

Michael Friendly
York University



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Darts



Missed Opportunities and Graphical Failures

One virtue of a good graphical display is to allow us to see patterns, trends, or other structures which would otherwise be concealed in another form of display. It may be heartbreaking to find out that some important information was there, but the graph maker missed it. The story behind the *Challenger Disaster* is perhaps the most poignant missed opportunity in the history of statistical graphics. But such graphical failures often provide useful lessons.

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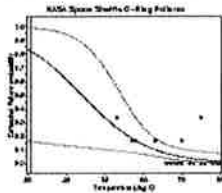
Picture



Words

The Challenger Disaster Full size (451x228) [3K].
The Space Shuttle Challenger exploded shortly after take-off in January 1986. Subsequent investigation determined that the cause was failure of the O-ring seals used to isolate the fuel supply from burning gases. This figure (scanned badly from Wainer, 1995) shows a graph accompanying the *Report of the Presidential Commission on the Space Shuttle Challenger Accident, 1986* (vol 1, p. 145) in the aftermath of the disaster.

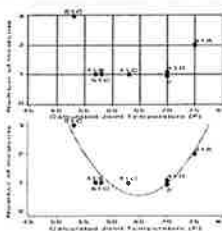
NASA staff had analysed the data on the relation between ambient temperature and number of O-ring failures (out of 6), but they had excluded observations where no O-rings failed, believing that they were uninformative. Unfortunately, those observations had occurred when the launch temperature was relatively warm (65-80 degF).



The Challenger Disaster Full size (494x424)[4K].
Reanalysis of the O-ring data involved fitting a logistic regression model. This provides a predicted extrapolation (black curve) of the probability of failure to the low (31 degF) temperature at the time of the launch and confidence bands on that extrapolation (red curves). See also Tappin, L. (1994). "Analyzing data relating to the Challenger disaster". *Mathematics Teacher*, 87, 423-426

There's not much data at low temperatures (the confidence band is quite wide), but the predicted probability of failure is uncomfortably high. Would you take a ride on Challenger when the weather is cold?

See also: Gary McClelland's *Graphs on the Web: Challenger Story*, with a Java applet



But, what if they had made a better graph? Initial graph, full size (525x263)[4K]; Re-designed graph, full size (525x269)[4K].
The original graph was prepared by engineers from the contractor, Morton Thiokol, and it is perhaps unreasonable to expect that a sophisticated statistical analysis of the data should have been carried out, given the time pressure for a launch / no-launch decision.

Nevertheless, it is of interest to ask whether a re-design of the original graph might have signalled that something was amiss. Apart from the disastrous blunder of omitting the observations with 0 failures, two