Plotting Failures and Successes

Reading the President's Message (*ASW* 12/06, p. 1) — the words, "Step back for a moment to consider the white space above the line. That space represents the accidents that did not occur" — triggered an image in my mind going back to the Challenger Space Shuttle mishap. *Engineering Ethics*, a book by Rosa L.B. Pinkus, is dedicated to a thorough analysis of that accident.

The proper use of statistics is discussed, and it is concluded, among other things, that on the evening before the launch, the wrong graph was made up. It plotted seal failures as a function of temperature (book fig. 14.5). This graph shows that three launches below 60 degrees F had failed joints (five in total). Four launches above 60 degrees F had failed joints (five in total).

But the graph included only the seven flights in which a failure had occurred, and the database essentially stopped at 53 degrees F at the lower end.

However, had they plotted *all* available seal statistics against temperature (book fig. 14.6) — based on 23 flights — it would have been clear that there was an inverse relationship between failure and temperature. This graph with also the successes shows that all three launches (i.e., 100 percent) below 60 degrees F had failed joints (five in total). Only four out of 20 launches (i.e., 20 percent) above 60 degrees F had failed joints (five in total).

(This was statistically a nonsignificant sample, but it was what they should have worked with, a situation familiar to engineers.) The flights in which no damage occurred were grouped toward the high-temperature end of the scale, and the single high-temperature failure was a far outlier. Because the predicted temperature the morning of the launch was below 40 degrees F, the inevitable conclusion would have been *not* to launch because of the high likelihood of the failure of a nonredundant seal.

Now, in aviation, we all do the same as in pre-Challenger days: we plot failures, and almost never failures *and* successes. In other words, this is the "white space" that William Voss talks about.

If we want to raise the safety bar, a better understanding of today's statistics would be a big bonus. Recording both failures and successes could do that.

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Balancing Act

Mr. Chiles's assertions in the InSight column (*ASW* 12/06, p. 24) are at odds with the U.S. Federal Aviation Administration advisory circular — 120-27E, *Aircraft Weight and Balance* — he references. He appears to have taken the position that using average weights is without risk because there are envelope constrictions to compensate for other center of gravity (CG) error-causing phenomena. For passenger seating, Mr. Chiles claims that envelope curtailments eliminate the negative safety aspects of using average weights. His reasoning is that the FAA requires CG curtailments to compensate for passengers leaving empty seats at other-than-expected locations. However, Mr. Chiles fails to note that air carriers are allowed to eliminate the curtailments when all seats are filled (the scenario in the original article; *ASW* 7/06, p. 55).

Mr. Chiles defeats his own argument with, "Cabins are frequently subdivided into separate loading zones to further reduce potential error and to minimize reductions of the certified limits." Taken to the extreme, an operator can designate every row of seats as a zone. Then there is no longer a need for curtailments because the location of every empty seat is known. That technique is used by at least one U.S. airline.

On Jan. 8, 2003, 21 people died in Charlotte, North Carolina, because the airplane was out of CG. The U.S. National Transportation Safety Board seems to believe that increased average weights would not have prevented the airplane from departing with the CG aft of limits.

While not easy or inexpensive, we must find solutions that will guarantee that an airplane is within its weight-and-balance limits prior to flight. Until we do that, every takeoff is playing the odds. Making "reasonable" assumptions will not change that fact.

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Editorial note: Keith Glasscock is the author of the original InSight article on this subject, "One Size Fits All? The Danger of Average Weights."