by his peers.

Maintenance Records

During the deployment, three checklists were used

a) Transit Check: A four page check list to be used whenever a turn-around was less than four hours. It called to inspect the tires for condition but not specifically for tire pressure.

b) Preflight Check: An 11 page checklist which was to be done on the first flight of each day and whenever a stop was more then four hours. It called for a check of the tire pressures and gave the required pressure with no tolerance. There was no space to record the pressures and one spot to initial that they all had been checked.

c) A-Check: A 20 page checklist which was to be done every 125 hours of flight time. This check called for the recording of each tire's pressure in a block and a sign off for each. The records showed that this was done at Accra on July 6, 32.5 hours before it was due. At the time of the accident 8.2 hours remained before the A-check was due and only the 20th page certification remained to be done.

The company did not have a provision for a progressive A-check.

A forensic inspection of the A-check sheet revealed that #2 tire pressure had been recorded as 160psi. (180 psi was the called-for pressure) and #4 was recorded as 155. Both of these had been altered and recorded as 180 and signed for by the A&P mechanic. The other tire pressures were signed for by the avionics specialist.

Maintenace records sent back to the company did not have the flight specifics, such as the aircraft registration and hours completed in the header portion.

Death of an Airline (Continued)

The maintenance records were often filled out at the end of the day and checklists were done from memory and signed for later.

Not all maintenance defects and maintenance actions were recorded in the aircraft journey log.

Not all of the maintenance records for the deployment could be located at the maintenance control center after the accident.

The flight engineers routinely accepted the aircraft for the next flight without confirming that the checks had been completed. They would assume the checks were properly completed.

There was some confusion as to what was the correct procedure for recording a tire with low pressure. It was not clear whether the mechanic should:

1. Record the low pressure and then top it up.
2. Not record the low pressure, only the corrected pressure.
3. Record the low pressure then cross it out and record the corrected pressure.

The checksheets gave no hint as to which was the correct procedure.

The lead mechanic reported the condition of the aircraft to the company by telephone every day.

Tire Pressure

The company checklists called for a main tire pressure of 180 psi with no tolerance. They further stated that if the main tire pressure was below 146 psi., it was to be changed. If the tire was flat and had been taxied flat then the axle mate tire must also be changed.

Douglas DC8 Maintenance Manual tire inflation chart gives a graph for the tire pressures which increase as the aircraft's gross weight goes up. The chart gives a tolerance of +5 -0 psi.. At the aircraft's gross weight of 325,000 lbs. the tire pressure should be 195 psi. +5 -0. At the aircraft's recorded gross weight the minimum tire pressure should have been 183 psi. The graph allowed the operator to operate the aircraft at the max gross weight tire pressure at lower gross weights. At 180 psi the maximum gross weight would have been 310,000 lbs. The recorded calculated take off weight was recorded as 313,493 lbs..

Death of an Airline (Continued)

The following is the recommended guidelines for tire replacement.

If less then 15 psi low = add air and record. *(166 psi+)*
If more then 15 psi. but less then 30 psi low = change the tire *(151 psi to 165 psi)*
If more then 30 psi = change both tires on the axle. *(150 psi-)*

Some Aircraft Tire Facts

The following material was obtain from a publication put out by Goodyear entitled "Aircraft Tires Care and Maintenance"

No other tire has to work as hard as an aircraft tire which must support both a heavy weight and travel at high speed.

An average sized aircraft tire is made up of 50% rubber, 45% fabric and 5% steel by weight.

A aircraft tire can lose up to 5% of its inflated pressure per day.

Heat build up is one of an aircraft tire's worst enemies.

Most heat is generated by a traction wave which cycles at the back of a rotating tire as it regains its shape.

Under inflation is more dangerous as it transfers its load to the other tire, which deflects more, generating more heat.

Nylon melts at slightly over 200 C (400 F) and at 200 C has lost 50% of its tensile strength.

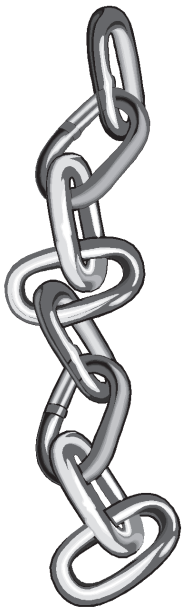
<u>At just 10% underinflation a tire has lost 90% of its performance.</u>

WORKSHEET

Complete as a team FIRST

CHAIN OF EVENTS

A link in the Chain of Events is any event, which is a contributing factor, and which if boken or removed, might prevent the occurrence



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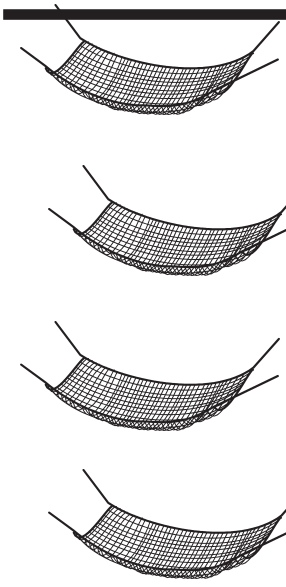
SAFETY NETS

A Safety Net is a regulation, policy, procedure or practice which, if in place might break a link or prevent a link from forming



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