A DEAD WEIGHT

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The pilot was under pressure because he needed to fund his project. He had built his Express 2000 ER (Extended Range due to the supplemental fuel tanks installed) with his own hands and had modified the original kit to match the performance requirements for his pioneering world record attempt. At that point, no one had succeeded in flying around the world via both poles in a SEP-powered airplane, alone.

This experienced long-haul pilot had already set numerous records and to increase visibility and attract sponsors, he had planned to fly non-stop from Basel (Switzerland, LFSB) to Oshkosh (USA, KOSH) to land at the annual International Experimental Aircraft Association's fly-in convention in 2007. But the construction of this experimental aircraft had taken longer than planned. In the beginning the pilot/builder had worked very conscientiously; documenting the building process with care. The engine was delivered late, and by the time the pilot needed to make the publicity-seeking flight to Oshkosh he simply hadn't enough time to test and calculate with the attentiveness he had applied in earlier phases of the project. An error in calculating the centre of gravity passed undetected. The pilot assumed that the centre of gravity for the flight was located in overweight-condition at 22 percent MAC, while in fact it was located at 35 percent MAC and outside the envelope for a take-off weight of 5445 lbs (instead of the kit designer's limits at 3592.6 lbs. In brief: the numbers did not add up, but the pilot was not aware of it. The FOCA approved the AFM Supplement for overweight operations, although with restrictions.

A few days before the day of the flight, problems started to crop up: The extra fuel tanks had been installed for the first time and there was much that needed attention. Then on the day of the flight, fuel leaks from the vent pipe of the auxiliary fuel tank installed in the fuselage, were discovered. The problem needed to be solved before take-off.

In its final report the AAIB noted that media representatives watched the Basel take-off, and were able to interview the pilot before he climbed into the aircraft. When a support at the tail was removed, the aircraft slowly tipped back. Corrective action consisted in quickly fixing four lead plates under the rudder pedals in an attempt to move the CG forward. The mass of these plates was not added up in the mass calculation. The pilot then sat in the cockpit and prepared for departure. When an assistant climbed onto the step located directly behind the wing to talk to the pilot, the airplane tipped back again and struck the ground with the tail. Assistants concluded that the damage was not relevant to the flight and temporarily repaired the tail with high-speed tape. Once the engine had been started, an assistant had to support the horizontal stabilizer in order to prevent the nose wheel from lifting. The pilot applied relatively high power to prevent the nose wheel from lifting when passing over bumps during taxi.

When cleared for take-off by the tower, with an indicated tailwind of five knots, the pilot applied power and initiated the take-off roll. Initial acceleration in the first 2295 ft (700m) was fairly normal. But then the airplane did not continue to accelerate as planned. Later it was found that the tires were running flattened due to the over weight of several hundred kilograms; they touched the wheel fairings resulting in abrasion and smoke. The fire brigade observed this and communicated it to the tower. The resistance caused by the chaffing tires prevented the airplane from accelerating as required meaning that the take-off run was three times longer than expected. The pilot decided to continue the take-off and eventually managed to get the aircraft airborne in ground effect.

Once airborne, the aircraft lacked the excess power to accelerate to a safe speed. The tail-heavy airplane barely took off, flew at a low level and wasn't able to climb any further. 2.11 miles (3.4 km) from the airport, HB-YMN crashed into the rooftop of a building in the neighborhood south of the aerodrome. The resulting impact and post crash fire killed the pilot, injured some people on the ground, destroying several houses and adjacent constructions.

1 Wrong Assumptions

Mass and balance considerations, in relation to the power available, played an important role in a second accident. On November 15 2009, ZS-OTU, a Sun Road Trading 10CC operated Cessna 208B, crashed after take-off from Eros Aerodrome in Namibia. The aircraft exceeded the maximum take-off weight by 629 lbs. It failed to maintain adequate speed and stalled shortly after take-off, killing three people on board and injuring one.

According to the Namibian AAIB, the pilot of ZS-OTU made one fundamental error in his weight calculation. He used the incorrect aircraft empty weight. In addition, the cargo was not weighed by the handling agent.

Moreover, some harsh anti-erosion type paint had been applied to the aircraft's wings leading edges. Such paint did not meet Type Certificate Standards and may have affected the stalling characteristics of the aircraft.

INADVERTENT
It's not usual for a pilot to deliberately take off when outside an aircraft's mass or balance limitations.

OVERCONFIDENT Mass and balance considerations in relation to the power available played an important role in the accident of the ZS-OTU.

2 Mass and Balance

ICAO Annex 6 Part II 2.2.3.1 (d) requires a pilot-in-command not to commence a flight unless he is satisfied that the "mass of the airplane and centre of gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected". This standard applies to non commercial operations.

ICAO Annex 6 part I 4.3.1 (d) requires exactly the same from commercial operators, as does EU-OPS 1.605 (a): "An operator shall ensure that during any phase of operation, the loading, mass and centre of gravity of the airplane complies with the limitations specified in the approved Airplane Flight Manual, or the Operations Manual if more restrictive".

Non-commercial operators may want to embrace the well recognized International Standards for Business Aircraft Operators (IS-BAO) 4.2.3 that reads: "The pilot-in-command shall be responsible for the operation, safety and security of the aircraft and the safety of all crew members, passengers and cargo on board. Specific duties and responsibilities shall include: (a)-(f) ...; (g) determining the aircraft weight/mass and balance limits."

Both our examples show clearly that errors committed in determining the mass and balance limits are very unforgiving. You can't cheat physics.

3 Taking Precursors Seriously

In both accidents we observe how two experienced pilots, one of whom held an Air Transport License, did not respect the mass and balance limitations. How can this be explained?

We cannot assume that a professional pilot will deliberately decide to take off when he or she is not within the mass and balance limitations of an aircraft. But, the reality is that when operating close to the limits, a number of events can combine and lead to an accident. Commercial or peer pressure can also aggravate the situation, by leading the pilots to take undesirable short cuts.

As is common in many accidents, more than one precursor was present, but the safety barriers were not strong enough to prevent the accident trajectory from developing. Some of the precursors, listed below, are not individually sufficient to cause an accident, but when added together, they can easily become fatal:

❍ Optimism and approximation in calculations vs. weighing the actual masses loaded on board

❍ Misinterpretation of wind information: believed to be headwind, while in fact it was tailwind, by pilots and other personnel involved

❍ Time pressure

❍ Stress from being under scrutiny by spectators

❍ Wishful thinking resulting in "seeing what you want to see" and ignoring obvious indicators (major tire deflection due to heavy load, centre of gravity is obviously near or aft of main wheel when aircraft tilts without additional weight in forward area and a person holding the horizontal stabilizer during taxi, very long take-off run before rotation)

❍ Stress from need to succeed and therefore irrational determination anand decision making based on subjective data

❍ Assuming without making sure

❍ Overconfidence

Our judgment is often misled by unrealistic expectations and the focus on achieving a target. It takes strong cultural inhibitors to avoid such pitfalls. Existing cultural techniques in this sense are collaborative decision making (formalized e.g. in briefings) and respecting known technical limitations. A critical element of any mature safety culture is mindfulness, which is characterized by:

❍ Preoccupation with failure

❍ Reluctance to simplify interpretations

❍ Sensitivity to operations

❍ Commitment to resilience

❍ Deference to expertise

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