Edward R. Tufte

The Cognitive Style of PowerPoint
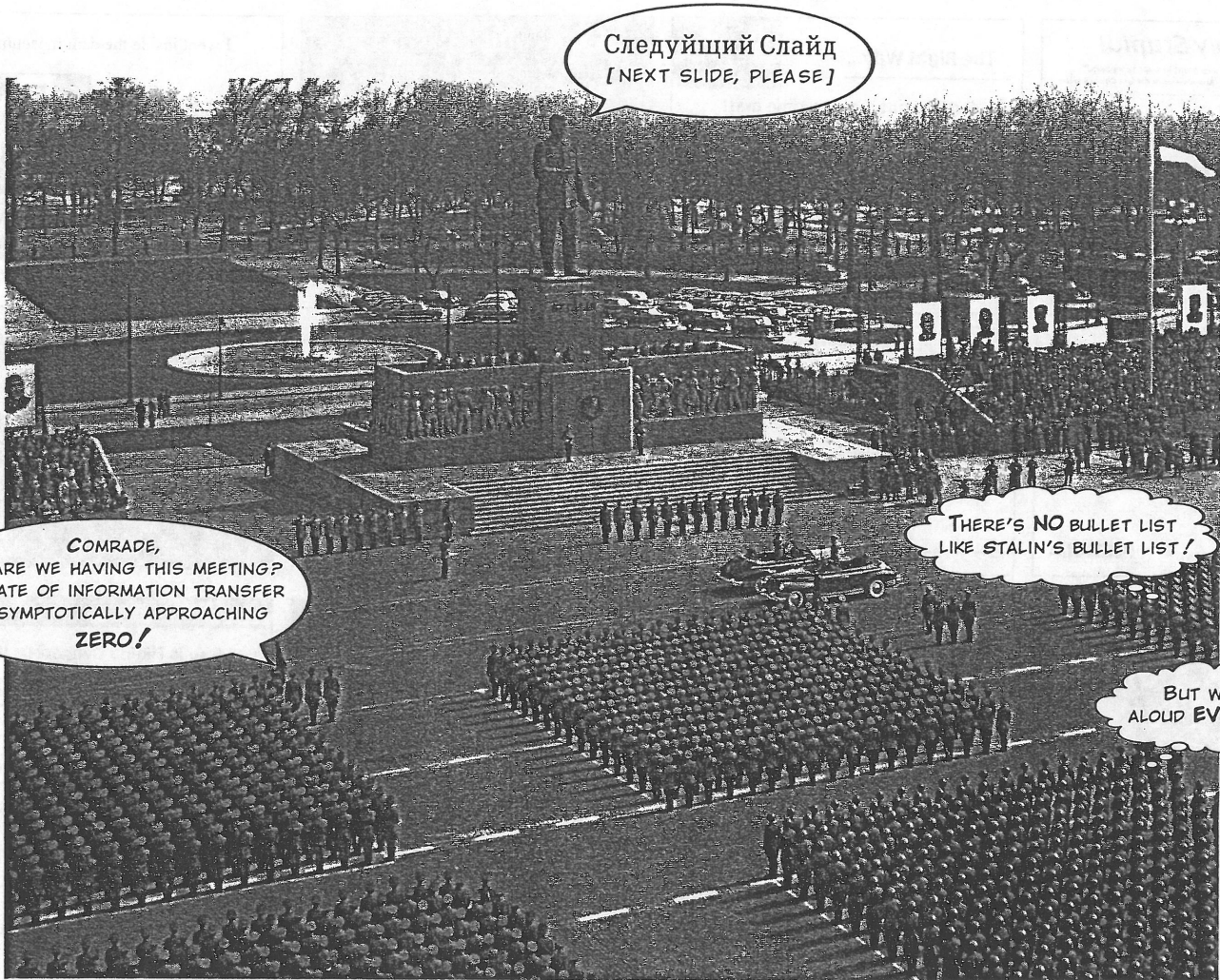
Military parade, Stalin Square, Budapest, April 4, 1956.

Marketing Strategy

Good 4 U

Evaluating Results

⇒ Determine methods
⇒ Set realistic goals
⇒ Analyze performance
⇒ Ensure objectivity

Vision Statement

- Improve quality produce
- Sell more produce to more customers
- Become clear market leader in southern California

Two-Year Goals

- Triple gross income
- Have market share of 50% in southern California
- Double customer base
- Reduce cost of storing and transporting produce by 8%

Projected Gross Income

It's the Supply Stupid!

"California has not built a major power plant in over ten years."
Assemblyman Rod Wright (D) Los Angeles

A Presentation by Senator Tom McClintock. Further Information (916) 445-6073

The Right Way...

Putting out the welcome mat!

Provide bold LEADERSHIP by showing that California is in the 'power plant building business'

Provide incentives for rapid construction of transmission lines and power plants

Revenue bonds for clean Hydro & Nuclear projects

WELCOME

A Presentation by Senator Tom McClintock. Further Information (916) 445-6073

Dad and I Visit the Dalles Dam

By Keith

I went inside the dam museum.

Welcome

---

3. Käyttäjäkeskeinen suunnittelu

Human/User Centred Design

NOKIA

Käytettävyys

Määritelmä: Usability

- an extent to which the product can be used by the user to achieve specified goals in a specified context of use (ISO 13407).

NOKIA

Käyttäjäkeskelsyys tuotesuunnittelussa – onko sitä?

- Miten käyttäjäkeskeinen tuotesuunnittelu tai sen puute näkyy tuotteessa?

NOKIA

Projected Revenue Growth

(millions)

1999   2000   2001   2002

The Sun is FAR AWAY!

U.S. & Canada:
Sales Growth %
A Strong Start to 1996

To May 1996

IRAQ FAILING TO DISARM

Iraq Is Hiding Evidence

Conversation between two Iraqi military officers, November 26, 2002

Iraqi trucks removing materials from sites to be inspected

Col: we have this modified vehicle......
Gen: I'm worried you all have something left.
Col: We evacuated everything. We don't have anything left.

U.S. SECRETARY OF STATE POWELL'S PRESENTATION TO THE UN SECURITY COUNCIL

IRAQ FAILING TO DISARM

Iraq Is Hiding Dangerous Weapons

After inspectors revealed his earlier biological program, Saddam built biological weapons factories on wheels

Instructions relayed to an officer in the field, January 2003

A: Capt. Ibrahim?
B: I am with you, sir.
A: Remove... the expression... nerve agents... whenever it comes up... in the wireless instructions.
B: Consider it done, sir.

U.S. SECRETARY OF STATE POWELL'S PRESENTATION TO THE UN SECURITY COUNCIL

Introduction

The Roman Empire included many different groups of people. This presentation tells you about eight different groups of people who lived in the Roman Empire.

People in the Roman Empire

The eight groups of people you will learn about are:
1. The Dacians (Romanians)
2. The Celts (British or French)
3. The Numidians (North Africans)

People in the Roman Empire

4. The Roman Citizens (from Italy)
5. The Greeks
6. The Syrians
7. The Jews (from Israel)
8. The Palmyrans (from Jordanian)

The Dacians (Romanians)

INFORMATION AWARENESS OFFICE
Scientia Est Potentia
DARPA

1999 Sales Categories

Take out 10%
Apparel 18%
Food 38%
Beverage 34%

Apparel includes revenue from trademark licensing

A Company With A Clear Focus

Metals

- Metals
- Metals
- Metals

2000 Special Events Revenue

(thousands)   New Health Marathon
$160
$120
$80
$40
$0

1st Quarter   2nd Quarter   3rd Quarter   4th Quarter

The Cognitive Style of PowerPoint

IN corporate and government bureaucracies, the standard method for making a presentation is to talk about a list of points organized onto slides projected up on the wall. For many years, overhead projectors lit up transparencies, and slide projectors showed high-resolution 35mm slides. Now "slideware" computer programs for presentations are nearly everywhere. Early in the 21st century, several hundred million copies of Microsoft PowerPoint were turning out trillions of slides each year.

Alas, slideware often reduces the analytical quality of presentations. In particular, the popular PowerPoint templates (ready-made designs) usually weaken verbal and spatial reasoning, and almost always corrupt statistical analysis. What is the problem with PowerPoint? And how can we improve our presentations?

When Louis Gerstner became president of IBM, he encountered a big company caught up in ritualistic slideware-style presentations:

> One of the first meetings I asked for was briefing on the state of the [main-frame computer] business. I remember at least two things about that first meeting with Nick Donofrio, who was then running the System/390 business. One is that I . . . experienced a repeat of my first day on the job. Once again, I found myself lacking a badge to open the doors at the complex, which housed the staffs of all of IBM's major product groups, and nobody there knew who I was. I finally persuaded a kind soul to let me in, found Nick, and we got started. Sort of.
>
> At that time, the standard format of any important IBM meeting was a presentation using overhead projectors and graphics that IBMers called "foils" [projected transparencies]. Nick was on his second foil when I stepped to the table and, as politely as I could in front of his team, switched off the projector. After a long moment of awkward silence, I simply said, "Let's just talk about your business."
>
> I mention this episode because it had an unintended, but terribly powerful ripple effect. By that afternoon an e-mail about my hitting the Off button on the overhead projector was crisscrossing the world. Talk about consternation! It was as if the President of the United States had banned the use of English at White House meetings.[1]

There is a lot going on here: the humiliation ceremony authorizing entry into the Corporate Palace, a new president symbolically demonstrating that things were going to be different from now on, and a blunt action indicating that there might be better ways to do serious analysis than reading aloud from projected lists—*"Let's just talk about your business."*

[1] Louis V. Gerstner, Jr., *Who Says Elephants Can't Dance? Inside IBM's Historic Turn-around* (2002), p. 43.

The Cognitive Style of PowerPoint

Gerstner's idea, *"Let's just talk about your business,"* means an exchange of information, an interplay between speaker and audience. Yet PowerPoint is entirely *presenter-oriented,* and *not content-oriented, not audience-oriented.* The claims of PP marketing are addressed to speakers: "A cure for the presentation jitters." "Get yourself organized." "Use the AutoContent Wizard to figure out what you want to say." The fans of PowerPoint are presenters, rarely audience members.

Slideware helps speakers to outline their talks, to retrieve and show diverse visual materials, and to communicate slides in talks, printed reports, and internet. And also to replace serious analysis with chartjunk, over-produced layouts, cheerleader logotypes and branding, and corny clip art. That is, PowerPointPhluff.

PP convenience for the speaker can be costly to both content and audience. These costs result from the *cognitive style characteristic of the standard default PP presentation:* foreshortening of evidence and thought, low spatial resolution, a deeply hierarchical single-path structure as the model for organizing every type of content, breaking up narrative and data into slides and minimal fragments, rapid temporal sequencing of thin information rather than focused spatial analysis, conspicuous decoration and Phluff, a preoccupation with format not content, an attitude of commercialism that turns everything into a sales pitch.

Extremely Low Resolution of PowerPoint

PP slides projected up on the wall are very low resolution—compared to paper, 35mm slides, and the immensely greater capacities of the human eye-brain system. Impoverished space leads to over-generalizations, imprecise statements, slogans, lightweight evidence, abrupt and thinly-argued claims. For example, this slide from a statistics course shows a seriously incomplete statement. Probably the *shortest true statement* that can be made about causality and correlation is *"Empirically observed covariation is a necessary but not sufficient condition for causality."* Or perhaps *"Correlation is not causation but it sure is a hint."* Many true statements are too long to fit on a PP slide, but this does not mean we should abbreviate the truth to make the words fit. It means we should find a better way to make presentations.

With so little information per slide, many many slides are needed. Audiences consequently endure a relentless sequentiality, one damn slide after another. When information is stacked in time, it is difficult to understand context and evaluate relationships. Visual reasoning usually works more effectively when the relevant information is shown adjacent in space within our eyespan. This is especially the case for statistical data, where the fundamental analytical act is to make comparisons.
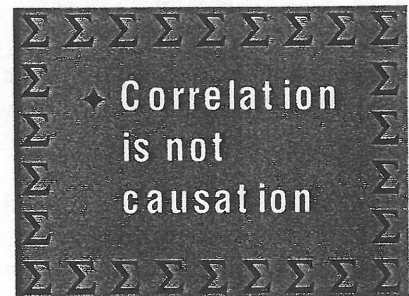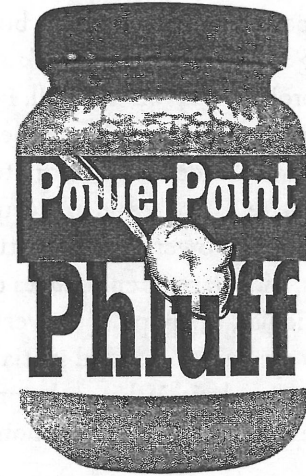
The statistical graphics generated by the PowerPoint ready-made templates are astonishingly thin, nearly content-free. In 28 books on PP presentations, the 217 data graphics depict an average of 12 numbers each. Compared to the worldwide publications shown in the table at right, the statistical graphics based on PP templates are the thinnest of all, except for those in *Pravda* back in 1982, when that newspaper operated as the major propaganda instrument of the Soviet communist party and a totalitarian government. Doing a bit better than *Pravda* is not good enough. Data graphics based on PP templates show 10% to 20% of the information found in routine news graphics. The appropriate response to such vacuous displays is for people in the audience to speak out: *"It's more complicated than that!" "Why are we having this meeting? The rate of information transfer is asymptotically approaching zero."*

Bullet Outlines Dilute Thought

Impoverished resolution coerces slide-makers into using the compressed language of presentations—the *bullet list* of brief phrases. Bullets, little marks sometimes decorative or cute, signal the beginning of each phrase for those unable to recognize it. Sometimes the bullet hierarchies are so complex and intensely nested that they resemble computer code.

By insisting that points be placed in an orderly structure, the bullet list may help extremely disorganized speakers get themselves organized. The bullet list is surely the most widely used format in corporate and government presentations. Bullets show up in many paper reports, as presenters simply print out their PP slides.

For the naive, bullet lists may create the appearance of hard-headed organized thought. But in the reality of day-to-day practice, the PP cognitive style is faux-analytical. A study in the *Harvard Business Review* found generic, superficial, simplistic thinking in the bullet lists widely used in business planning and corporate strategy. What the authors are saying here, in the *Review's* earnestly diplomatic language, is that bullet outlines can make us stupid:

> In every company we know, planning follows the standard format of the bullet outline. . . [But] bullet lists encourage us to be lazy in three specific, and related ways.

> **Bullet lists are typically too generic.** They offer a series of things to do that could apply to any business. . . .

> **Bullets leave critical relationships unspecified.** Lists can communicate only three logical relationships: sequence (first to last in time); priority (least to most important or vice versa); or simple membership in a set (these items relate to one another in some way, but the nature of that relationship remains unstated). And a list can show only one of those relationships at a time.[2]

MEDIAN NUMBER OF ENTRIES IN DATA MATRICES FOR STATISTICAL GRAPHICS IN VARIOUS PUBLICATIONS, 2003

Science	>1,000
Nature	>700
New York Times	120
Wall Street Journal	112
Frankfurter Allgemeine Zeitung	98
New England Journal of Medicine	53
The Lancet	46
Asahi	40
Financial Times	40
Time	37
The Economist	32
Le Monde	28
28 textbooks on PowerPoint presentations (1997-2003)	12
Pravda (1982)	5

Additional evidence on data matrices for various publications, including *Pravda*, is reported in Edward R. Tufte, *The Visual Display of Quantitative Information* (1983, 2001), p. 167. In this table above, the medians are based on at least 20 statistical graphics and at least one full issue of each publication. Except for scientific journals, most of these publications use standard formats issue after issue; replications of several of the counts above were within 10% of the original result.

[2] Gordon Shaw, Robert Brown, Philip Bromiley, "Strategic Stories: How 3M is Rewriting Business Planning," *Harvard Business Review*, 76 (May-June, 1998), pp. 42-44.

By leaving out the narrative between the points, the bullet outline ignores and conceals the causal assumptions and analytic structure of the reasoning. In their *Harvard Business Review* paper on business planning, Shaw, Brown, and Bromiley show that even simple one-way causal models are vague and unspecified in bullet outlines. And more realistic multivariate models with feedback loops and simultaneity are way over the head of the simplistic bullets:

> Bullets leave critical assumptions about how the business works unstated. Consider these major objectives from a standard five-year strategic plan:
>
> - Increase market share by 25%.
> - Increase profits by 30%.
> - Increase new-product introductions to ten a year.

Vision Statement
- Improve quality produce
- Sell more produce to more customers
- Become clear market leader in southern California

> Implicit in this plan is a complex but unexplained vision of the organization, the market, and the customer. However, we cannot extrapolate that vision from the bullet list. The plan does not tell us how these objectives tie together and, in fact, many radically different strategies could be represented by these three simple points. Does improved marketing increase market share, which results in increased profits (perhaps from economies of scale), thus providing funds for increased new-product development?

$$\text{Market share} \longrightarrow \text{Profits} \longrightarrow \text{New-product development}$$

> Or maybe new-product development will result in both increased profits and market share at once:

$$\text{New-product development} \longrightarrow \begin{array}{l} \text{Market share} \\ \text{Profits} \end{array}$$

> Alternatively, perhaps windfall profits will let us just buy market share by stepping up advertising and new-product development:

$$\text{Profits} \longrightarrow \text{New-product development} \longrightarrow \text{Market share}[3]$$

Bullet outlines might be useful in presentations now and then, but *sentences* with subjects and verbs are often better. Instead of this type of soft, generic point found in many business plans

✓ *Accelerate the introduction of new products!*

it would be better to say *who* might do it and *how, when, and where* they might do it. Then several sentences together in a row, a *narrative,* could spell out the specific methods and processes by which the generic feel-good goals of mission statements might be achieved. Presentations for strategic planning might go beyond the words in lists and sentences by using annotated diagrams, images, sketches of causal models, equations, tables of numbers, and multivariate evidence.

[3] Gordon Shaw, Robert Brown, Philip Bromiley, "Strategic Stories: How 3M is Rewriting Business Planning," *Harvard Business Review*, 76 (May-June, 1998), p. 44. © 1998 Harvard Business School Publishing Corporation, all rights reserved.

As in corporate planning, bullet outlines are far from the optimal format for reporting scientific analysis. Indeed such outlines may be pessimal. During the spaceflight of the shuttle Columbia in January 2003, Boeing Corporation engineers prepared 3 quick reports assessing possible damage to the left wing resulting from the impact of several chunks of debris 81 seconds after liftoff.[4] Although the evidence is thin and uncertain, the logical structure of the engineering analysis is straightforward:

kinetic energy of debris impact (function of mass, velocity, and angle of incidence)   **+**   debris hits locations of *varying vulnerability* on the left wing   **⟶**   resulting *level of threat* to Columbia during re-entry heating of tiles
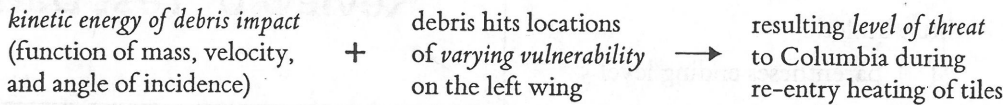
Unfortunately the reports provided an over-optimistic assessment of the problem. Presented as slides with bullet outlines, tables, and graphics, all 3 reports have PP format problems: strict, elaborate hierarchies of points; segregation of text and image (12 of the 14 slides presenting data tables and graphics have no accompanying analysis); atrocious typography; data imprisoned in tables by thick nets of spreadsheet grid lines; and 10 to 20 short lines of text per slide.

Summary and Conclusion

- **Impact analysis ("Crater") indicates potential for large TPS damage**
  - Review of test data shows wide variation in impact response
  - RCC damage limited to coating based on soft SOFI
- **Thermal analysis of wing with missing tile is in work**
  - Single tile missing shows local structural damage is possible, but no burn through
  - Multiple tile missing analysis is on-going
- **M/OD criteria used to assess structural impacts of tile loss**
  - Allows significant temperature exceedance, even some burn through
    - Impact to vehicle turnaround possible, but maintains safe return capability

Conclusion

- **Contingent on multiple tile loss thermal analysis showing no violation of M/OD criteria, safe return indicated even with significant tile damage**

BOEING   2/21/03   13

Results of Impact Analysis for particle size = 20" x 10" x 6"

XT	YT	ZT	VMAX (ft/sec.)	VX (ft/sec.)	VY (ft/sec.)	VZ (ft/sec.)	IMPANG (degrees)
1755	193	625	690	682	104	20	9.0
1759	194	630	699	680	107	25	9.4
1744	190	637	693	683	107	36	8.7
1755	191	641	686	680	107	41	7.6
1800	197	648	702	693	105	46	6.5
1747	190	625	694	677	104	21	7.0
1769	192	629	682	674	105	23	7.1
1751	188	637	685	678	106	33	10.4
1754	188	641	690	681	104	40	7.6
1754	187	644	694	684	103	44	6.6
1755	187	627	683	664	107	23	11.9
1748	185	630	691	682	107	27	13.3
1756	194	636	699	689	109	37	8.9
1806	262	645	712	703	109	42	11.3
1788	199	647	711	701	109	46	10.4
1762	200	637	700	691	109	24	21.5
1833	211	633	707	696	110	28	8.6
1802	204	641	715	705	110	36	12.8
1790	202	644	711	702	110	42	11.3
1781	200	647	712	703	108	09	11.1
1652	169	635	635	627	96	32	6.4
1759	181	627	634	611	903	92	34	2.0
1742	184	636	653	645	98	30	2.0
1706	190	621	705	697	104	18	7.5
1799	291	624	702	694	105	19	7.7
1758	194	624	691	683	104	20	9.1
1830	210	617	723	715	105	12	5.4
1788	205	620	710	702	105	15	7.8
1760	202	622	707	699	106	17	8.1
1762	196	625	694	686	107	21	11.6
1769	196	620	705	697	102	14	7.0
1786	199	623	698	691	103	17	7.2
1755	191	634	687	923	903	19	8.8
2023	238	615	762	756	103	7	1.1
1830	210	617	723	715	108	12	5.4

STS-107 Debris Impacting Orbiter Wing   *BOEING*

In the reports, *every single text-slide* uses bullet-outlines with 4 to 6 levels of hierarchy. Then another multi-level list, another bureaucracy of bullets, *starts afresh* for a new slide. How is it that each elaborate architecture of thought always fits *exactly* on one slide? The rigid slide-by-slide hierarchies, indifferent to content, slice and dice the evidence into arbitrary compartments, producing an anti-narrative with choppy continuity. Medieval in its preoccupation with hierarchical distinctions, the PowerPoint format signals every bullet's status in 4 or 5 different simultaneous ways: by order in sequence, extent of indent, size of bullet, style of bullet, and size of type associated with the bullet. On the next page, we see up close a slide from the Columbia analysis.

[4] Carlos Ortiz, Arturo Green, Jack McClymonds, Jeff Stone, Abdi Khodadoust, "Preliminary Debris Transport Assessment of Debris Impacting Orbiter Lower Surface in STS-107 Mission," January 21, 2003; P. Parker, D. Chao, I. Norman, M. Dunham, "Orbiter Assessment of STS-107 ET Bipod Insulation Ramp Impact," January 23, 2003; Carlos Ortiz, "Debris Transport Assessment of Debris Impacting Orbiter Lower Surface in STS-107 Mission," January 24, 2003. The Boeing reports were published by NASA at their websites in official records of the Columbia investigation: http://www.nasa.gov/columbia and other public STS-107 investigation files.

On this single Columbia slide, in a PowerPoint festival of bureaucratic hyper-rationalism, 6 different levels of hierarchy are used to classify, prioritize, and display 11 simple sentences:

Level 1   Title of Slide
Level 2   ● Very Big Bullet
Level 3   — dash
Level 4   ◆ diamond
Level 5   • little bullet
Level 6   ( ) parentheses ending level 5

The analysis begins with the dreaded "Executive Summary." A conclusion is presented as a headline title: "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" is *not* about the predicted tile damage but rather about the *choice of models* that might be used to predict damage! But why, after 112 flights, are models being calibrated during a crisis? How can "conservatism" be inferred from a loose comparison of a computer model and some thin data? Divergent evidence means divergent evidence, not inferential security. Claims of analytic "conservatism" should be viewed with skepticism. Such claims are sometimes a rhetorical tactic that substitutes verbal fudge factors for quantitative assessments.

As the analysis continues, the seemingly reassuring conclusion of the headline fades away.

These lower-level bullets at the end of the slide reveal that the headline conclusion is irrelevant and diverting. This third-level point notes that "Flight condition [that is, the Columbia] is significantly outside of test database." How far outside? The final bullet will tell us.

This fourth-level bullet concluding the slide says that, by the way, the debris that struck the Columbia is estimated to be 1920/3 = 640 times larger than data used in the tests of the model! Thus a better headline would be "Review of Test Data Indicates Irrelevance of Two Models." There is an interesting dynamic to this slide: the headline is an exercise in misdirection, which the text then awkwardly and slowly eviscerates.

Spray On Foam Insulation

Review of Test Data Indic
Pene

● **The existing SOFI on tile te**
  was reviewed along with ST
  — **Crater overpredicted pe**
    significantly
    ◆ **Initial penetration to de**
      • **Varies with volume/**
        3cu. In)
    ◆ **Significant energy is re**
      to penetrate the relative
      • **Test results do shov**
        and velocity
    ◆ **Conversely, once ⌂e is**
      significant damage
      • **Minor variations in t**
        can cause significar
  — **Flight condition is signi**
    ◆ **Volume of ramp is 1920**

BOEING   2

A model to estimate damage to
the tiles protecting the left wing

tes Conservatism for Tile
ation

data used to create Crater
-87 Southwest Research data
tration of tile coating

ribed by normal velocity
ass of projectile (e.g., 200ft/sec for

ired for the softer SOFI particle
hard tile coating
hat it is possible at sufficient mass

enetrated SOFI can cause

l energy (above penetration level)
ile damage

antly outside of test database
in vs 3 cu in for test

/03   6

A reference to a foam insulation piece that
separated from the bipod ramp tying the orbiter
to the large liquid fuel tank. Instead of "ramp,"
say "estimated volume of one of several pieces
of debris that might have damaged the wing."

The vaguely quantitative words "significant" and
"significantly" are used 5 times on this slide, with *de facto*
meanings ranging from "detectable in largely irrelevant
calibration case study" to "an amount of damage so that
everyone dies" to "a difference of 640-fold." None of
these 5 usages appears to refer to the technical meaning
of "statistical significance."

The low resolution of PowerPoint slides promotes
the use of compressed phrases like "Tile Penetration."
As is the case here, such phrases may well be ambiguous.
The low resolution and large font generate 3 typographic
orphans, lonely words dangling on a separate line:
Penetration   **significantly**   3cu. In

?

This vague pronoun reference "it" alludes to *damage*
to the protective tiles, which caused the destruction of the
Columbia. The slide weakens important material with
ambiguous language (sentence fragments, passive voice,
multiple meanings of "significant"). The 3 reports
were created by engineers for high-level NASA officials
who were deciding whether the threat of wing damage
required further investigation before the Columbia
attempted to return. Satisfied that the reports indicated
that the Columbia was not in danger, the officials made
no further attempts to assess the threat. The slides were
part of an oral presentation, later circulated as e-mail
attachments.

In this slide the same unit of measure for volume
(cubic inches) is shown a different way every time
         3cu. In   1920cu in   3 cu in
rather than in clear and tidy exponential form 1920 in^3.
Perhaps the available font cannot show exponents.
Shakiness in units of measurement provokes concern.
Slides that use hierarchical bullet-outlines do not
handle statistical data and scientific notation gracefully.
If PowerPoint is a corporate-mandated format for all
engineering reports, then some competent scientific
typography (rather than the PP market-pitch style) is
essential. In this slide, the typography is so choppy and
clunky that it impedes understanding.

This is a lot of format for a simple engineering problem. During the Columbia flight, NASA engineers wrote several hundred e-mails (with the Boeing reports in PP format sometimes attached).[5] The text of 90% of these e-mails simply used paragraphs and sentences; 10% used bullet lists with 2 or 3 levels. The engineers were able to reason about the issues without the multi-level hierarchical outlines of the original PP pitch. Do more complicated topics require ever more layered bullet structures? People have communicated about complex matters for centuries without hierarchical bullet lists. Richard Feynman wrote about much of physics—mechanics, optics, thermodynamics, quantum behavior—in a 600-page book with *only 2 levels*: chapters and headings within chapters. →

In the Columbia reports, the hierarchical bullet lists failed to bring clarity or focus to the presentation; on the contrary, the argument and evidence appeared broken up into arbitrary fragments. And the *Harvard Business Review* study of corporate planning found that the widely used bullet outlines did not bring intellectual discipline to planning—instead the bullets accommodated the generic, superficial, simplistic.

High-Resolution Visual Channels

A talk, which proceeds at a pace of 100 to 160 spoken words per minute, is not an especially high resolution method of data transmission. Rates of transmitting *visual* evidence can be far higher. The artist Ad Reinhardt said, "As for a picture, if it isn't worth a thousand words, the hell with it." People can quickly look over tables with hundreds of numbers in, say, financial or sports pages in newspapers. People read 300 to 1,000 printed words a minute, and find their way around a printed map or a 35mm slide displaying 5 to 40 MB in the visual field. Yet, in a strange reversal, the PP visuals that accompany a talk have a much *lower* rate of information transmission than the talk itself. As shown at right, *the PP slide typically shows 40 words, which is about 8 seconds-worth of silent reading material.* For serious presentations, it will often be useful to replace slides with paper handouts showing words, numbers, data graphics, images together.

High-resolution handouts allow viewers to contextualize, compare, narrate, and recast evidence. In contrast, data-thin, forgetful displays tend to make audiences ignorant and passive, and also to diminish the credibility of the presenter. Thin visual content prompts suspicions: "What are they leaving out? Is that all they know? Does the speaker think we're stupid?" Sometimes PowerPoint's low resolution is said to promote a clarity of reading and thinking. Yet in visual reasoning, art, typography, cartography, even sculpture, *the quantity of detail is an issue completely separate from the difficulty of reading.*[6] Often, the more intense the detail, the *greater* the clarity and understanding—because meaning and reasoning are *contextual*. Less is a bore.

[5] The NASA internal e-mails were published by NASA at their website in the files on the Columbia investigation: http://www.nasa.gov and in other official STS-107 investigation files.

Above, page layout in Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics* (1963), chapter 38, page 5.

WORDS ON TEXT-ONLY POWERPOINT SLIDES

Columbia slides by Boeing, median number of words per slide	97
1,460 text-only slides in 189 PP reports top-ranked by Google in March 2003, posted on internet, median number of words per slide	40
654 slides in 28 PowerPoint textbooks, 1997–2003, median number of words per slide	15

[6] Edward R. Tufte, *Envisioning Information* (1990), pp. 36–51.

Metaphors for Presentations

Years before today's slideware, presentations at companies such as IBM and in the military used bullet lists shown by overhead projectors. Then, in 1984, a software house developed a presentation package, "Presenter," which was eventually acquired by Microsoft and turned into PowerPoint.

This history is revealing, for the metaphor behind the PP cognitive style is *the software corporation itself*. That is, a big bureaucracy engaged in *computer programming* (deeply hierarchical, nested, highly structured, relentlessly sequential, one-short-line-at-a-time) and in *marketing* (fast pace, misdirection, advocacy not analysis, slogan thinking, branding, exaggerated claims, marketplace ethics). *To describe a software house is to describe the PowerPoint cognitive style.* Why should the structure, activities, and values of a large commercial bureaucracy be a useful metaphor for our presentations? Could any metaphor be worse? Voice-mail menu systems? Billboards? Television? Stalin?

The pushy PP style imposes itself on the audience and, at times, seeks to set up a dominance relationship between speaker and audience. The speaker, after all, is making *power points with bullets to followers*. Such aggressive, stereotyped, over-managed presentations—the Great Leader up on the pedestal—are characteristic of hegemonic systems:

> The Roman state bolstered its authority and legitimacy with the trappings of ceremony. . . . Power is a far more complex and mysterious quality than any apparently simple manifestation of it would appear. It is as much a matter of impression, of theatre, of persuading those over whom authority is wielded to collude in their subjugation. Insofar as power is a matter of presentation, its cultural currency in antiquity (and still today) was the creation, manipulation, and display of images. In the propagation of the imperial office, at any rate, art was power.[7]

[7] Jás Elsner, *Imperial Rome and Christian Triumph: The Art of the Roman Empire AD 100–450* (1998), p. 53.

A better metaphor for presentations is *good teaching*.[8] Teachers seek to explain something with credibility, which is what many presentations are trying to do. The core ideas of teaching—*explanation, reasoning, finding things out, questioning, content, evidence, credible authority not patronizing authoritarianism*—are contrary to the hierarchical market-pitch approach.

Particularly disturbing is introduction of the PowerPoint cognitive style into schools. Instead of writing a report using sentences, children learn how to make client pitches and info-mercials, which is better than encouraging children to smoke. Elementary school PP exercises (as seen in teacher's guides, and in student work posted on the internet) typically show 10 to 20 words and a piece of clip art on each slide in a presentation consisting of 3 to 6 slides—a total of perhaps 80 words (15 seconds of silent reading) for a week of work. Rather than being trained as mini-bureaucrats in PPPhluff and foreshortening of thought, students would be better off if the schools simply closed down on those days and everyone went to The Exploratorium. Or wrote an illustrated essay explaining something.

[8] For various and sometimes divergent ideas about teaching and presentations, see Joseph Lowman, *Mastering the Techniques of Teaching* (1995); Wilbert J. McKeachie and Barbara K. Hofer, *McKeachie's Teaching Tips* (2001); Frederick Mosteller, "Classroom and Platform Performance," *The American Statistician,* 34 (February 1980), 11–17 (posted at www.edwardtufte.com); and Edward R. Tufte, *Visual Explanations* (1997), pp. 68–71.

12

The Gettysburg PowerPoint Presentation

The PP cognitive style is so distinctive and peculiar that presentations relying on the standard ready-made templates appear to be over-the-top parodies instead of the sad realities that they are. Here is an intentional parody: imagine if Abraham Lincoln had used PowerPoint at Gettysburg. . . .

Um, my name is Abraham Lincoln and, um, I have to reboot . . . .

As we see in the Organizational Overview slide, four score and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation or any nation so conceived and so dedicated can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. But in a larger sense, we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead who struggled here have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is for us the living rather to be dedicated here to the unfinished work which they who fought here have thus far so

Gettysburg Cemetery Dedication

Abraham Lincoln

11/19/1863

Organizational Overview

□ New Nations

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

-87 Years   Now

11/19/1863

Agenda

- Met on battlefield (great)
- Dedicate portion of field - fitting!
- Unfinished work (great tasks)

11/19/1863
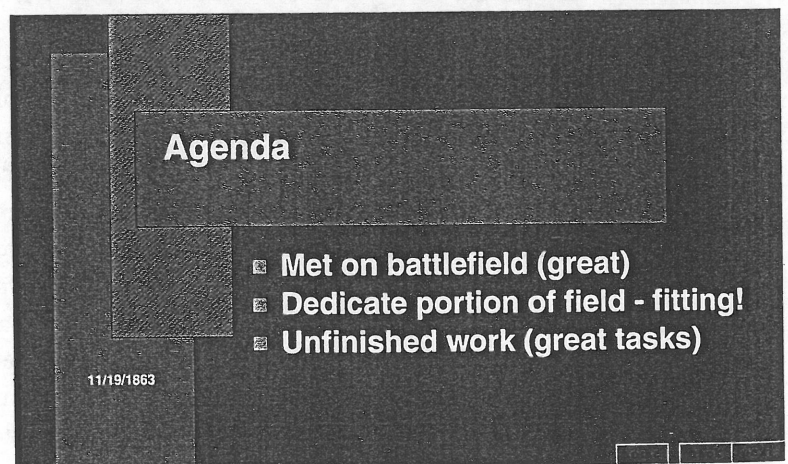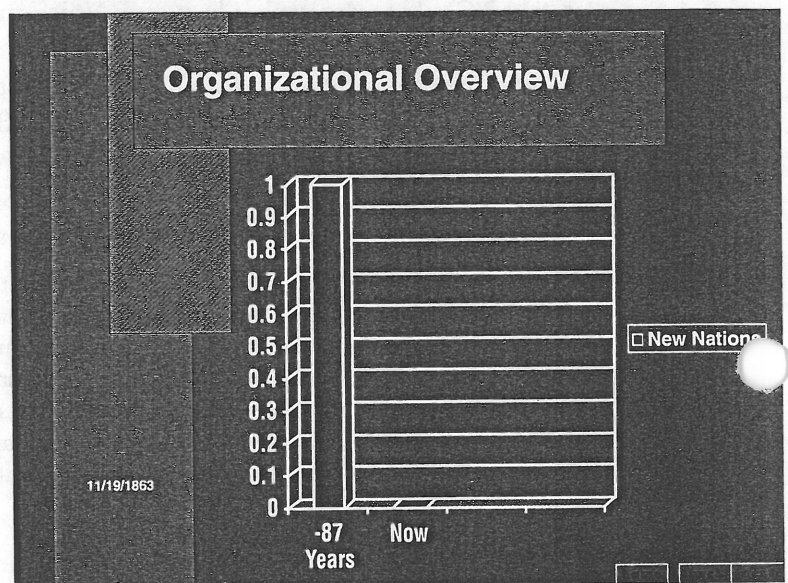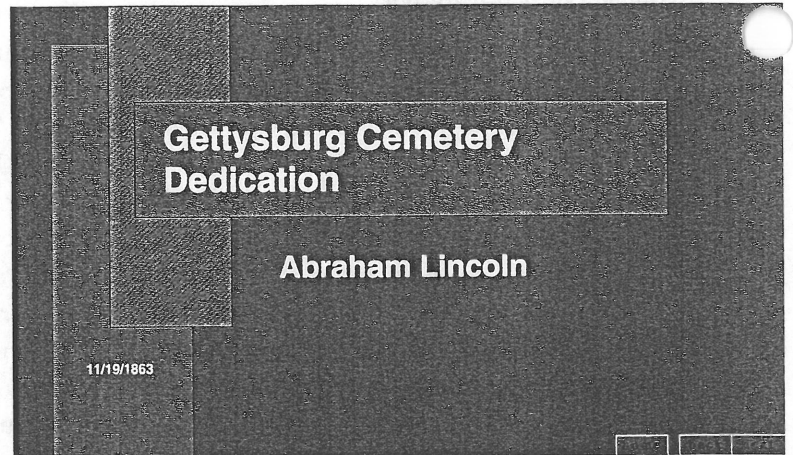
nobly advanced. It is rather for us to be here dedicated to the great task remaining before us— that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion, that we here highly resolve that these dead shall not have died in vain, that this nation under God shall have a new birth of freedom, and that government of the people, by the people, for the people shall not perish from the earth.

This PowerPoint presentation was created by Peter Norvig; see www.norvig.com. Norvig notes that these slides were quickly constructed by means of the PP "AutoContent Wizard." Just fancy that, "AutoContent."

Review of Key Objectives & Critical Success Factors

11/19/1863

- **What makes nation unique**
  - Conceived in Liberty
  - Men are equal
- **Shared vision**
  - New birth of freedom
  - Gov't of/for/by the people

Not on Agenda!

11/19/1863

- **Dedicate**
- **Consecrate**
- **Hallow** (in narrow sense)
- **Add or detract**
- **Note or remember what we say**

Summary

11/19/1863

- **New nation**
- **Civil War**
- **Dedicate field**
- **Dedicated to unfinished work**
- **New birth of freedom**
- **Government not perish**

PowerPoint and Statistical Evidence

To investigate the performance of PP for statistical data, let us consider an important and intriguing table of cancer survival rates relative to those without cancer for the same time period. Some 196 numbers and 57 words describe survival rates and their standard errors for 24 cancers:

Estimates of relative survival rates, by cancer site[9]

	% survival rates and standard errors						
	5 year		10 year		15 year		20 year	
Prostate	98.8	0.4	95.2	0.9	87.1	1.7	81.1	3.0
Thyroid	96.0	0.8	95.8	1.2	94.0	1.6	95.4	2.1
Testis	94.7	1.1	94.0	1.3	91.1	1.8	88.2	2.3
Melanomas	89.0	0.8	86.7	1.1	83.5	1.5	82.8	1.9
Breast	86.4	0.4	78.3	0.6	71.3	0.7	65.0	1.0
Hodgkin's disease	85.1	1.7	79.8	2.0	73.8	2.4	67.1	2.8
Corpus uteri, uterus	84.3	1.0	83.2	1.3	80.8	1.7	79.2	2.0
Urinary, bladder	82.1	1.0	76.2	1.4	70.3	1.9	67.9	2.4
Cervix, uteri	70.5	1.6	64.1	1.8	62.8	2.1	60.0	2.4
Larynx	68.8	2.1	56.7	2.5	45.8	2.8	37.8	3.1
Rectum	62.6	1.2	55.2	1.4	51.8	1.8	49.2	2.3
Kidney, renal pelvis	61.8	1.3	54.4	1.6	49.8	2.0	47.3	2.6
Colon	61.7	0.8	55.4	1.0	53.9	1.2	52.3	1.6
Non-Hodgkin's	57.8	1.0	46.3	1.2	38.3	1.4	34.3	1.7
Oral cavity, pharynx	56.7	1.3	44.2	1.4	37.5	1.6	33.0	1.8
Ovary	55.0	1.3	49.3	1.6	49.9	1.9	49.6	2.4
Leukemia	42.5	1.2	32.4	1.3	29.7	1.5	26.2	1.7
Brain, nervous system	32.0	1.4	29.2	1.5	27.6	1.6	26.1	1.9
Multiple myeloma	29.5	1.6	12.7	1.5	7.0	1.3	4.8	1.5
Stomach	23.8	1.3	19.4	1.4	19.0	1.7	14.9	1.9
Lung and bronchus	15.0	0.4	10.6	0.4	8.1	0.4	6.5	0.4
Esophagus	14.2	1.4	7.9	1.3	7.7	1.6	5.4	2.0
Liver, bile duct	7.5	1.1	5.8	1.2	6.3	1.5	7.6	2.0
Pancreas	4.0	0.5	3.0	1.5	2.7	0.6	2.7	0.8

Applying the PowerPoint templates for statistical graphics to this nice straightforward table yields the analytical disasters on the facing page. "Sweet songs never last too long on broken radios," wrote John Prine. These PP default–designs cause the data to explode into 6 separate chaotic slides, consuming 2.9 times the area of the table. *Everything* is wrong with these smarmy, incoherent graphs: uncomparative, thin data-density, chartjunk, encoded legends, meaningless color, logotype branding, indifferent to content and evidence. Chartjunk is a clear sign of statistical stupidity; use these designs in your presentation, and your audience will quickly and correctly conclude that you don't know much about data and evidence.[10] Poking a finger into the eye of thought, these data graphics would turn into a nasty travesty if used for

[9] Redesigned table based on Hermann Brenner, "Long-term survival rates of cancer patients achieved by the end of the 20th century: a period analysis," *The Lancet,* 360 (October 12, 2002), 1131–1135. Brenner recalculates survival rates from data collected by the U.S. National Cancer Institute, 1973–1998, from the Surveillance, Epidemiology, and End Results Program.

[10] PP-style chartjunk occasionally shows up in graphics of evidence in scientific journals. Below, the clutter half-conceals thin data with some vibrating pyramids framed by an unintentional Necker illusion, as the 2 back planes optically flip to the front:
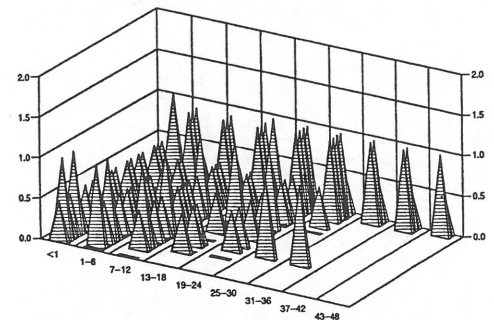
For such small data sets, usually a simple table will show the data more effectively than a graph, let alone a chartjunk graph. Source of graph: N. T. Kouchoukos, *et al.*, "Replacement of the Aortic Root with a Pulmonary Autograft in Children and Young Adults with Aortic-Valve Disease," *New England Journal of Medicine,* 330 (January 6, 1994), p. 4. On chartjunk, see Edward R. Tufte, *The Visual Display of Quantitative Information* (1983, 2001), chapter 5.

I. Cancer Survival Rates
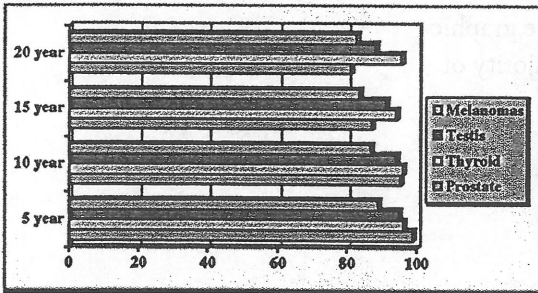
II. Cancer Survival Rates
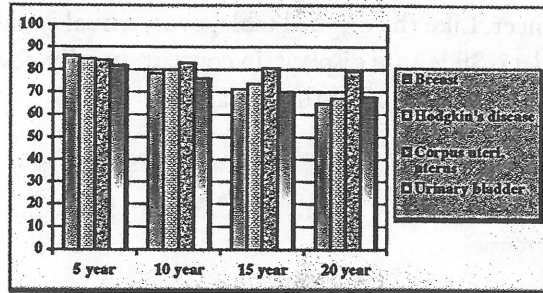
III. Cancer Survival Rates
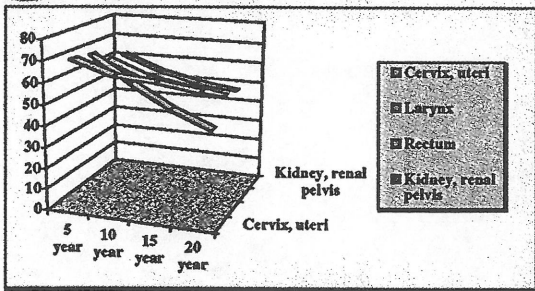
IV. Cancer Survival Rates
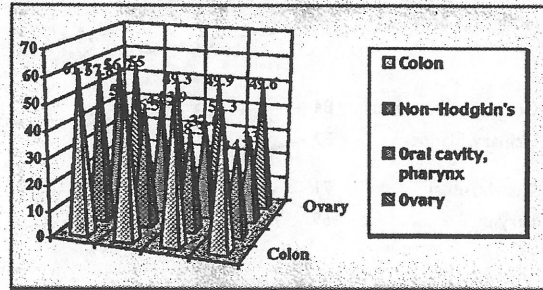
V. Cancer Survival Rates
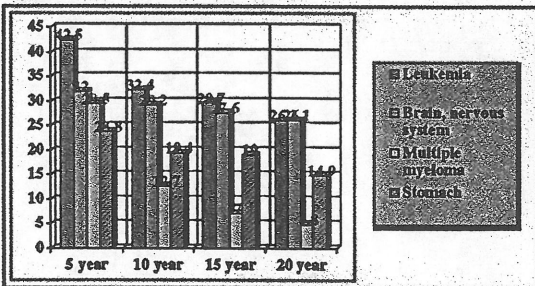
VI. Cancer Survival Rates
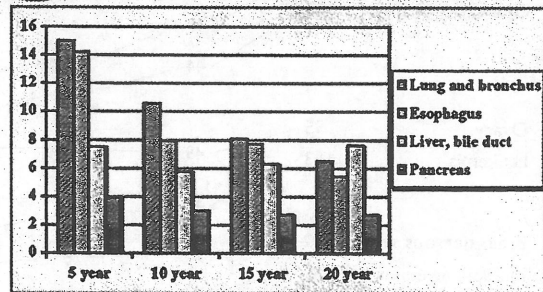
a serious purpose, such as cancer patients seeking to assess their survival chances. To deal with a product that messes up data with such systematic intensity must require an enormous insulation from statistical integrity and statistical reasoning by Microsoft PP executives and programmers, PP textbook writers, and presenters of such chartjunk.

The best way to show the cancer data is the original table with its good comparative structure and reporting of standard errors. And PP default graphics are not the way to see the data. Our table-graphic, however, does give something of a *visual idea* of time-gradients for survival for each cancer. Like the original table, every visual element in the graphic shows data. Slideware displays, in contrast, usually devote a majority of their space to things other than data.

Estimates of % survival rates

	5 year	10 year	15 year	20 year
Prostate	99	95	87	81
Thyroid	96	96	94	95
Testis	95	94	91	88
Melanomas	89	87	84	83
Breast	86	78	71	65
Hodgkin's disease	85	80	74	67
Corpus uteri, uterus	84	83	81	79
Urinary, bladder	82	76	70	68
Cervix, uteri	71	64	63	60
Larynx	69	57	46	38
Rectum	63	55	52	49
Kidney, renal pelvis	62	54	50	47
Colon	62	55	54	52
Non-Hodgkin's	58	46	38	34
Oral cavity, pharynx	57	44	38	33
Ovary	55	49	50	50
Leukemia	43	32	30	26
Brain, nervous system	32	29	28	26
Multiple myeloma	30	13	7	5
Stomach	24	19	19	15
Lung and bronchus	15	11	8	6
Esophagus	14	8	8	5
Liver, bile duct	8	6	6	8
Pancreas	4	3	3	3

PowerPoint Stylesheets

The PP cognitive style is propagated by the templates, textbooks, stylesheets, and complete pitches available for purchase. Some corporations and government agencies *require* employees to use designated PPPhluff and presentation logo-wear. With their strict generic formats, these designer stylesheets serve only to enforce the limitations of PowerPoint, compromising the presenter, the content, and, ultimately, the audience.

Here we see a witless PP pitch on how to make a witless PP pitch. Prepared at the Harvard School of Public Health by the "Instructional Computing Facility," these templates are uninformed by the practices of scientific publication and the rich intellectual history of evidence and analysis in public health. The templates do, however, emulate the format of reading primers for 6 year-olds.
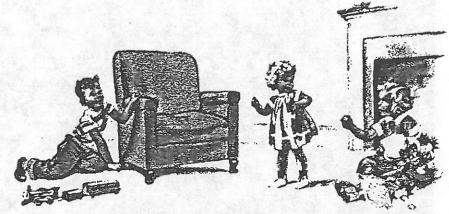
Jane said, "Here is a ball.
See this blue ball, Sally.
Do you want this ball?"

Sally said, "I want my ball.
My ball is yellow.
It is a big, pretty ball."

Instructional Computing Facility

Guidelines for Preparing Slides

**Instructional Computing
Facility**

Harvard School of Public Health
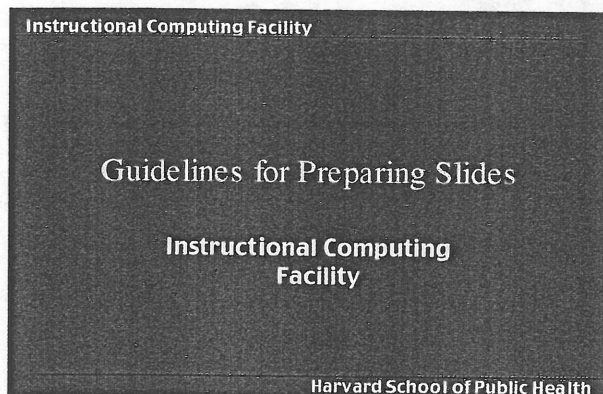
Stylesheet-makers often seek to leave *their* name on *your* show; "branding," as they say in the Marketing Department. In case you didn't notice, this presentation is from the "Instructional Computing Facility." But where are the names of the people responsible for this? No names appear on any of the 21 slides.

Instructional Computing Facility

Use the 6 X 6 rule:

**6 lines of text
6 words per line**

Harvard School of Public Health
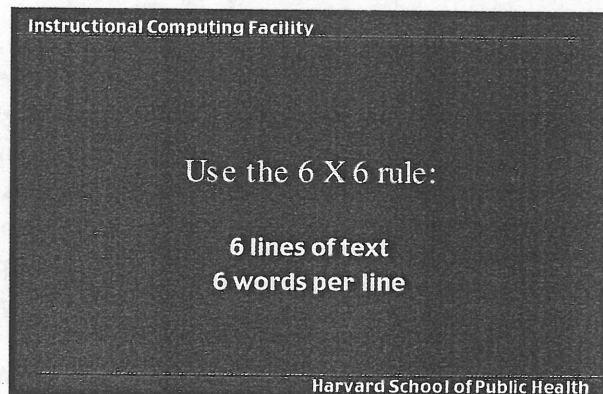
This must be the Haiku Rule for formatting scientific lectures. At least we're not limited to 17 syllables per slide. Above this slide, the rule can be seen in action—in a first-grade reading primer. The stylesheet typography, distinctly unscientific, uses a capital X instead of a multiplication sign.

Instructional Computing Facility

No More than One Topic per Slide

What about them Sox hey?

Harvard School of Public Health
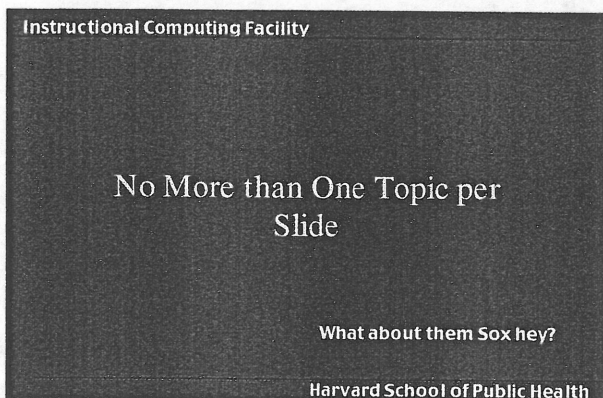
But this breaks up the evidence into arbitrary fragments. Why aren't we seeing examples from actual scientific reports? What are the Sox (a rather parochial reference) doing here? The inept PP typography persists: strange over-active indents, oddly chosen initial caps, typographic orphans on 3 of 4 slides.

Instructional Computing Facility

Outline Formats are Easier to Follow

Harvard School of Public Health
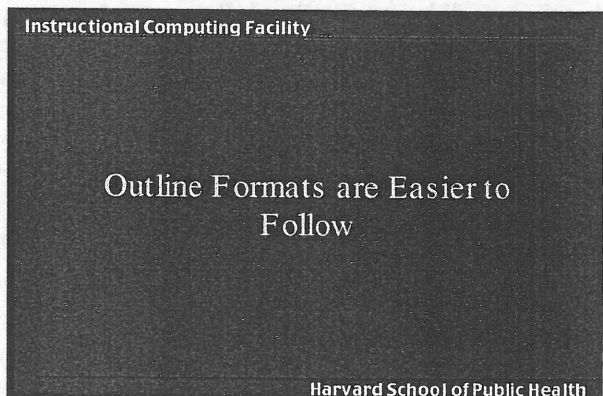
Why is this relevant to scientific presentations? Are there other principles than ease of following? Didn't the *Harvard Business Review* article indicate that bullet outlines corrupted thought? Text, imaging, and data for scientific presentations should be at the level of scientific journals, much *higher* resolution than speech.

Instructional Computing Facility

Use Simple Tables to Present Numbers

	Use Tables	For Your Numbers	But Not too Many
This row	10	90	100
This row	0.6	0.4	1
This row	1	2	3
That row	1	2	3

Try not to make footnotes too small

Harvard School of Public Health

The stylesheet goes on to victimize statistical data, the fundamental evidence of public health. The table shows 12 numbers which is lousy for science but normal for PowerPoint.[11] Table design is a complex and intriguing matter in typographic work, but there is nothing thoughtful about the arangement here. The unsourced numbers are not properly aligned, the row and column labels are awful, the units of measurement not given. In this stylesheet, there lurks a casual, flippant, almost smirky attitude toward data. That attitude—*what counts are power and pitches, not truth and evidence*—also lurks within PowerPoint.

Consider now a real table. John Graunt's *Bills of Mortality* (1662) is the foundation work of public health, introducing scientific methods to medical and demographic data. Graunt calculated the first tables of life expectancy, compared different causes of death, and even discussed defects in the evidence. His renowned "Table of Casualties" (at right) shows 1,855 different counts of death from 1629 to 1659. How fortunate that Graunt did not have PowerPoint and the assistance the Harvard School of Public Health Instructional Computing Facility. Their guidelines (above) imply the construction of 155 separate PowerPoint slides to show the data in Graunt's original table!

For tables, the analytical idea is to make comparisons. The number of possible pairwise comparisons in a table increases as the square of the number of cells.[12] In Graunt's table, 1,719,585 pairwise comparisons, of varying relevance to be sure, are within the eyespan of the inquiring mind. In contrast, the 155 tiny tables on 155 PP slides would offer only 10,230 pairwise comparisons, about 6 in 1,000 of those available in Graunt's original table. These PP tables would also block all sorts of interesting comparisons, such as time patterns over many years. What Graunt needs to do for his presentation at Harvard is simply to provide printed copies of his original table to everyone in the audience.

[11] Some 39 tables appear in our collection of 28 PP textbooks. These tables show an average (median) of 12 numbers each, which is extremely low, approaching the *Pravda* level again. In contrast, sports or financial pages in newspapers routinely present tables with hundreds of numbers.

[12] A table with n cells yields $n(n-1)/2$ pairwise comparisons of cell entries.

John Graunt, *National and Political Observations mentioned in a following index, and made upon the Bills of Mortality. With reference to the Government, Religion, Trade, Growth, Ayre, Diseases, and the several Changes of the said City* (London, 1662). "The Table of Casualties" follows folio 74.

THE TABLE OF CASUALTIES.

The Years of our Lord	1647	1648	1649	1650	1651	1652	1653	1654	1655	1656	1657	1658	1659	1660	1629	1630	1631	1632	1633	1634	1635	1636	1629–1632	1633–1636	1647–1650	1651–1654	1655–1658	1629/1649/1659	In 20 Years
Abortive, and ftilborn	335	329	327	351	389	381	384	433	483	419	463	467	421	544	499	439	410	445	500	475	507	523	1793	2005	1342	1587	1832	1247	8559
Aged	916	835	889	696	780	834	864	974	743	892	869	1176	909	1095	579	712	661	671	704	623	794	523	2814	3336	3452	3680	2377		15757
Ague, and Fever	1260	884	751	970	1038	1212	1282	1371	689	875	999	1800	2303	2148	956	1091	1115	1108	953	1279	1622	2360	4418	6235	3865	4903	4363	4010	23784
Apoplex, and fodainly	68	74	64	74	106	111	118	86	92	102	113	138	91	67	22	36		17	24	35	26	2360	75	85	280	421	445	177	1306
Bleach			1		3		7	2				1																	
Blafted	4	1			7	6	4		4		5	5	3	8	13	8	10	13	6	4		4	54	14	5	12	14	16	15
Bleeding	3	2	5	1	3	4		2		5	5	4	7	5	2	5	5	4	4	3			16	7	11	12	19	17	99
Bloudy Flux, Scouring, and Flux	155	176	802	289	833	762	200	386	168	368	362	233	346	251	449	438	352	348	278	512	330	1587	1466	1422	2181	1161	1597	65	7818
Burnt, and Scalded	3	6	10	5	11	8	5	7	10	5	7	4	6	6	3	10	7	5	1	3	12	3	25	19	24	31	26	19	125
Calenture	1																	1			1	3			4	2	4	3	13
Cancer, Gangrene, and Fiftula	26	29	31	19	31	53	36	37	73	31	24	35	63	52	20	14	23	28	27	30	24	30	85	112	105	157	150	114	609
Wolf				8																				8					8
Canker, Sore-mouth, and Thrufh	66	28	54	42	68	51	53	72	44	81	19	27	73	68	6	4	4	1			5	74	15	79	190	244	161	133	689
Childbed	161	106	114	117	206	213	158	192	177	201	236	225	226	194	150	157	112	171	132	143	163	230	590	668	498	769	839	490	3364
Chrifomes, and Infants	1369	1254	1065	990	1237	1280	1050	1343	1089	1393	1162	1144	858	1123	2596	2378	2035	2268	2130	2315	2113	1895	9277	8453	4678	4910	4788	4519	32106
Colick, and Wind	103	71	85	82	76	102	80	101	85	120	113	179	116	167	48	57			37	50	105	87	341	359	497	247			1389
Cold, and Cough							41	36	21	58	30	31	33	24	10	58	51	55	45	54	50	57	174	207	00	77	140	43	598
Confumption, and Cough	2423	2200	2388	1988	2350	2410	2286	2868	2606	3184	2757	3610	2982	3414	1827	1910	1713	1797	1754	1955	2080	2477	5157	8266	8999	9914	12157	7197	44487
Convulfion	684	491	530	493	569	653	606	828	702	1027	807	841	742	1031	52	87	18	241	221	386	418	709	498	1734	2198	2656	3377	1324	9073
Cramp															1	0	0	0	0	0	0		01	00	01	0			2
Cut of the Stone		2	1	3		1	1	2		4	1		3		0	0	0	2	0		0		01	00	01	0	13	47	2
Dropfy, and Tympany	185	434	421	508	444	556	617	704	660	706	631	931	646	872	235	252	279	280	266	250	329	389	10	6	4				38
Drowned	47	40	30	27	49	50	53	30	43	45	63	60	57	48	43	33	29	34	37	32	32	45	048	1734	1538	2321	2982	1302	9623
Exceffive drinking			2																			139	147	144	182	215	130	827
Executed	8	17	29	43	24	12	19	21	19	22	20	18	7	18	19	13	12	18	13	13	13	13	62	52	97	76	79	55	384
Fainted in a Bath					1																					1			1
Falling-Sicknefs	3	2	2	3		3	4	1	4		1		4	5	3	10	7	7	2	5	6	8	27	21	10	8	8	9	74
Flox, and fmall pox	139	400	1190	184	525	1279	139	812	1294	823	835	409	1523	354	72	40	58	531	72	1354	293	127	701	1846	1913	2755	3361	2785	10576
Found dead in the Streets	6	6	9	8	7	9	14	4	4	3	4	9	11	2	6	18	33	26	6	13	8	24	83	69	29	34	27	29	243
French-Pox	18	29	15	18	21	20	20	20	29	23	25	51	51		7	12	12	12		7	17	12	22	53	48	80	81	130	83	392
Frighted	4	4	1		3		2		1	1			9						1				3	2	3		2	2	21
Gout	9	5	12	9	7	7	5	6	8	7	8	13	14	2	7	4	4	4		5	7	8	14	24	35	25	36	28	134
Grief	12	13	16	7	17	14	11	17	10	11	10	12	13	4	18	20	22	11	4	14	17	5	20	71	56	48	59	45	279
Hanged, and made-away themfelves	11	10	13	14	9	14	15	9	14	16	24	18	11	36	8	6	8	6	15		3	8	7	37	18	48	47	72	32	222
Head-Ach		1	1	2		2	6	6	3	4	5	5	30	26							4	2	0	6	14	14	17	46	051
Jaundice	57	35	39	49	41	43	57	71	61	41	46	77	102	76	47	59	35	43	35	45	54	63	184	197	180	212	225	188	998
Jaw-faln	1				3					2		1			10	16	13	8	10	10	4	1	47	35	02	5	6	10	95
Impoftume	75	61	65	59	80	105	79	90	92	122	80	134	105	96	58	76	73	74	50	62	73	130	282	315	260	354	428	228	1639
Itch	1																			10			00	10	00				11
Killed by feveral Accidents	27	57	39	94	47	45	57	58	52	43	52	47	55	47	54	55	47	46	49	41	51	60	202	201	217	207	194	148	1021
King's Evil	27	26	22	19	22	20	26	26	27	24	23	28	28	54	16	25	18	38	35	20	26	69	97	150	94	94	102	66	537
Lethargy	3	4	2	4	4	3	3		10		9	6	4	1	2	2	3	1	2		5	7	13	21	21	9	67	
Leprofy												1			2					2		2	2	1					06
Livergrown, Spleen, and Rickets	53	46	56	59	65	72	67	65	52	50	38	51	8	15	94	112	99	87	82	77	98	99	392	356	213	269	191	158	1421
Lunatique	12	18	6	11	7	11	9	12	6	7	13	5	14	14	6	11	6	5	4	2	5	28	13	47	39	31	26	158
Meagrom	12	13		5	8	6	6	14	3	6	7	6		5	4		24				22	24	22	30	34	22	05	132
Meafles	5	92		33	33	62	8	52	11	153	15	80	6	74	42	2	3	80	21	33	27	12	127	83	133	155	259	51	757
Mother	2					1		2	2		3		8	1			3	7				6	10	3	2	4	8	02	18
Murdered	3	2	7	5	4	3	3	3	9	6	5	7	70		3	7		6	5	5	8	10	19	17	13	27	77	86	
Overlayd, and ftarved at Nurfe	25	22	36	28	28	29	30	36	58	53	44	50	46	43	4	10	13	7	8	14	10	14	34	46	111	123	215	86	529
Palfy	27	21	19	20	23	20	29	18	22	23	20	22	17	21	17	23	17	25	14	21	25	17	82	77	87	90	87	53	423
Plague	3597	611	67	15	23	16	6	16	9	6	4	14	36	14			1317	274	8		1	10400	1599	10401	4290	61	33	103	16384
Plague in the Guts				1		110	32			37	315	446			253	402								00	61	142	844	253	991
Pleurify	30	26	13	20	23	19	17	23	10		17	16	12	10	26	24	21	36	21		45	24	112	90	89	72	52	51	415
Poyfoned		3		7												2						2	00	4	10	00	00	00	14
Purples, and fpotted Fever	145	47	43	65	54	60	75	89	56	52	56	126	368	146	32	58	58	38	24	125	245	397	186	791	300	278	290	243	1845
Quinfy, and Sore-throat	14	11	12	17	24	20	18	9	15	13	7	10	21	14	01	8		7	24	04	5	22	22	55	54	71	45	34	247
Rickets	150	224	216	190	260	329	229	372	347	458	317	476	441	521						14	49	50	00	113	780	1190	1598	657	3681
Mother, rifing of the Lights	150	92	115	120	134	138	135	178	166	212	203	228	210	249	44	72	99	98	60	84	72	104	309	220	777	585	809	369	2700
Rupture	16	7	7	6	7	16	7	15	11	20	19	18	12	28	4	9	4	4	3	10	13	21	30	36	45	68	2	201
Scal'd-head	2				1			2															2	1		2		05
Scurvy	32	20	21	21	29	43	41	44	103	71	82	82	95	12	5	7	9		9		25	33	34	94	132	300	115	593
Smothered, and ftifled			2												24						24		2			2	26	
Sores, Ulcers, broken and bruifed	15	17	17	16	26	32	25	32	23	34	40	47	61	48	23		20	48	19	19	22	29	91	89	65	115	144	141	504
Shot (Limbs	12	17					13	13		6	2	5	7	20									29	26	07	27			
Spleen													7	7													07	27	
Shingles													1										29	26		07	68	
Starved		4	8	7	1	2		1	3	1	1	14				1				1			19	5	13	29	2	
Stitch				1																		14	1	1	51			
Stone, and Strangury	45	42	29	28	50	41	44	38	49	57	72	69	22	30		58	56	58	49	33	45	114	185	144	173	247	51	863
Sciatica												2					1						1				15	
Stopping of the Stomach	29	29	30	33	55	67	66	107	94	145	129	277	186	214						6		6	121	295	247	216	669
Surfet	217	137	136	123	104	177	178	212	128	161	137	218	202	192	63	157	149	86	104	114	132	371	445	721	613	671	644	401	3094
Swine-Pox	4	4	3					1			5		4			8	4	6	3			23	13	1	5	10	57	
Teeth, and Worms	767	597	540	598	709	905	691	1131	803	1198	878	1036	839	1008	440	506	335	470	432	454	539	1207	1751	2632	2502	3436	3915	1819	14236
Tiffick	62	47													8	12	14	34	23	15	27	68	65	109	8	242
Thrufh										57	66				15	23	17	40	28	31	34	95	93		123	211
Vomiting	1	6	3	7	4	6	3	14	7		16	19	8	10		2	5	6	2		7	16	17	27	69	12	136
Worms	147	107	105	65	85	86	53								19	31	28	27	19	28	27	105	74	424	224	124	830
Wen	1		1			2							1	1			4						4	2	4	2	15
Sodainly															63	59	37	62	58	62	78	34	221	233		63	454

*Creeping PowerPoint: PP Slide Formats for Paper Reports
and Computer Screens*

In addition to outlining and accompanying a talk, PP slides often serve other functions—printed out on paper to make a report, attached to e-mails, posted on the internet. The PP slide format now shows up on paper and computer screen. These slides, especially those following ready-made templates, replicate and intensify all the problems of the PP cognitive style onto paper and computer screen. *Again the short-run convenience for the presenter (and for PowerPoint) comes at an enormous cost to the content and the audience.*

As those who have flipped through pages and pages and pages of printed-out PP slides already know, such reports are physically thick and intellectually thin. Their resolution is remarkably low. The table at right compiles data comparing the information densities of one image-equivalent for books (one page), for the internet (one screen), and for PP (one slide). In terms of character density, printed reports in PP format typically perform at 2% to 10% of the typographic richness of nonfiction bestsellers! Looking from the top line down to the bottom line of the table, we see that a single printed page in the *Physicians' Desk Reference* shows more than 50 PP slide-equivalents of information.

People see, read, and think all the time at intensities vastly greater than those presented in printed PP reports. Instead of showing a long sequence of tiny information-fragments on slides, and instead of dumping those slides onto paper, report writers should have the courtesy to write a real report (which might also be handed out at a meeting) and address their readers as serious people. PP templates are a lazy and ridiculous way to format printed reports.

PP slides also format material on the internet. Presenters post their slides; then readers, if any, march through one slide after another on the computer screen. And you thought PP talks were boring. Popular news sites on the internet show 10 to 12 times more information on a computer screen than a typical PP slide posted on a computer screen. The shuttle Columbia reports prepared by Boeing, when sent around by e-mail in PP format, were running at information densities of 20% of popular news sites on the internet (table above right).

The PP slide format has probably the worst signal/noise ratio of any known method of communication on paper or computer screen. Extending PowerPoint to embrace paper and internet screens pollutes those display methods.

CHARACTER COUNTS AND DENSITY PER PAGE-IMAGE

	CHARACTERS PER PAGE	DENSITY: CHARACTERS/IN²
BEST SELLING BOOKS		
Physicians' Desk Reference	13,600	168
Your Income Tax	10,400	118
World Almanac	9,800	232
Joy of Cooking	5,700	108
Baby and Child Care	2,500	95
The Merck Manual	4,700	42
Guinness Book of World Records	4,600	162
Consumer Reports Buying Guide	3,900	112
How to Cook Everything	3,900	53
Elmore Leonard, *Maximum Bob*	3,100	115
Carl Hiassen, *Basket Case*	2,800	104
NEWS SITES ON THE INTERNET		
Google News	4,100	44
New York Times	4,100	43
Los Angeles Times	4,000	42
MSN Slate	3,300	36
CNN	3,300	35
Yahoo	3,200	34
USA Today	2,700	29
Time	2,700	28
ABC News	2,500	27
MSNBC	2,400	26
POWERPOINT SLIDE FORMAT ON PAPER OR COMPUTER SCREEN		
Columbia reports by Boeing	630	7
1,460 text slides in 189 PP reports	250	3
654 text slides in 28 PP textbooks	98	1
Content-free slides	0	0

Sequentiality of the Slide Format

With information quickly appearing and disappearing, the slide transition is an event that attracts attention to the presentation's compositional methods. The slide serves up a small chunk of promptly vanishing information in a restless one-way sequence. It is not a contemplative analytical method; it is like television, or a movie with frequent random jump cuts. Sometimes quick chunks of thin data may be useful (flash-card memorizing), other times not (comparisons, links, explanations). *But formats, sequencing, and cognitive approach should be decided by the character of the content and what is to be explained, not by the limitations of the presentation technology.* The talk that accompanies PP slides may overcome the noise and clutter that results from slideville's arbitrary partitioning of data, but why disrupt the signal in the first place? And why should we need to recover from a technology that is supposed to help our presentations?

Obnoxious transitions and partitions occur not only slide-by-slide but also line-by-line. We have seen the problems with the bullet list. Worse is the method of line-by-line slow reveal (at right). Beginning with a title slide, the presenter unveils and reads aloud the single line on the slide, then reveals the next line, reads that aloud, on and on, as stupefied audience members impatiently await the end of the talk.

It is often helpful to provide audience members with at least one mode of information that allows *them* to control the order and pace of learning—unlike slides and unlike talk. Thus paper handouts for talks, which provide a permanent record for review—again unlike projected images and talk. Another way to break free of low-resolution temporal comparisons is to show multiple slides, several images at once within the common view. Spatial parallelism takes advantage of our notable capacity to reason about multiple images that appear simultaneously within our eyespan. We are able to select, sort, reconnoiter, review—ways of seeing quickened and sharpened by direct spatial adjacency of evidence.

Now and then the narrow bandwidth and relentless sequencing of slides are said to be virtues, a claim justified by loose reference to George Miller's classic 1956 paper "The Magical Number Seven, Plus or Minus Two." That essay reviews psychological experiments that discovered people had a hard time remembering more than about 7 unrelated pieces of really dull data all at once. These studies on memorizing nonsense then led some interface designers to conclude that only 7 items belong on a list or a slide, a conclusion that can only be reached by not reading Miller's paper. In fact the paper neither states nor implies rules for the amount of information to be shown in a presentation (except possibly for slides consisting of nonsense syllables that the audience must memorize and repeat back to a psychologist). Indeed, the deep point of Miller's work is to suggest strategies, such as placing information within a context, that help extend the reach of memory beyond tiny clumps of data.[13]

The Dreaded Build Sequence

The Dreaded Build Sequence
THE FIRST LINE IS REVEALED

The Dreaded Build Sequence
THE FIRST LINE IS REVEALED
THE SECOND LINE IS REVEALED!

The Dreaded Build Sequence
THE FIRST LINE IS REVEALED
THE SECOND LINE IS REVEALED!
THE THIRD LINE IS REVEALED

[THE AUDIENCE FLEES]

[13] George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review,* 63 (1956), 81–97 (posted at www. well.com/ user/smalin/miller.html). At Williams College in September 2000, I saw George Miller give a superb presentation that used the optimal number of bullet points on the optimal number of slides—zero in both cases. Just a nice straightforward talk with a long narrative structure.

What to do about PowerPoint

Imagine a widely used and expensive prescription drug that claimed to make us beautiful but didn't. Instead the drug had frequent, serious side effects: making us stupid, degrading the quality and credibility of our communication, turning us into bores, wasting our colleagues' time. These side effects, and the resulting unsatisfactory cost/benefit ratio, would rightly lead to a worldwide product recall.

Improving Our Presentations

Presentations largely stand or fall depending on the quality, relevance, and integrity of the content. The way to make big improvements in a presentation is to get better content.

Designer formats will not salvage weak content. If your numbers are boring, then you've got the wrong numbers. If your words or images are not on point, making them dance in color won't make them relevant. Audience boredom is usually a content failure, not a decoration failure.

At a minimum, a presentation format should *do no harm* to content. Yet again and again we have seen that the PP cognitive style routinely disrupts, dominates, and trivializes content. Thus PP presentations too often resemble the school play: very loud, very slow, and very simple.

The practical conclusions are clear. PowerPoint is a competent slide manager and projector for low-resolution materials. And that's about it. PP has some occasionally useful low-end design tools and way too many Phluff-tools. No matter how beautiful your PP ready-made template is, it would be better if there were less of it. Never use PP templates for arraying words or numbers. Avoid elaborate hierarchies of bullet lists. Never read aloud from slides. Never use PP templates to format paper reports or web screens. Use PP as a projector for showing low-resolution color images, graphics, and videos that cannot be reproduced as printed handouts at a presentation.

Paper handouts at a talk can effectively show text, numbers, data graphics, images. Printed materials, which should largely replace PP, bring information transfer rates in presentations up to that of everyday material in newspapers, magazines, books, and internet screens. A useful paper size for handouts at presentations is 11 by 17 inches (28 by 43 cm), folded in half to make 4 pages. This piece of paper can show images with a resolution of 1,200 dpi and up to 60,000 characters of words and numbers, the content-equivalent of 50 to 250 typical PP slides of text and data. Thoughtfully planned handouts at your talk tell the audience that you are serious and precise; that you seek to leave traces and have consequences. And that you respect your audience.

In day-to-day practice, PowerPoint templates may improve 10% or 20% of all presentations by organizing inept, extremely disorganized speakers, at a cost of detectable intellectual damage to 80%. For statistical data, the damage levels approach dementia. Since about 10^{10} to 10^{11} PP slides (many using the templates) are made each year, that is a lot of harm to communication with colleagues. Or at least a big waste of time.

The damage is mitigated since meetings relying on the PP cognitive style may not matter all that much. By playing around with Phluff rather than providing information, *PowerPoint allows speakers to pretend that they are giving a real talk, and audiences to pretend that they are listening.* This prankish conspiracy against substance and thought should always provoke the question, *Why are we having this meeting?*

As a consumer of presentations, you should not trust speakers who rely on the PP cognitive style. It is likely that these speakers are simply serving up PowerPointPhluff to mask their lousy content, just as this massive tendentious pedestal in Budapest once served up Stalin-cult propaganda to orderly followers feigning attention.

Military parade, Stalin Square, Budapest, April 4, 1956. Photograph by AP/Wide World Photos.
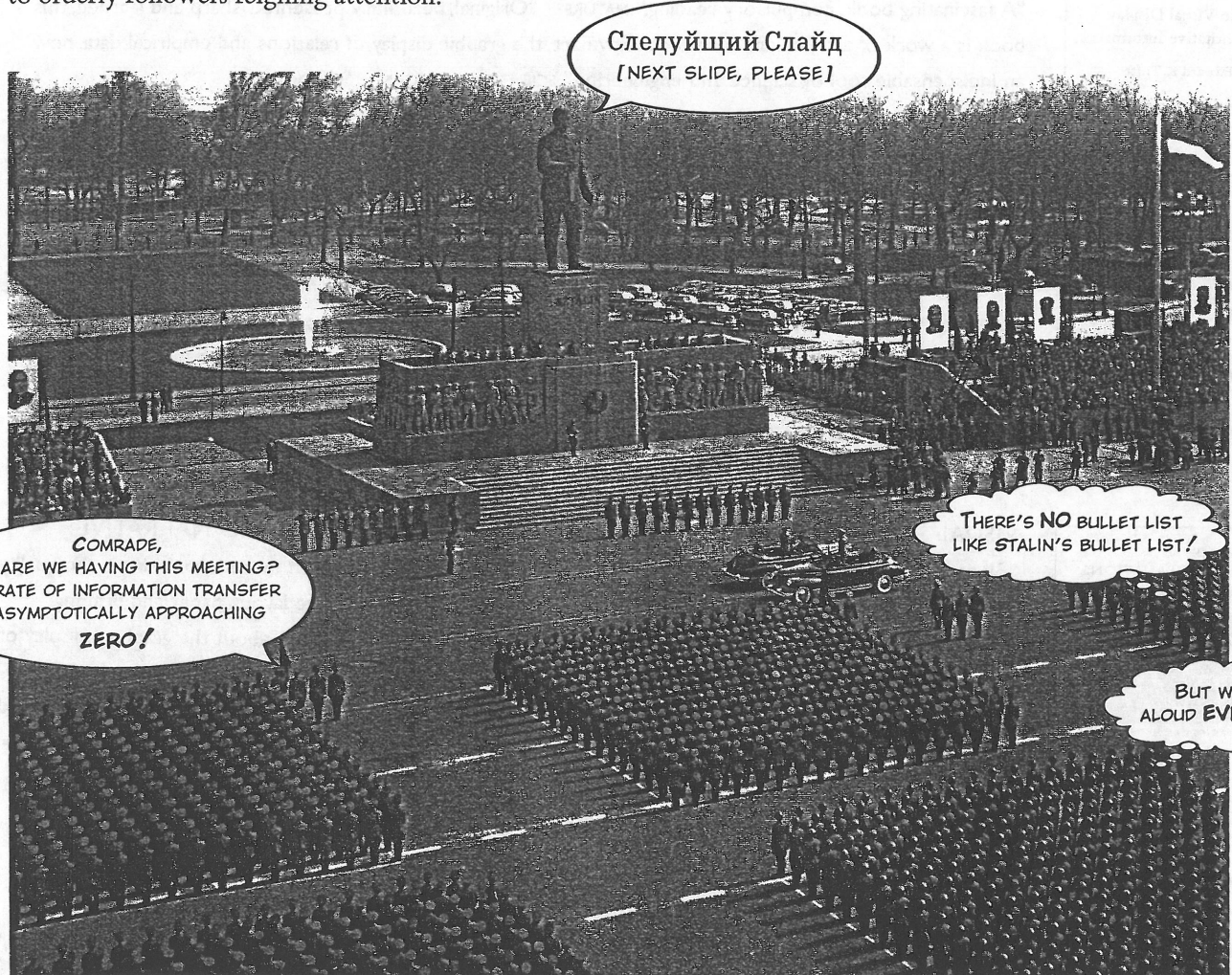
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Edward Tufte has written seven books, including *Visual Explanations*, *Envisioning Information*, *The Visual Display of Quantitative Information*, *Data Analysis for Politics and Policy*, *Political Control of the Economy*, and *Size and Democracy* (with Robert A. Dahl). He writes, designs, and self-publishes his books on analytical design, which have received 40 awards for content and design. He is Professor Emeritus at Yale University, where he taught courses in statistical evidence, analytical design, and interface design. His current work includes digital video, sculpture, printmaking, and a new book called *Beautiful Evidence*, which will be published in 2004.
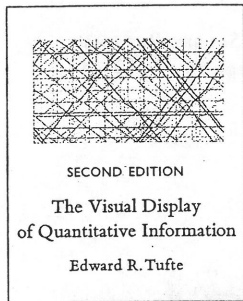
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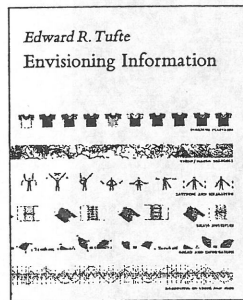
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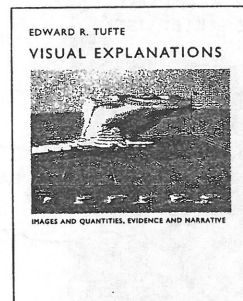
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Edward Tufte also teaches a one-day course 'Presenting Data and Information,' which is offered in many cities; go to www.edwardtufte.com for more information. His new book, *Beautiful Evidence*, will be published in 2004. Order the books directly from Graphics Press.