

CASE STUDY 7.1

Classic Case: de Havilland's Falling Comet

The Development of the Comet

The de Havilland Aircraft Company of Great Britain had long been respected in the aircraft manufacturing industry for its innovative and high-performance designs. Coming off its excellent work during World War II, the company believed that it stood poised on the brink of success in the commercial airframe industry. The de Havilland designers and executives accurately perceived that the next generation of airplane would be jet-powered. Consequently, they decreed that their newest commercial airframe, tentatively called the Comet, would employ jet power and other leading-edge technology.

Jets offered several advantages over propeller-driven airplanes, the most obvious of which was speed. Jets could cruise at nearly 450 miles per hour compared with the 300 miles per hour a propeller could generate.

For overseas flight, in particular, this advantage was important. It could reduce the length of long flights from a mind-numbing two or three days to mere hours, encouraging more and more businesspeople and tourists to use airplanes as their primary method for travel. Further, jets tended to be quieter than propeller-driven aircraft, giving a more comfortable interior sound level and ride to passengers.

De Havilland engineers sought to create a streamlined airplane that could simultaneously carry up to 50 passengers in comfort, while maintaining aerodynamics and high speed. After working with several design alternatives, the Comet began to take shape. Its design was indeed distinctive: the four jet engines were embedded in pairs in the wing roots, at the point where they joined the fuselage. From the front, the aircraft looked as though its wings were held in place by the engines.

(continued)



FIGURE 7.10 The de Havilland Comet

Source: Heanly Mirrorpix/Newscom

The result of these innovative engineering designs was an aircraft that had remarkable stability in flight, was sleek in appearance, and was very fast.

Another distinctive feature of the aircraft was the pressurized cabin, intended to maintain passenger comfort at cruising altitudes of up to 30,000 feet. In its original testing for safety, de Havilland engineers had pressurized the airframe to more than five times the recommended air density to ensure that there was a clean seal. Consequently, they were confident that the pressurization system would perform well at its lower, standardized settings. Finally, in an effort to add some flair to the design, each window in the passenger cabin was square, rather than the small, round or oval shapes so commonly used.

Knowing that it was facing competition from Boeing Corporation to be first to market with a commercial jet, de Havilland's goal was to introduce its new aircraft as quickly as possible in order to establish the standard for the commercial airline industry. At first it appeared the company had succeeded: BOAC (British Overseas Airways Corporation) ordered several Comets, as did Air France and the British military. De Havilland also received some queries from interested American airline companies, notably Pan American Airlines. It looked as though de Havilland's strategy was working; the company was first to market with a radical new design, using several state-of-the-art technologies. BOAC's first nine Comet 1s entered service with the airline on May 2, 1952. The future looked bright.

Troubles

In early May of 1953, a brand-new Comet operated by BOAC left Calcutta, India, and flew off into the afternoon sky. Six minutes later and only 22 miles from Calcutta's Dum Dum Airport, the aircraft exploded and plunged to earth, killing all 43 passengers and crew on board. There had been no indication of problems and no warning from the pilots of technical difficulties. Investigators from Great Britain and India tended to believe the crash came about due to pilot error coupled with weather conditions. Evidence from the wreckage, including the tail section, seemed to indicate that the aircraft had been struck by something heavy, but without any additional information forthcoming, both the authorities and de Havilland engineers laid the blame on external causes.

January 10, 1954 was a mild, clear day in Rome as passengers boarded their BOAC aircraft for the final leg of their flight from Singapore to London. When the airplane reached its cruising altitude and speed, it disintegrated over the Mediterranean Sea, near the island of Elba. Most of the airplane was lost at the bottom of the sea, but amid the flotsam 15 bodies of passengers and crew were recovered. A local physician who examined the remains noted: "They showed no look of terror. Death must have come without warning." As a safety precaution, BOAC instituted a ban on the use of Comets until the airplanes had been thoroughly checked over. Technicians could find nothing wrong with the new

aircraft and, following recertification, the airplanes were again brought back into service.

Alas, it was too soon. On April 8, only 16 days after the Comet was reintroduced into service, a third aircraft, operated by South African Airways, departed from Rome's Ciampino airport for Cairo, one of the legs of its regular flight from London to Johannesburg. Under perfect flying weather, the airplane rapidly gained its cruising altitude of 26,000 feet and its airspeed of almost 500 miles an hour. Suddenly, the flight radio went silent and failed to answer repeated calls. A search of the ocean off the island of Stromboli, Italy, turned up an oil slick and some debris. Because of the depth of the water and the time necessary to arrive at the crash site, there was little to be found by search crews. Five bodies were all that were recovered this time, though with an eerie similarity to the victims of the second disaster: Facial expressions showed no fear, as though death had come upon them suddenly.

What Went Wrong?

Investigators swarmed over the recovered wreckage of the aircraft and reexamined the pieces from the first Calcutta accident while also conducting underwater searches at the sight of the second crash near the island of Elba. Guided by underwater cameras, investigators could collect sufficient aircraft fragments (in fact, they finally recovered nearly 70% of the airframe) to make some startling discoveries. The foremost finding, from the recovery of the entire, intact tail section, was that the fuselage of the aircraft had exploded. Second, it appeared that engine failure was not the cause of the accidents. Another finding was equally important: the wings and fuselage showed unmistakable signs of metal fatigue, later shown to be the cause of failure in all three aircraft. This point was important, because it advanced the theory that the problem was one of structural design rather than simple part failure.

Britain's Civil Aviation Board immediately grounded the entire Comet fleet pending extensive reviews and airworthiness certification. For the next five months, the CAB set out on an extensive series of tests to isolate the exact causes of the mysterious crashes. Before testing was complete, one Comet had been tested to destruction, another had its fuel tanks ruptured, more than 70 complete test flights were made in a third, and between 50 and 100 test models were broken up. The results of the extensive tests indicated several structural and design flaws.

Although the aircraft's designers were convinced that the structure would remain sound for 10,000 flight hours before requiring major structural overhauling, simulations showed unmistakable signs of metal fatigue

after the equivalent of only 3,000 flight hours. Experts argued that even when fatigue levels were revised downward to less than 3,000 hours, Comets would not be safe beyond 1,000 flying hours, a ludicrously low figure in terms of the amount of use a commercial airliner is expected to receive. In addition, testing of the fuselage offered disturbing indications of the cause of failure. Specifically, cracks began developing in the corners of the cabin windows, and these cracks were exacerbated by repeated pressurization and depressurization of the cabin. The investigators noted that this result was most pronounced along the rivet lines near the fuselage windows.

Testing also demonstrated that the wings had a low resistance to fatigue. At several stages in the tests, serious cracks appeared, starting at the rivet holes near the wheel wells and finally resulting in rivet heads in the top wing surface actually shearing off. Engineers and investigators were finding incontrovertible evidence in the pieces of recovered wreckage that the cause of the sudden disintegration of the aircraft could only have been due to cabin pressure blowout. Engineers suspected that the critical failure of the aircraft occurred following sudden depressurization, when one or more windows were literally blown out of the aircraft. This led to a sudden "gyroscopic moment" as the aircraft nosed down and began its plunge to earth.

Although at the time no one would admit it, the handwriting was on the wall. After two years, in which Comets carried more than 55,000 passengers over 7 million air miles, the Comet 1 was never to fly again. De Havilland had indeed won the race to be first to market with a commercial jet—a race that it would have been better to never run at all.¹⁷

Questions

1. How could risk management have aided in the development of the Comet?
2. Discuss the various types of risk (technical, financial, commercial, etc.) in relation to the Comet. Develop a qualitative risk matrix for these risk factors and assess them in terms of probability and consequences.
3. Given that a modified version of the Comet (the Comet IV) was used until recently by the British government as an antisubmarine warfare aircraft, it is clear that the design flaws could have been corrected, given enough time. What, then, do you see as de Havilland's critical error in the development of the Comet?
4. Comment on this statement: "Failure is the price we pay for technological advancement."