HOW DO YOU REPORT SOMETHING THAT'S PHYSICALLY IMPOSSIBLE?

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This story emphasizes some flight testing done during the extensive development phase of Cessna's twin jet T-37 Air Force trainer, but highlights a side issue undertaken having unexpected consequences.

It was required that we do a project to evaluate dives and recoveries of the airplane, though I was not then, and am still not, sure how that was to be utilized in the training curriculum. We decided to do the two ingredients separately in programmed, and recorded, flight testing – dives at various angles, and pullouts at various g's – and then recombine them in various combinations analytically. That essentially left the test pilot to decide how to recover from the dives in that part of the test program – and that caused me, as Chief of Aerodynamics, some concern.

Let's dive at 400 mph and see what happens…

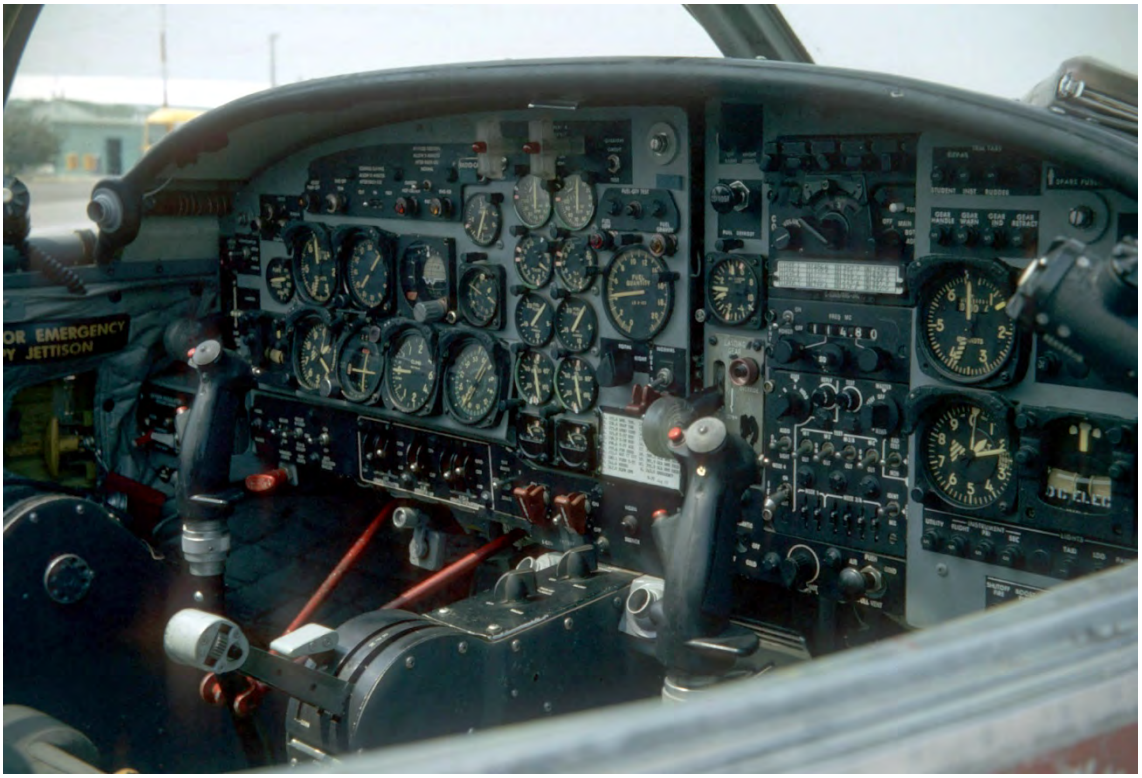
To put some numbers to this concern, consider a dive at normal cruise speed (say 400 mph) from a pretty typical training altitude expected for the airplane of 20,000 feet – say at a not too exceptional dive angle of 45 degrees. We did not plan to exceed, or even closely approach, the posted (with some "pad" in it) compressibility limit speed of the configuration either at a starting condition or during a dive, but to maintain the entry velocity throughout.

The startling thing was that ground level would be approached under the above dive conditions in less than a minute – from 20,000 feet!

What worried me was that there might be a lag in the altitude shown on the airplane's altimeter, maybe due to the length of the pressure tubing system from the static port to the instrument, maybe connections, maybe in the instrument itself – and it seemed that even a little delay might unknowingly put the pilot in a dangerous situation – whether it was our test pilot or, later, a student. So I devised a ground test to measure that potential lag.

I don't remember if the airplane used for the ground test was a prototype or a production unit, probably just what was readily available. But on it, a variable pressure simulating a descending standard altitude was introduced at the static port end (it was possible that the input location was moved to improve my viewing convenience), and while pressures were recorded there and at the altimeter in the cockpit, I sat in the cockpit in front of that altimeter, and another engineer held a larger altimeter I could view at the pressure input end, about ten feet span-wise from where I sat.

We ran a first trial, and I was able to glance back and forth and see how the two viewed altitudes varied and mentally measured the general difference – to possibly be compared to the recorded data. It didn't strike me at first, but then I realized the cockpit altimeter actually preceded the reading on the one held by the other engineer! But, I thought, that is physically impossible – there had to be even a little lag, not a "lead," due to the time it would take for the pressure change to be transmitted over that system with roughly ten feet of tubing from the test input "static" source to the airplane altimeter.



How can the altimeter lead the static port in a descent?

So, of course, we repeated a couple of cases and the result was the same: the cockpit altimeter led the one at the beginning and controlling end of the test setup. I racked my brain and about the only thing I could come up with was that the bigger altimeter itself somehow had a lag in it that let the cockpit one get ahead of it.

Then it occurred to me – even though I couldn't readily accept it, if the reality was that the cockpit altimeter didn't demonstrate a lag, my concern was really a relief – the pilot was at least correctly informed, maybe even forewarned, of his transient altitude. I took advantage of my supervisory position and left the (non-flight) test people to explain any unusual phenomena that happened in our ground experiment, like something that was physically impossible.

But I took the precaution and did the analysis that combined dive and pullup flight test results to predict various real life situations, and satisfied myself – and the Air Force – that our airplane was really controllable, and safe, with conventional flying techniques. Our successful test program of dives and ad hoc, and then programmed, recoveries gave credibility to those analytical results, and to my knowledge the many years of service of the T-37 never gave any hint of a problem with planned, or perhaps not well planned or controlled, dives. I guess our project was rigorous enough in all aspects.

By the way, I don't know the answer to the question of the title. I sluffed that off to some other folks.