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The Spin--an Accident Analysis

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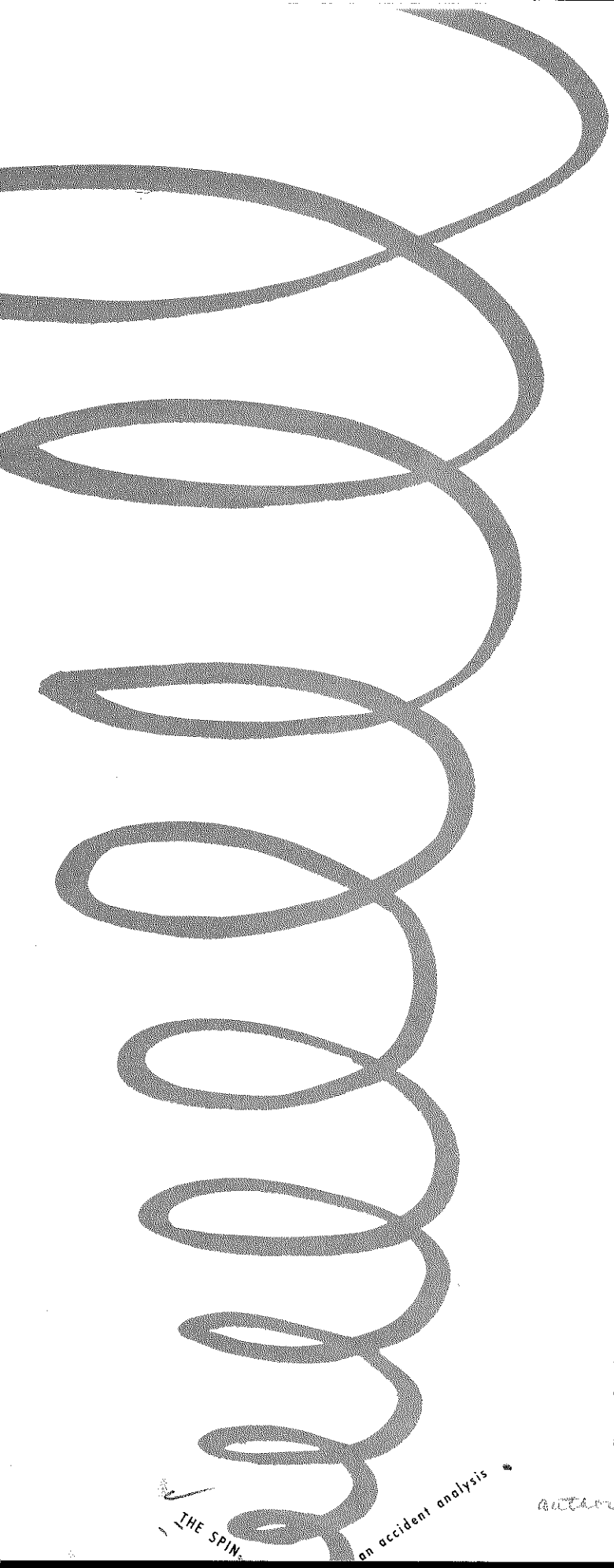


THE SPIN

an accident analysis

When the word "spin" rumbles around in the gray matter, it usually produces a picture of a fighter or trainer aircraft gyrating out of control toward terra. Phrases like "Throttles-Idle," "Controls-Neutral," "Stick-Aft," "Rudder-Full Opposite," (or the spin recovery procedure for your aircraft) may quickly follow the vision. But rarely does that same word conjure up a mental picture of a large transport aircraft spinning and floundering toward that same piece of ground. Matter of fact, when you put the word "spin" and C-130 in the same sentence, it creates a picture which makes you want to grit your teeth. As well it should.

While most fighter aircraft are spin-tested, transport aircraft, for obvious reasons, are not. But that, of course, doesn't mean they won't spin. The same aerodynamics apply, the laws of Newton work the same, and the ground comes up at just as fast a clip. In case you're a non-believer, there's an accident in our files that will quickly convert you. It happened several years ago.

The mission was scheduled as a five-hour show-and-tell during which time the Instructor Pilot was to demonstrate such things as normal landings, instrument approaches of all varieties, engine shutdown and airstart procedures, and airwork which included, among other things, an approach to stall series. It was the first ride for the two student pilots and the student flight engineer.

The student pilots met the IP at base operations two hours prior to the scheduled takeoff time for the planned phase of the mission. The IP introduced the students to the various intricacies of flight planning so necessary in airlift operations. A 175 was filed as a stopover with thirty minutes en route to the transition base (IFR), with 3+45 VFR in the transition base local area, then IFR back to home plate. The plan was to shoot a penetration at the transition base to a touch-and-go, cancel IFR and remain in the local traffic pattern for landing demonstrations in various configurations and to demonstrate instrument approach procedures. Since there were two pilot students aboard, the instructor would spend about two hours with each student in the right seat and sometime during the mission would give each student the airwork demonstrations, including the approach to stall series.

When the pilots arrived at the aircraft, the instructor flight engineer and student had completed the preflight. Forty-two thousand pounds of fuel were on board with 7000 pounds in each of the outboard tanks, 6000 pounds in each of the inboard wing tanks, 3000 in each auxillary tank, and 5000 pounds in each external tank. Engine start and taxi were standard and a normal takeoff was made at 1546 local. While inbound on an ILS at the completion of a penetration at the transition base, the IP was notified to

action on p. 7

illus 4-7

make a low approach only due to some runway construction which had begun. The IP acknowledged, made a low approach to a missed approach, then cancelled his IFR clearance and stated that he would remain VFR in the local area for some airwork. Shortly afterward, the tower passed along a new altimeter setting which the IP acknowledged. The time was 1726 local and was the last radio contact with the aircraft. The aircraft crashed at 1753; all aboard perished.

The aircraft impacted in a slightly nose-down attitude with approximately 30 degrees of left bank, in pasture land near an old railway embankment. The angle of bank was determined by measuring the distance between elevator counterweights imbedded in the ground and comparing that to the known installed distance. The aircraft did not make a crater nor were there any terrain scars leading to the impact site. This, and the distribution of pieces at the main impact site, indicated that the machine hit the ground with minimal forward velocity and with a counter-clockwise inertial force.

As noted in the accompanying photograph, pieces of the airplane were scattered about a large area, some as much as 4000 feet from the site of the main wreckage. A thirty-foot section of the left wing outboard of the number one engine was found almost 1800 feet from the main site. Number one engine landed very close to a private residence but caused no injuries to the residents. Number four engine and prop landed somewhat away from the main distribution pattern, which indicated that separation from the airplane occurred under high outward centrifugal forces. The right main gear door was found about 1500 feet from the main site with yellow paint markings on the intake aft portion. The paint matched with that of number one prop and further substantiated the fact that the airplane was in a very unusual attitude when the number one prop separated. Engines two and three were still attached to the airframe when it hit.

It wasn't too hard to figure out that the airplane had broken up in flight but the hows and whys proved a little more elusive to the accident investigation board.

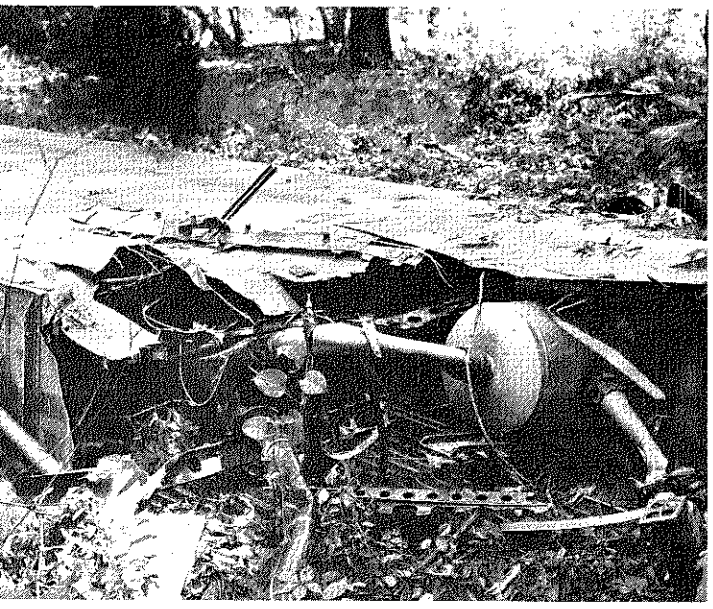
One of the first efforts was to find out if some kind of an inflight fire or explosion had occurred, causing the breakup. Because of a recent C-130 accident due to ruptured bleed air ducting which caused a fire, investigations proceeded in that direction. However, nothing was found to indicate that the bleed air system was operating other than normally. Additionally, the possibility of an inflight fuel fire and explosion caused by a malfunctioning fuel booster pump was investigated. (In each fuel tank on the C-130, a fuel booster pump is immersed in fuel which both cools and lubricates the pump.) The aircraft forms carried a booster pump write-up and in a past accident, an explosion and fire had occurred because of a short in the pump circuitry. An examination of the left wing proved beyond doubt that no explosion or fire had occurred prior to the separation of the wing section. Additionally, the suspected booster pump was found still attached to a portion of the tank with the electrical wiring intact and undamaged by fire. An inflight explosion or fire was ruled out as a possible cause.

Every effort was made to tag and plot on a wreckage diagram each part of the airplane. Technical experts both from the Air Force and from industry were called in to identify and examine each chunk. In order to determine what happened, it was necessary to find out what kind of stresses had been imposed on the various components which had separated, and to find out what, if anything,

had malfunctioned.

The engines, props, flight control components, instruments, fluid samples, hydraulic system components, and engine mounting brackets (called lord mounts) were sent to the various laboratories for analysis. Results of these tests indicated that no pre-accident malfunctions existed for any system. The lord mounts were found to have broken under an outward lateral force of from one to two Gs. It was obvious that the forces on the airplane necessary to cause the separation of number one engine were exactly opposite to those required to cause number four to tear off. And yet both engines, plus thirty feet of the left wing, had ripped off in flight.

The inspection plates for the thirty-foot section of the



This thirty-foot section of the left wing landed 1800 feet from the site of the main wreckage.

left wing were pulled off and the investigators found that the baffle plates which normally prevent the fuel from sloshing around were forced outward and had sheared loose from their attachments to the lower wing surface and that some of the wing ribs were damaged. This damage was caused prior to separation and was the result of the hydraulic action of fuel pushing against the plates laterally. Without the baffles performing their intended function, the surging fuel had sufficient force to rupture a portion of the lower wing skin near the wing tip, allowing the fuel to spill out. With the integrity of the wing destroyed, it could no longer resist the bending moments for which it was designed and the greater part of the remaining ribs were broken by wing flex. At that point, wing separation was inevitable.

An intense effort was made by the investigation board through local newspapers and radio stations to locate eyewitnesses. A total of twenty-eight people who had witnessed the aircraft were interviewed. Nine of those witnesses were in the immediate area of the crash site and saw the airplane as it fell. Generally, the witnesses agreed that the airplane was high (from 5000 to 10,000 feet), and had a slow forward movement, and either made a tight spiral or spin into the ground. They heard several explosions which were, in all likelihood, the sounds of the aircraft breaking up in flight. Some who had witnessed the aircraft further down the flight path from the crash site reported that the aircraft was unusually low. Still others nearer the site stated that large quantities of black smoke were seen coming from the aircraft prior to breakup.

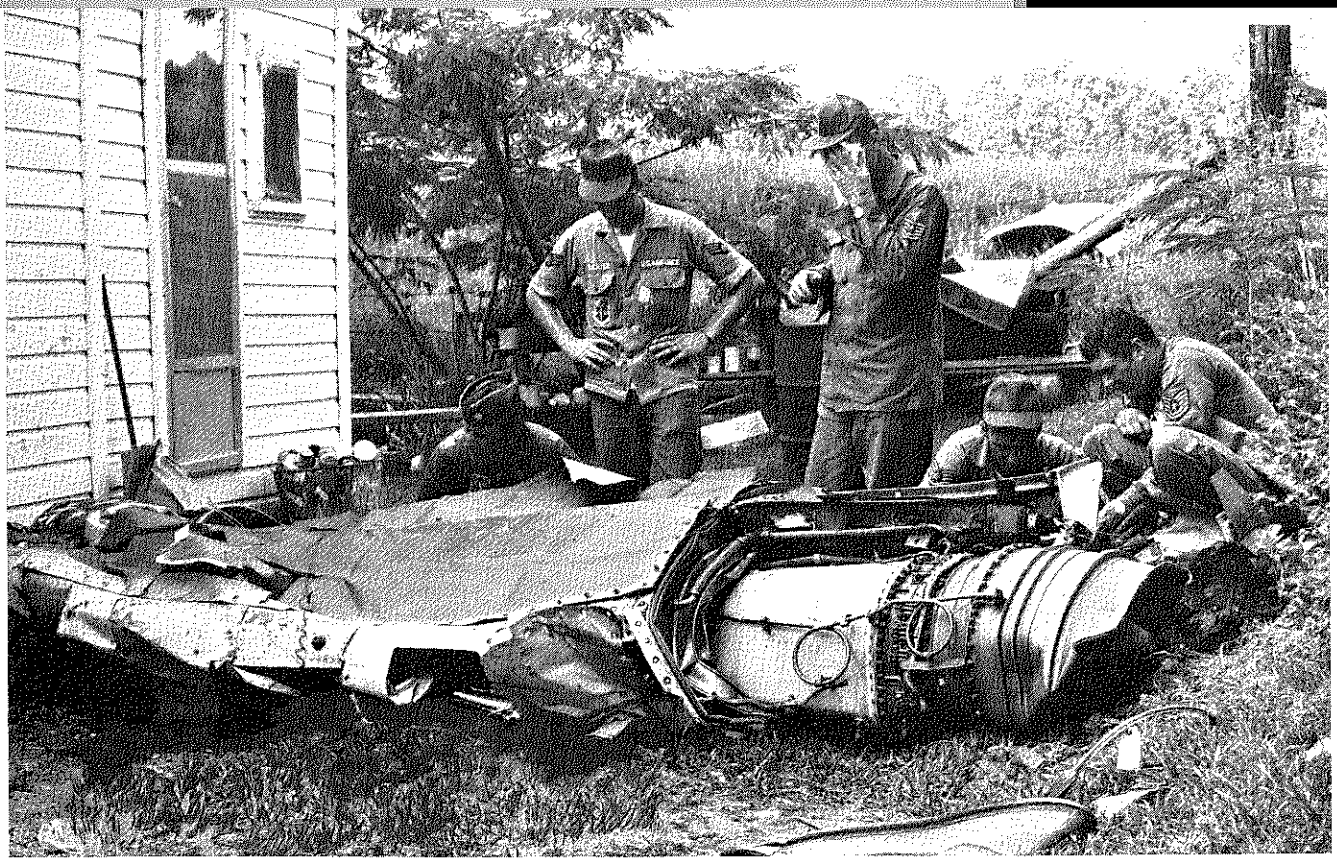
From these statements, the board concluded that the aircraft was above 5000 feet when it entered the general accident site area and since there was no evidence of inflight fire, the smoke was probably normal engine exhaust.

From the data available, including the wreckage diagram, the various structural analyses, and the witness statements, it became quite apparent that the aircraft had entered a spin. The accident board then attempted to determine which separated first, the wing or number one engine. Various industry representatives, including a structural engineer, offered opinions, but no conclusive supporting data could be found endorsing either theory. However, the evidence indicated that the aircraft entered a right spin which caused the damage to the left wing and the lord mounts on the number one engine followed by a separation of the engine, prop, and wing (but not necessarily in that order). Then the aircraft reversed spin directions and began to spin to the left which, in turn, caused number four engine and prop to separate.

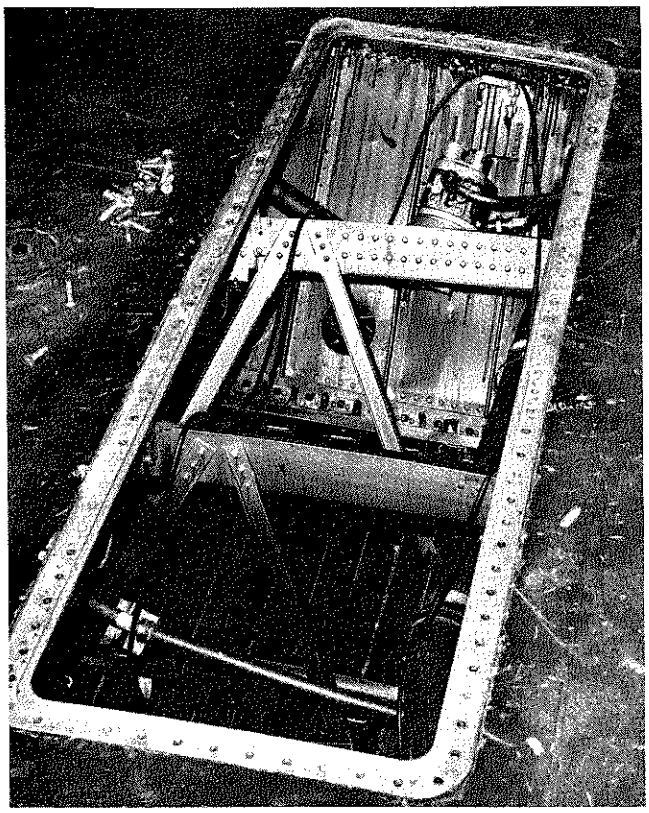
Two possible sequences of events leading to the crash are suggested in the report.

The first is: the aircraft entered the area of the accident site at an altitude of between 5000 and 10,000 feet with either the IP demonstrating an approach to stall or the student practicing the maneuver. A full stall developed and the aircraft entered a right spin followed very shortly by separation of number one engine and thirty feet of the left wing. The aircraft then entered a spin to the left (caused by the loss of the left wing, number one engine, and a large power imbalance on the right wing), followed by separation of the number four engine.

The second possible sequence of events is: down the



Number one engine landed very close to a private dwelling.



Damage to the fuel tank baffle plates (left wing) was caused by surging fuel.

flight path from the wreckage site, the aircraft entered a right spin because of control inputs from either the student or the IP. The IP was successful in recovering from the spin; however, the forces on the left wing were sufficient to produce a hydraulic action of the fuel which greatly weakened the integrity of the wing. While the IP was attempting to get the airplane back to the transition field, the fuel pouring out of the fissure at the wing tip further weakened the wing and normal aerodynamic forces were sufficient to cause wing separation followed almost simultaneously by number one engine separation. The fuel streaming out of the wing tip would explain what witnesses referred to as large quantities of black smoke trailing the airplane. The remaining sequence is as stated above.

Regardless of which sequence of events actually occurred, one point remains discouragingly pertinent to both. The IP ALLOWED THE AIRCRAFT TO ENTER A SPIN WHICH EXCEEDED THE STRUCTURAL LIMITATIONS OF THE AIRFRAME.

So, each of us must come away from this accident with two things in mind. The first you know. The C-130 will spin. The second, you must never forget. If the C-130 is allowed to spin, it will probably break up in flight.

And if that happens, mister, YOU'RE DEAD.

by Maj Tim Brady