

The Dangers of Using PowerPoint as a Communication Tool

...and How Best to Use it if you Must

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Visual Aids

This document contains figures 1—5 which are referenced in the oral presentation.

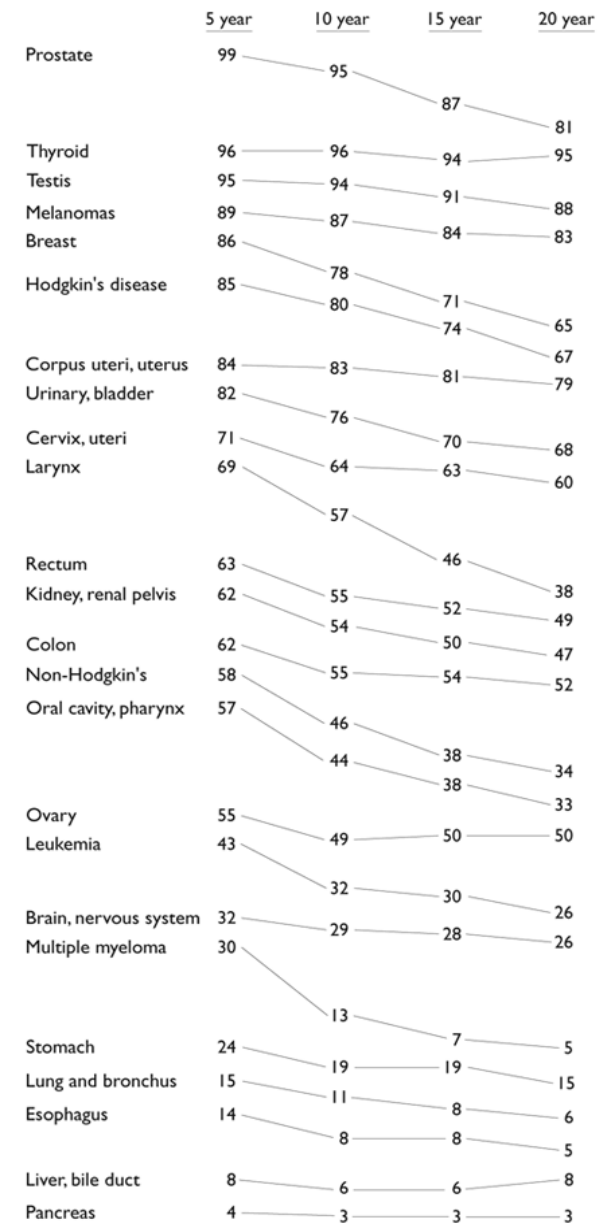
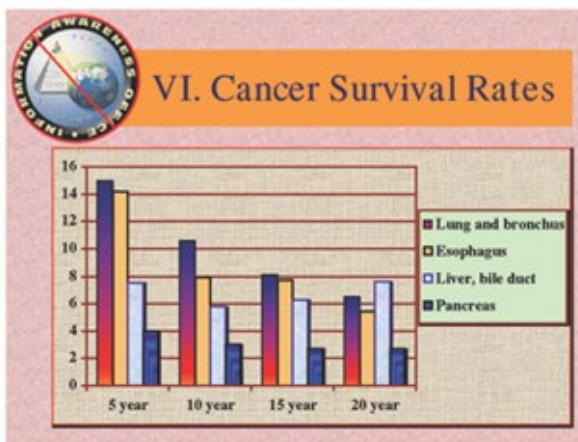
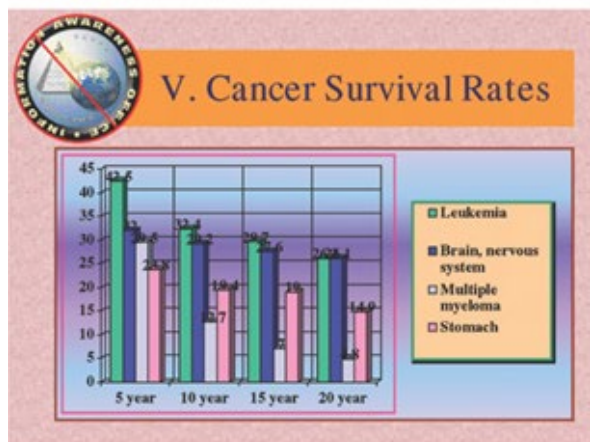
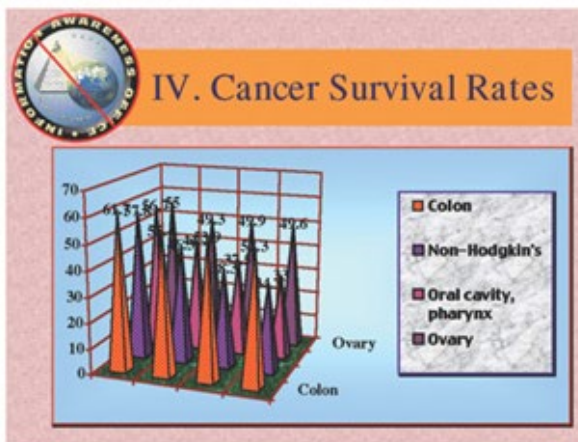
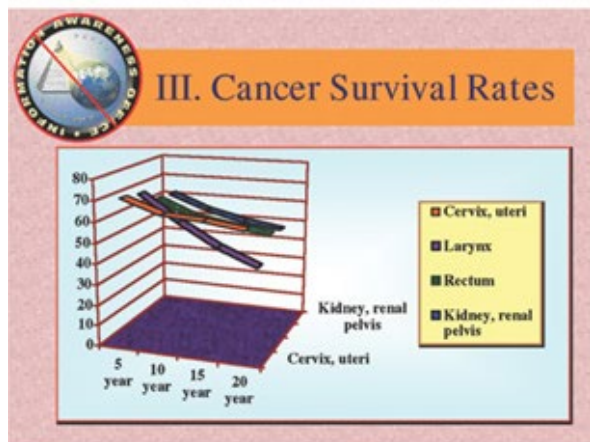
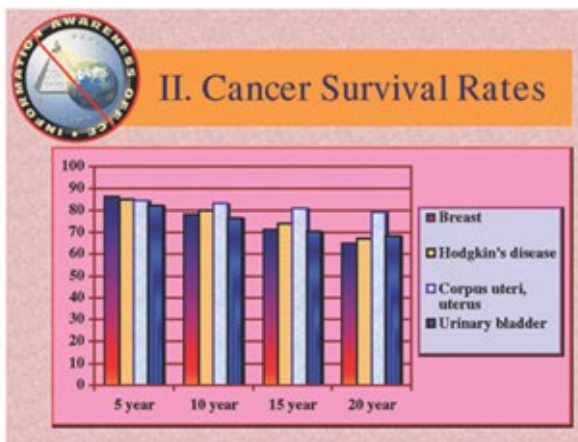
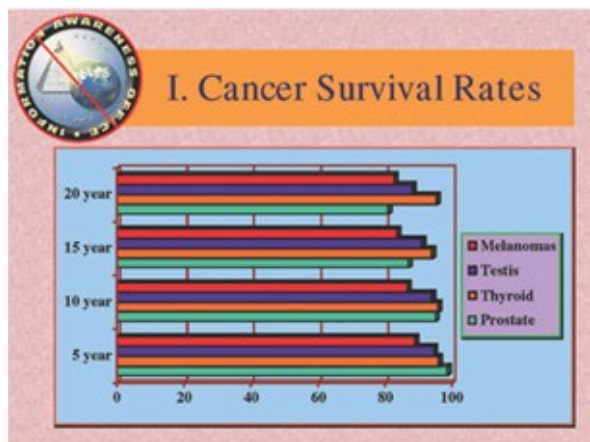


Fig. 1. An example of extreme "chartjunk:" The data in these charts becomes incomprehensible as format takes precedence over content. Survival Rates chart from the Information Awareness Office of Defense Advanced Research Projects Agency (DARPA), 2002.

Fig. 2. An elegantly simple chart: It contains the *same* data as that of the six charts on the left. Note how the data has been ordered, and how the viewer can comprehend at a glance the relative survival rates over five-year periods. Cancer survival chart revision by Edward Tufte. *Beautiful Evidence*, p. 176.

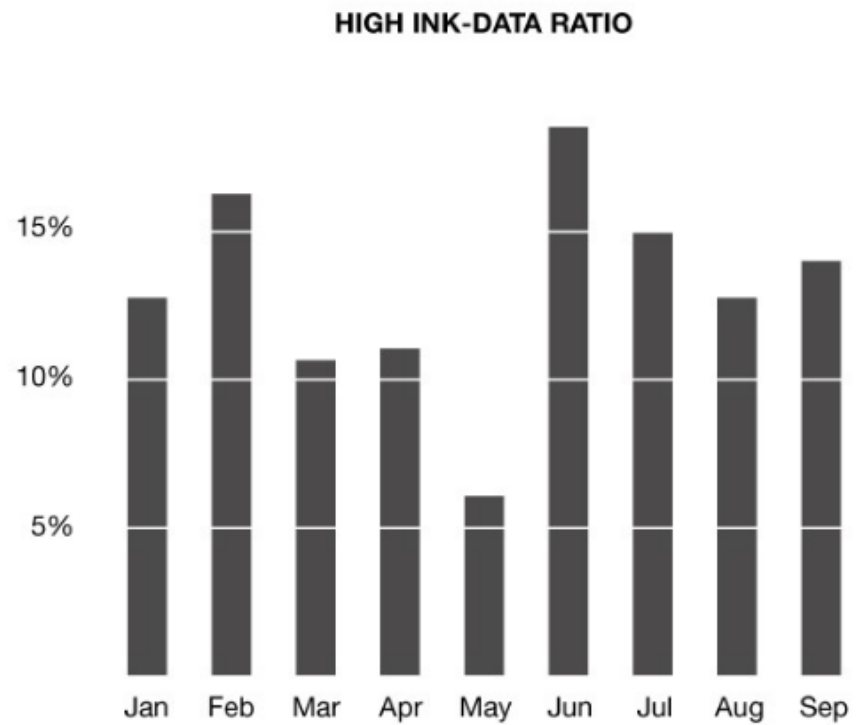
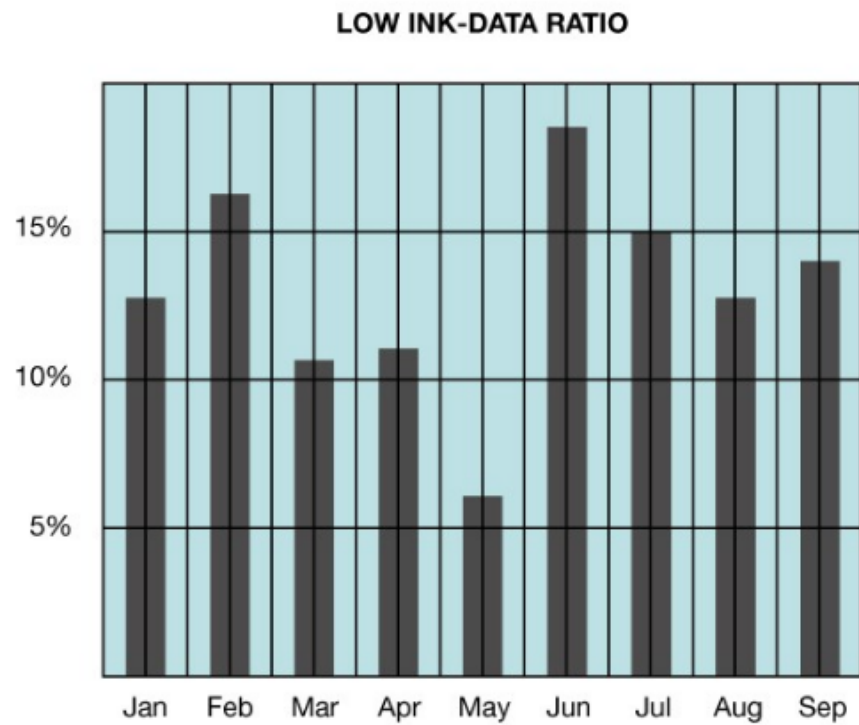


Fig. 3. Removing extraneous elements of a chart to remove distractions: The background color and grid have been removed from the chart on the left, resulting in the chart on the right which contains no excess “ink;” it has a high ink-data ratio. (Data ÷ ink = ink-data ratio.) <https://www.winwire.com/data-visualization/>.

On this one Columbia slide, a PowerPoint festival of bureaucratic hyper-rationalism, 6 different levels of hierarchy are used to display, classify, and arrange 11 phrases:

- Level 1 Title of Slide
- Level 2 ● Very Big Bullet
- Level 3 — big dash
- Level 4 ♦ medium-small diamond
- Level 5 • tiny square bullet
- Level 6 () parentheses ending level 5

The analysis begins with the dreaded Executive Summary, with a conclusion presented as a headline: "Test Data Indicates Conservatism for Tile Penetration." This turns out to be unmerited reassurance. Executives, at least those who don't want to get fooled, had better read far beyond the title.

The "conservatism" concerns the *choice of models* used to predict damage. But why, after 112 flights, are foam-debris models being calibrated during a crisis? How can "conservatism" be inferred from a loose comparison of a spreadsheet model and some thin data? Divergent evidence means divergent evidence, not inferential security. Claims of analytic "conservatism" should be viewed with skepticism by presentation consumers. Such claims are often a rhetorical tactic that substitutes verbal fudge factors for quantitative assessments.

As the bullet points march on, the seemingly reassuring headline fades away. Lower-level bullets at the end of the slide undermine the executive summary. This third-level point notes that "Flight condition [that is, the debris hit on the Columbia] is significantly outside of test database." How far outside? The final bullet will tell us.

This fourth-level bullet concluding the slide reports that the debris hitting the Columbia is estimated to be $1920/3 = 640$ times larger than data used in the tests of the model! The correct headline should be "Review of Test Data Indicates Irrelevance of Two Models." This is a powerful conclusion, indicating that pre-launch safety standards no longer hold. The original optimistic headline has been eviscerated by the lower-level bullets.

Note how close readings can help consumers of presentations evaluate the presenter's reasoning and credibility.

The Very-Big-Bullet phrase fragment does not seem to make sense. No other VBB's appear in the rest of the slide, so this VBB is not necessary.

Spray On Foam Insulation, a fragment of which caused the hole in the wing

A model to estimate damage to the tiles protecting flat surfaces of the wing

Review of Test Data Indicates Conservatism for Tile Penetration

- The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data
 - Crater overpredicted penetration of tile coating significantly

- Initial penetration to described by normal velocity
 - Varies with volume/mass of projectile (e.g., 200ft/sec for 3cu. in)
- Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating
 - Test results do show that it is possible at sufficient mass and velocity
- Conversely, once tile is penetrated SOFI can cause significant damage
 - Minor variations in total energy (above penetration level) can cause significant tile damage

- Flight condition is significantly outside of test database
 - Volume of ramp is 1920cu in vs 3 cu in for test


BOEING

Here "ramp" refers to foam debris (from the bipod ramp) that hit Columbia. Instead of the cryptic "Volume of ramp," say "estimated volume of foam debris that hit the wing." Such clarifying phrases, which may help upper level executives understand what is going on, are too long to fit on low-resolution bullet outline formats. PP demands the shorthand of acronyms, phrase fragments, and clipped jargon in order to get at least some information into the tight format.

Fig. 4. Edward Tufte's analysis of a Boeing PowerPoint slide for the Columbia Accident Investigation Board. Source: Edward Tufte, "PowerPoint Does Rocket Science: Assessing the Quality and Credibility of Technical Reports," *Beautiful Evidence* (Cheshire, CT: Graphics Press LLC, 2006) p. 164. https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001yB&topic_id=1&topic=Ask+E%2eT%2e.

Review of Test Data Indicates Conservatism for Tile Penetration

- The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data
 - Crater overpredicted penetration of tile coating **significantly**
 - Initial penetration to described by normal velocity
 - Varies with volume/mass of projectile (e.g., 200ft/sec for 3cu. In)
 - **Significant** energy is required for the softer SOFI particle to penetrate the relatively hard tile coating
 - Test results do show that *it* is possible at sufficient mass and velocity
 - Conversely, once tile is penetrated SOFI can cause **significant** damage
 - Minor variations in total energy (above penetration level) can cause **significant** tile damage
 - Flight condition is **significantly** outside of test database
 - Volume of ramp is 1920cu in vs 3 cu in for test



The vigorous, vaguely quantitative, words “significant” and “significantly” are used 5 times on this slide, with meanings ranging from “detectable in a perhaps irrelevant calibration case study” to “an amount of damage so that everyone dies” to “a difference of 640-fold.” None of the 5 “significants” refer to “statistical significance;” such wordplay may suggest that a formal statistical analysis has been done.

Note the analysis is about *tile* penetration. But what about RCC penetration? As investigators later demonstrated, the foam did not hit the tiles on the wing surface, but instead the delicate reinforced-carbon-carbon (RCC) protecting the wing leading edge. Alert consumers should carefully watch how presenters delineate *the scope of their analysis*, a profound and sometimes decisive matter.

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Slideville’s low resolution and large type generate space-wasting typographic orphans, lonely words dangling on 4 separate lines:

Penetration **significantly** 3cu. In and velocity

The really vague pronoun reference “it” alludes to *damage to the left wing*, which ultimately destroyed the Columbia (although the slide here deals with tile not RCC damage). Low-resolution formats may encourage vague pronoun references because there isn’t enough space for specific and precise phrases.

The same unit of measurement for volume (cubic inches) is shown in a slightly different way every time

3cu. In 1920cu in 3 cu in

rather than in clear and tidy exponential form 1920 in³. Shakiness in conventions for units of measurement should always provoke concern, as it does in grading the problem sets of sophomore engineering students.* PowerPoint is not good at math and science; here at NASA, engineers are using a presentation tool that makes it difficult to write scientific notation. The pitch-style typography of PP is hopeless for science and engineering, yet this important analysis relied on PP. Technical articles are not published in PP; why then should PP be used for serious technical analysis, such as diagnosing the threat to Columbia?

*The Columbia Accident Investigation Board (final report, p. 191) referred to this point about units of measurement: “While such inconsistencies might seem minor, in highly technical fields like aerospace engineering a misplaced decimal point or mistaken unit of measurement can easily engender inconsistencies and inaccuracies.” The phrase “mistaken unit of measurement” is an unkind veiled reference to a government agency that had crashed \$250 million of spacecraft into Mars because of mix-up between metric and non-metric units of measurement.

Fig. 5. Edward Tufte’s analysis of a Boeing PowerPoint slide for the Columbia Accident Investigation Board. Source: Edward Tufte, “PowerPoint Does Rocket Science: Assessing the Quality and Credibility of Technical Reports,” *Beautiful Evidence* (Cheshire, CT: Graphics Press LLC, 2006) p. 165. https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001yB&topic_id=1&topic=Ask+E%2eT%2e.