

## CHAPTER OVERVIEW

### 6: Data Visualization

#### Learning Objectives

- Describe the principles that distinguish between good and bad graphs, and use them to identify good versus bad graphs.
- Understand the human limitations that must be accommodated in order to make effective graphs.
- Promise to never create a pie chart. *Ever.*

On January 28, 1986, the Space Shuttle Challenger exploded 73 seconds after takeoff, killing all 7 of the astronauts on board. As when any such disaster occurs, there was an official investigation into the cause of the accident, which found that an O-ring connecting two sections of the solid rocket booster had leaked, resulting in failure of the joint and explosion of the large liquid fuel tank (see figure 6.1).



Figure 6.1: An image of the solid rocket booster leaking fuel, seconds before the explosion. By NASA (Great Images in NASA Description) [Public domain], via Wikimedia Commons

The investigation found that many aspects of the NASA decision making process were flawed, and focused in particular on a meeting that was had between NASA staff and engineers from Morton Thiokol, a contractor who had built the solid rocket boosters. These engineers were particularly concerned because the temperatures were forecast to be very cold on the morning of the launch, and they had data from previous launches showing that performance of the O-rings was compromised at lower temperatures. In a meeting on the evening before the launch, the engineers presented their data to the NASA managers, but were unable to convince them to postpone the launch. Their evidence was a set of hand-written slides showing numbers from various past launches.

The visualization expert Edward Tufte has argued that with a proper presentation of all of the data, the engineers could have been much more persuasive. In particular, they could have shown a figure like the one in Figure 6.2, which highlights two important facts. First, it shows that the amount of O-ring damage (defined by the amount of erosion and soot found outside the rings after the solid rocket boosters were retrieved from the ocean in previous flights) was closely related to the temperature at takeoff. Second, it shows that the range of forecasted temperatures for the morning of January 28 (shown in the shaded area) was well outside of the range of all previous launches. While we can't know for sure, it seems at least plausible that this could have been more persuasive.

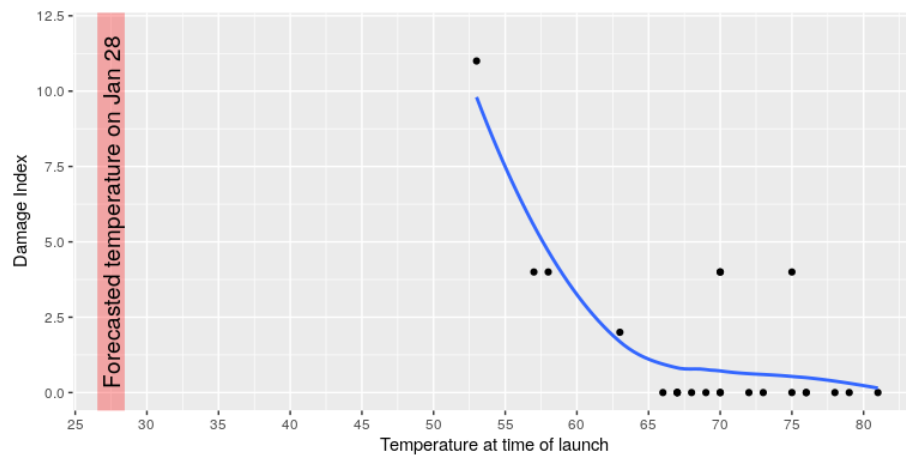


Figure 6.2: A replotting of Tufte's damage index data. The line shows the trend in the data, and the shaded patch shows the projected temperatures for the morning of the launch.

[6.1: Anatomy of a Plot](#)

[6.2: Principles of Good Visualization](#)

[6.3: Accommodating Human Limitations](#)

[6.4: Correcting for Other Factors](#)

[6.5: Suggested readings and videos](#)

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