Visual Explanations: Images and Quantities, Evidence and Narrative

Introduction

- Written by Edward Tufte, an American statistician and professor of political science, statistics, and computer science at Yale University
- Understanding *what cause provokes what effect, by what means, at what rate*
- How such knowledge is represented
- Describes design strategies (the proper arrangement in space and time of images, words, and numbers) for presenting information about motion, process,mechanism, cause and effect
- Clarity and excellence in thinking = Clarity and excellence in display of data

- First Half: examining the logic of depicting quantitative evidence
- Second Half: design strategies

Images and Quantities

Depicting Quantities:

- *direct labels* (numerically labeled grids of statistical graphics, or dimensional tripods in architectural drawings)

- *encodings* (color scales)

- *self-representing scales* (objects of known size appearing in an image)

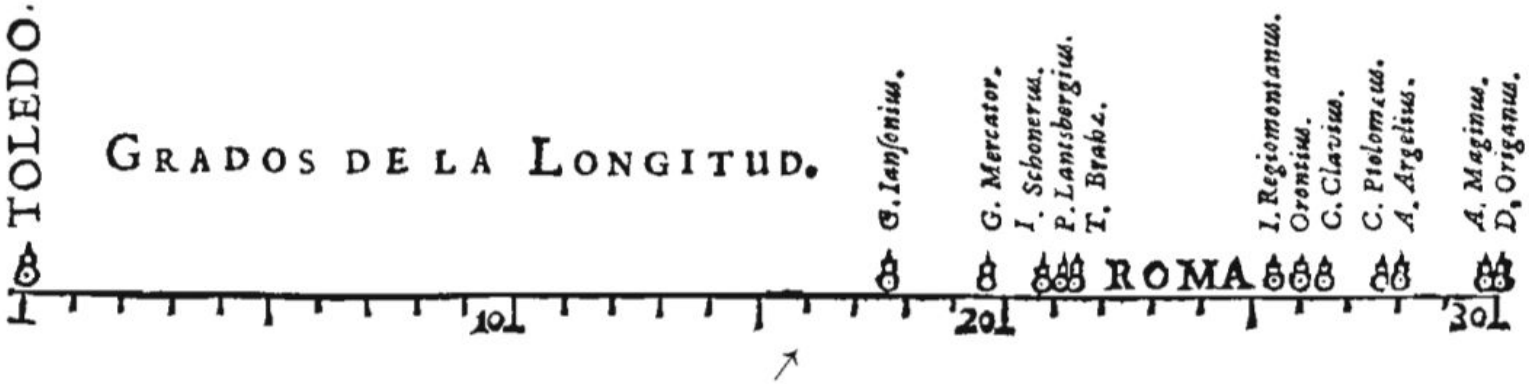
Direct label: Watch documents the hour
Encoding: Shadows and gray light hint at time of day
Self-Representing Scales: familiar objects in perspective demarcate the street and photographers location

Early Maps to Modern Statistical/ Scientific Visualization

- Maps express quantities visually by location (*two-dimensional addresses off latitude and longitude*) and by areal extent (*surface coverage*)

- To go from maps of existing scenery to graphs of newly measured and collated data was an enormous conceptual step

- Took around 5,000 years to change the name of the coordinates from *west-east* and *north-south* to empirically measured variables X and Y



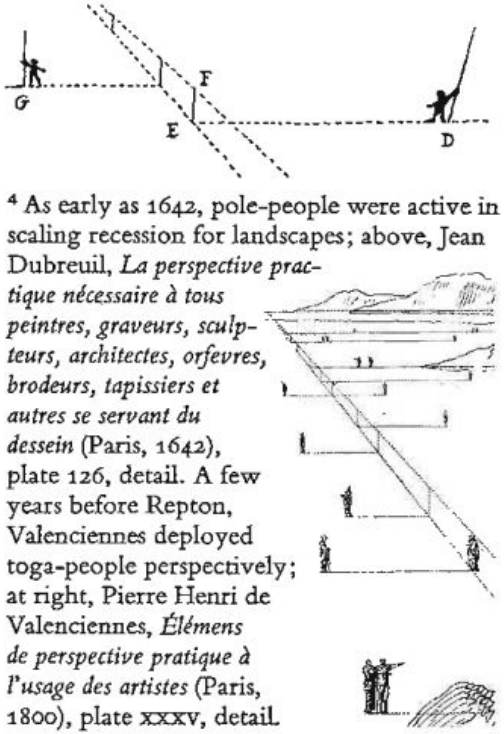
One of the earliest visual representations of statistical data drawn in 1644 my Michael Florent van Langren. Shows 212 diverse estimates of distance between Toldeo and Rome. A one-dimensional map of data, Tufte believes that the chart is remarkably advanced for its time, as it spatially arranged (rather than merely recording in a table) various estimates of the same quantity. It is Tufte's candidate for the first statistical graphic ever.

Early Maps to Modern Statistical/ Scientific Visualization

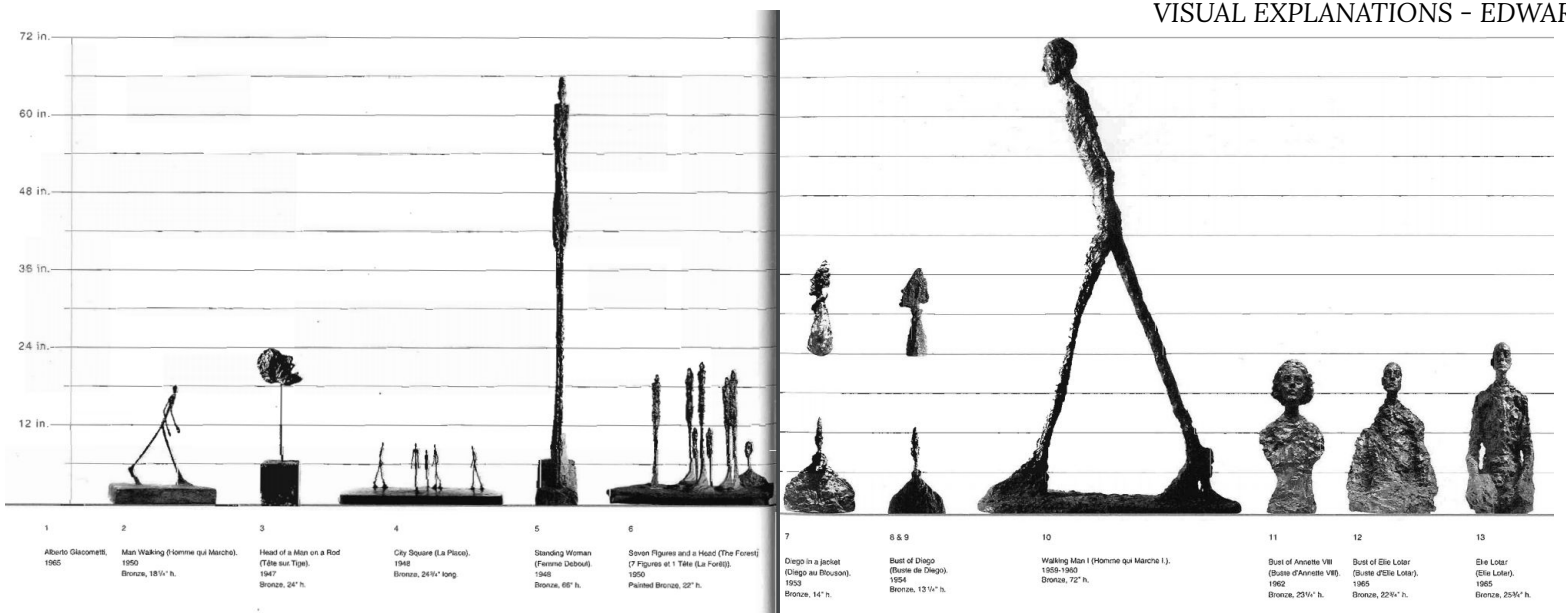
- By 1765, modern scientific graphics were now in place; the two-dimensional plane was quantified, available for any measured data - graphical grids were not analogous to maps

- However, a great amount of substantive problems are not exclusively two-dimensional, the world is generally multivariate

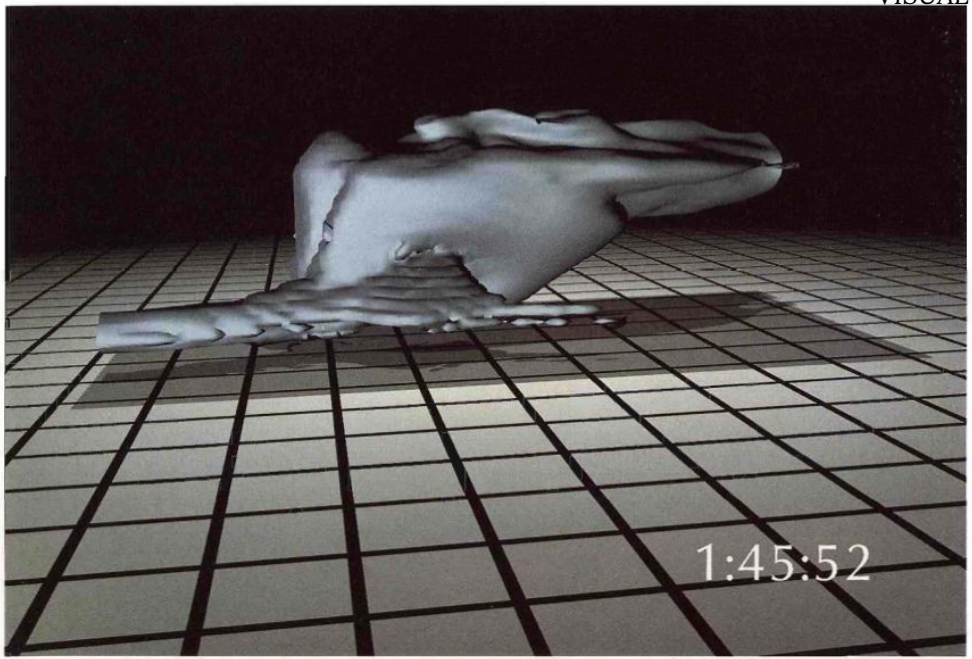
- Humphrey Repton, a British landscape architect, tried to address this, but this suffered visual consequences as the scaling was not accurate



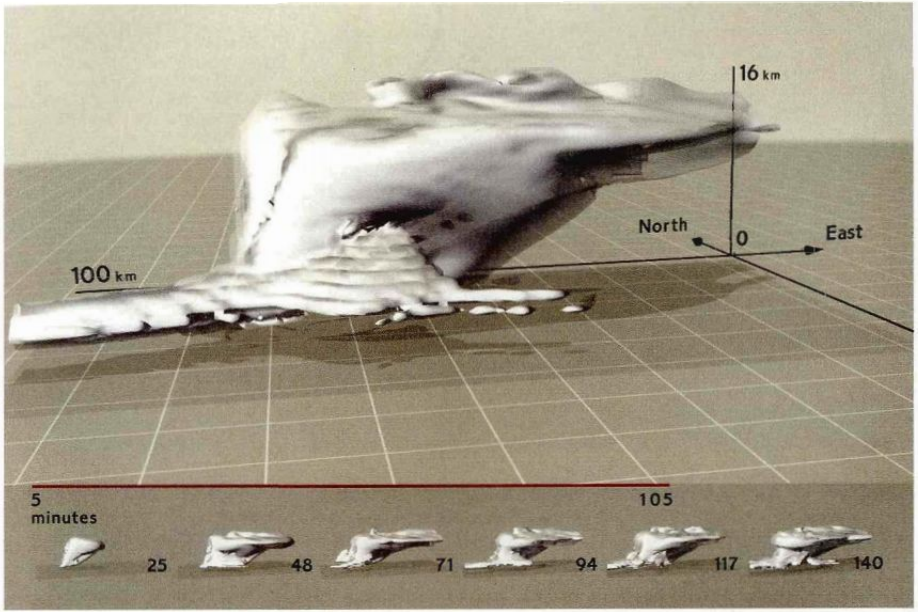
[4] As early as 1642, pole-people were active in scaling recession for landscapes; above, Jean Dubreuil, *La perspective practique nécessaire à tous peintres, graveurs, sculpteurs, architectes, orfevres, brodeurs, tapissiers et autres se servant du dessein* (Paris, 1642), plate 126, detail. A few years before Repton, Valenciennes deployed toga-people perspectively; at right, Pierre Henri de Valenciennes, *Élémens de perspective pratique à l'usage des artistes* (Paris, 1800), plate XXXV, detail.

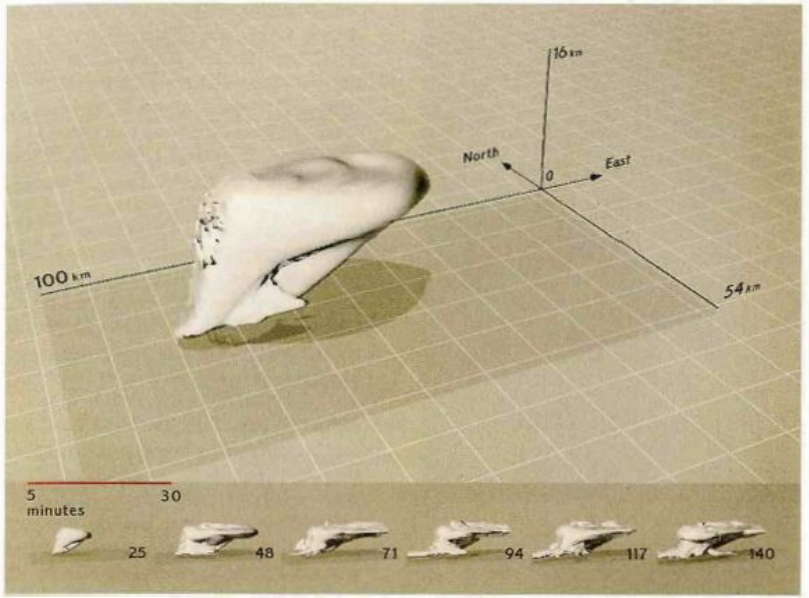


Partial visual knowledge about size of a subject can be conveyed by maintaining a *consistent relative scale* throughout an entire set of reproduced images. A constant scale factor is used in this visual table of contents for Herbert Matter's portfolio of photographs of Alberto Giacometti's sculptures.



- De-quantification characteristic of art reproductions is seen in scientific and technical imaging
- This is a video frame from a numerical model simulating a thunderstorm - classic of scientific visualization
- How big is that cloud? What direction is it moving? What are the dimensions of the grid? The fundamentals of scale, orientation, and labels are often missing from these visualizations

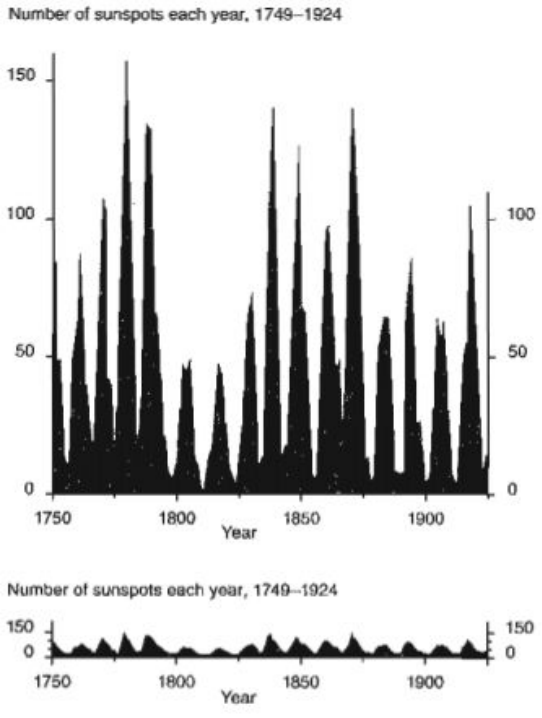




- Restores quantitative order, locates the storm within a 3-dimensional tripod of scales and directional arrows
- Six small clouds depict a still-land history of the storm and serve as 3-dimensional tick marks for the red time-line

- Despite the chronic dangers of misrepresentation, appropriate re-expression and transforms of scales are among the most powerful strategies for exploring data

- On the right is an example of a helpful recaling - from the original spiky mass of data, fresh and subtle information about quantities emerges with a radiant clarity in the rescaled image



[13] William S. Cleveland, *The Elements of Graphing Data* (Murray Hill, New Jersey, revised edition, 1994), pp. 66–79. Redrawn.

Visual and Statistical Thinking:
Displays of Evidence for Making Decisions

- Certain methods for displaying and analyzing data are better than others

- Superior methods are more likely to produce truthful, credible, and precise findings

- The difference between excellent analysis and a faulty one can have sometimes have momentous consequences

The chapter examines the statistical and graphical reasoning used in making two life-and-death decisions:

How to stop a cholera epidemic in London during September 1854

Whether to launch the space shuttle Challenger on January 28, 1986

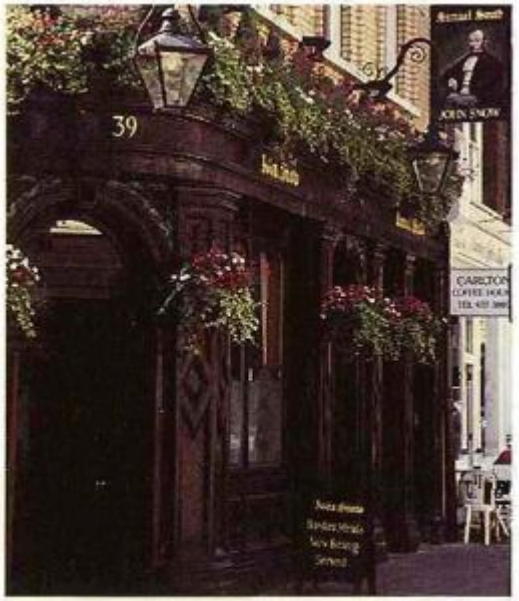
For both cases, the consequences resulted directly from the *quality* of methods used in displaying and assessing quantitative evidence.

The Cholera Epidemic in London, 1854

- Cholera broke out in the Broad Street area of central London on the evening of August 31, 1854. John Snow, who'd investigated earlier epidemics, suspected the water from a community pump-well was contaminated.

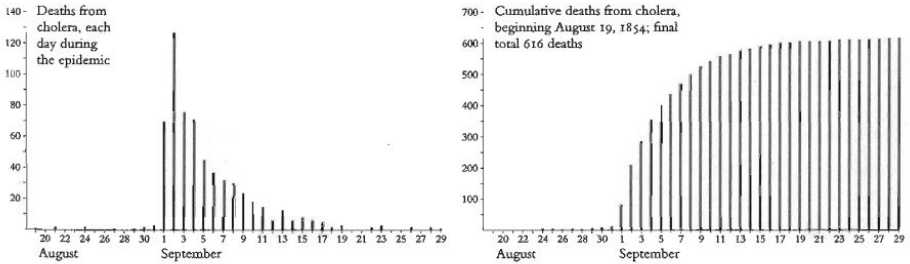
- Using empirical data, Snow figured out that the cause of the epidemic was a contaminated pump-handle, and the epidemic soon ended

- Today he is celebrated for establishing the mode of cholera transmission and consequently the method of prevention

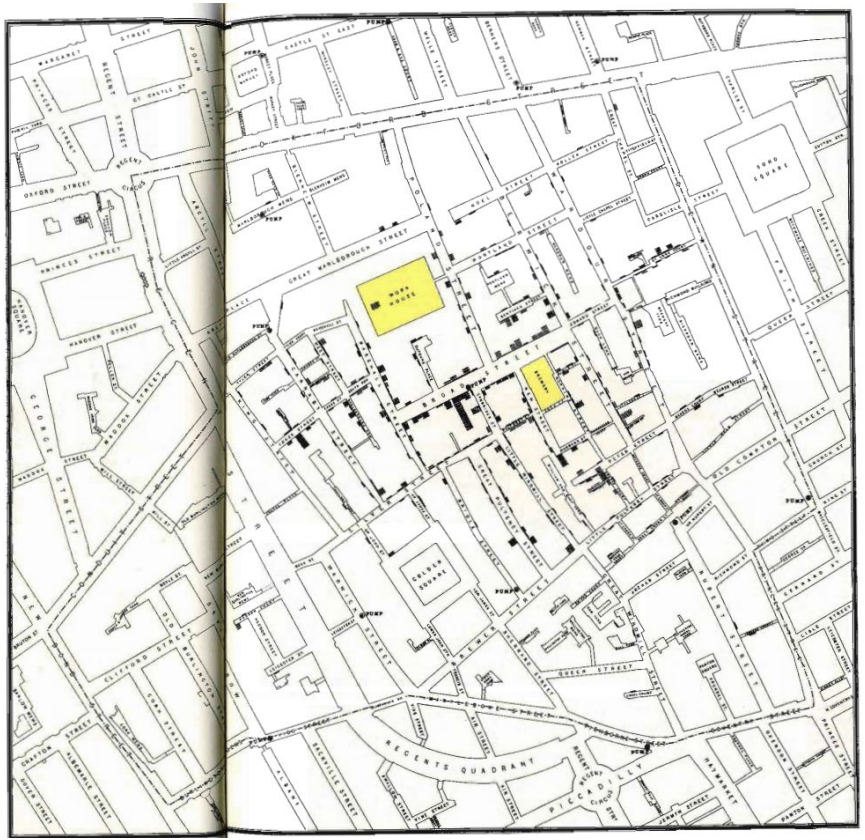


[6] H. Harold Scott, *Some Notable Epidemics* (London, 1934), pp. 3–4.

1. *Placing the data in an appropriate context for assessing cause and effect*



Instead of plotting a time-series, Snow constructed a graphical display that provided powerful testimony about a possible cause-effect relationship. Snow marked deaths from cholera ( ) on this map, along with the locations of community water pump wells ( ). Revealed strong association between cholera and proximity to Broad Street



2. ***Making quantitative comparisons***

Snow not only analyzed data of victims of cholera, but also those who escaped the disease

3. ***Considering alternative explanations and contrary cases***

The credibility of a report is enhanced by careful assessment of all relevant evidence, not just evidence overtly consistent with explanations enhanced by a report. The point is to get it right, not to win the case.

4. ***Assessment of possible errors in the numbers reported in graphics***

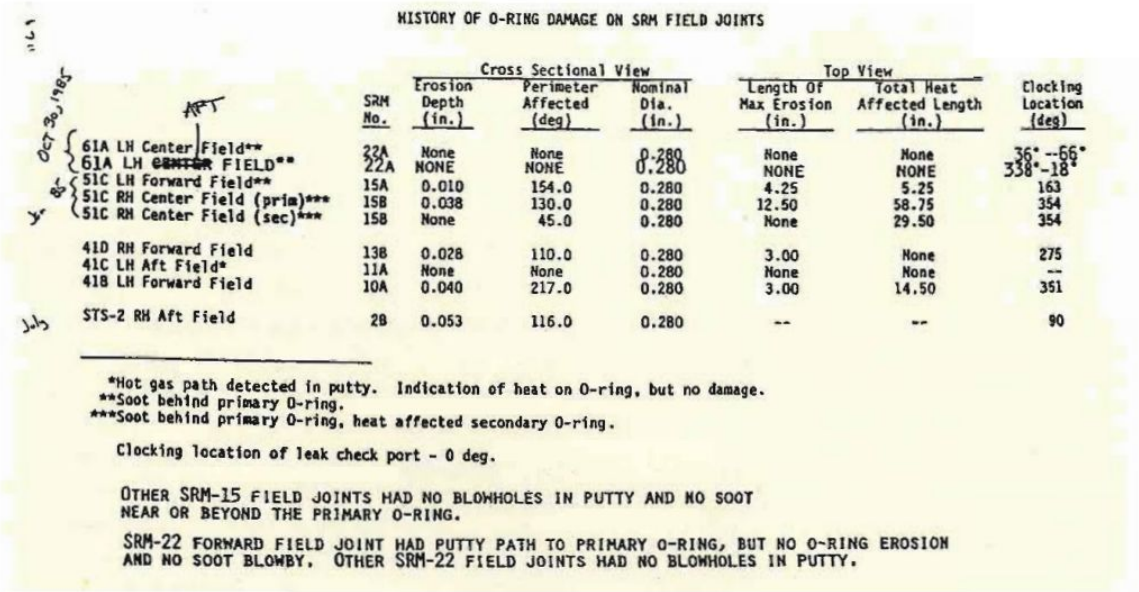
The Decision to Launch the Space Shuttle Challenger

- On January 28, 1986, the space shuttle Challenger exploded and seven astronauts died because two rubber O-rings leaked.

- The clear proximate cause: an inability to assess the link between cool temperature and O-ring damage in earlier flights. Such a pre-launch analysis would have revealed the flight was a considerable risk.

- In the field of statistics, this accident evoked to demonstrate the importance of risk assessment, data graphs, fitting models to data, and requiring students of engineering to attend statistics class

- Engineers at NASA had prepared 13 charts to make the case that the Challenger should *not* be launched, however, the charts were unconvincing, the arguments against the launch failed; the Challenger blew up.



HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36°--66°
61A LH ~~CENTER~~ FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

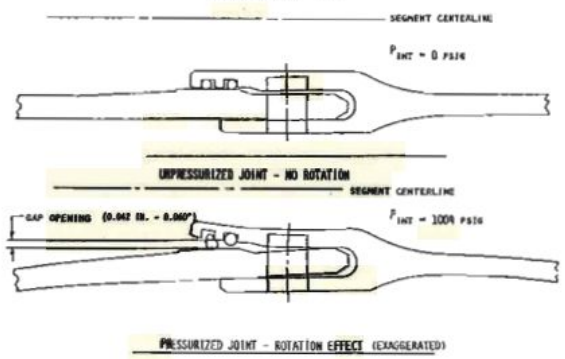
- Does not provide the *names* of the people who prepared the material
- Public, named authorship indicates responsibility, both to immediate audience and long-term record
- Describes historical distribution of the effect endangering the Challenger, does not provide data about possible cause
- The same rocket has 3 different names

PRIMARY CONCERNS -

FIELD JOINT - HIGHEST CONCERN

- EROSION PENETRATION OF PRIMARY SEAL REQUIRES RELIABLE SECONDARY SEAL FOR PRESSURE INTEGRITY
  - IGNITION TRANSIENT - (0-600 MS)
    - (0-170 MS)HIGH PROBABILITY OF RELIABLE SECONDARY SEAL
    - (170-330 MS) REDUCED PROBABILITY OF RELIABLE SECONDARY SEAL
    - (330-600 MS) HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
- STEADY STATE - (600 MS - 2 MINUTES)
  - IF EROSION PENETRATES PRIMARY O-RING SEAL - HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
    - BENCH TESTING SHOWED O-RING NOT CAPABLE OF MAINTAINING CONTACT WITH METAL PARTS GAP OPENING RATE TO MEOP
    - BENCH TESTING SHOWED CAPABILITY TO MAINTAIN O-RING CONTACT DURING INITIAL PHASE (0-170 MS) OF TRANSIENT

PRIMARY CONCERNS - CONT

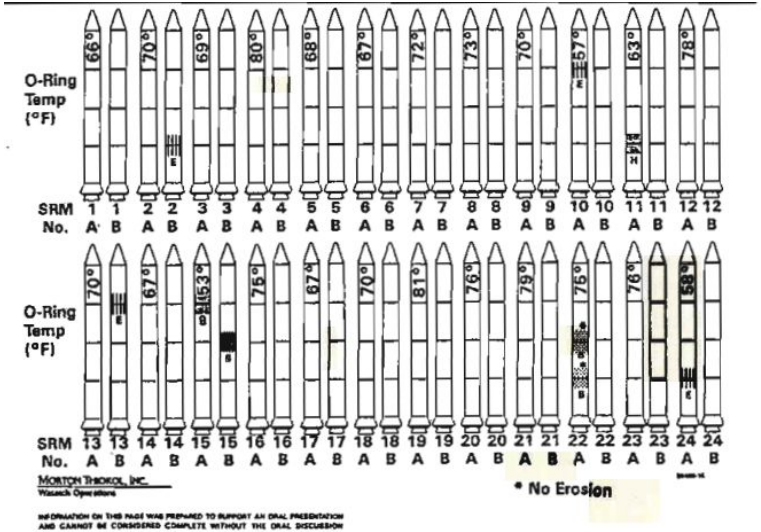


[33] The table of temperature data, shown in full at left, is described as a "History of O-ring Temperatures." It is a highly selective history, leaving out nearly all the actual flight experience of the shuttle:

MOTOR	O-RING	
DM-4	47	Test rockets ignited on fixed horizontal platforms in Utah.
DM-2	52	
QM-3	48	The only 2 shuttle launches (of 24) for which temperatures were shown in the 13 Challenger charts.
QM-4	51	
SRM-15	53	
SRM-22	75	
SRM-25	29 27	Forecasted O-ring temperatures for the Challenger.

- Charts utilized in presentation did not express the main correlation between temperature and O-ring damage in a clear way
- Displayed data set was thin - comparable to if John Snow had ignored some areas with cholera and *all* the cholera-free areas and their water pumps - *Numbers become evidence by being put in context and in relation to*

VISUAL EXPLANATIONS - EDWARD TUFTE



Poor design choices also made it difficult/impossible to learn and decipher information:

- 1. Disappearing Legend
- 2. Chartjunk
- 3. Lack of Clarity in Depicting Cause and Effect
- 4. Wrong Order

Conclusion: *Thinking and Design*

1. *Documenting* the sources and characteristics of the data
2. Insistently enforcing appropriate *comparisons*
3. Demonstrating mechanisms of *cause and effect*
4. Expressing those mechanisms *quantitatively*
5. Recognizing the inherently *multivariate* nature of analytic problems
6. Inspecting and evaluating *alternative explanations*
7. An endless commitment to finding, telling and showing the truth

When consistent with the substance and in harmony with the content, information displays should be documentary, comparative, causal and explanatory, quantified, multivariate, exploratory, skeptical.

Explaining Magic:
Pictorial Instructions and Disinformation Design

- To create illusions is to engage in *disinformation design*
- Two primary principles: *suppressing context* and *preventing reflective analysis*

When reversed, reinforces strategies of informative design: audience *should* understand and know what you are going to do, so they can evaluate how your verbal and visual evidence supports your argument.

Disinformation Design Reversed: Practical Advice

1. **Near the beginning of presentation, tell the audience: what the problem is, why it is important, and what the solution is.** If these questions cannot be answered, it is a sure sign the content of the presentation is deficient

2. **To explain complex ideas or data, use the method of PGP: Particular, General, Particular.** Give *high-resolution* talks that are clear and rich in content, and seek to *maximize the rate of information transfer*

3. **No matter what, give everybody in the audience one or more pieces of paper, packed with material related to your presentation.** Paper serves as a testimonial record documenting the talk, letting audience know the speaker takes responsibility for what they say

Disinformation Design Reversed: Practical Advice

4. **Analyze the details of the presentation; then master those details through practice.** Work on what the audience *sees* and also *hears*.

5. **Show up early.** By arriving early, one can prepare themselves mentally and check that technical aspects will go smoothly.

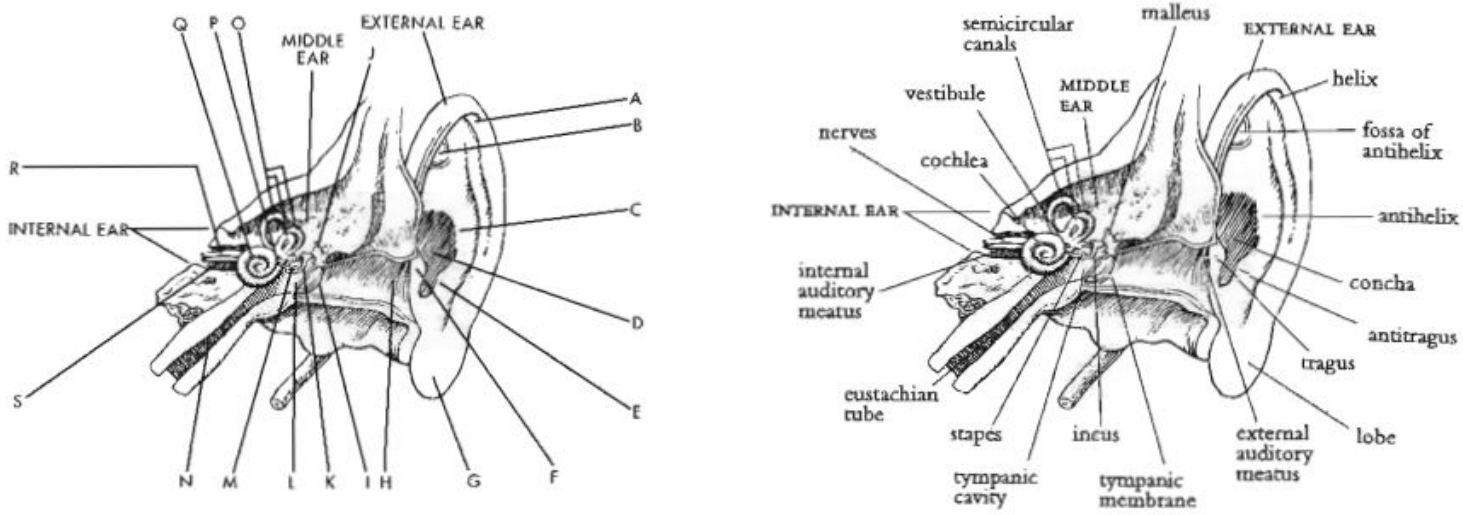
6. **Finish early.** People never complain about a presentation ending early. Get to the point, be brief, keep interesting audience, quit before the audience has had enough.

The Smallest Effective Difference

- In designing information, the idea is to use *just notable differences*, visual elements that make a clear difference - contrasts that are definite, effective, *and* minimal.

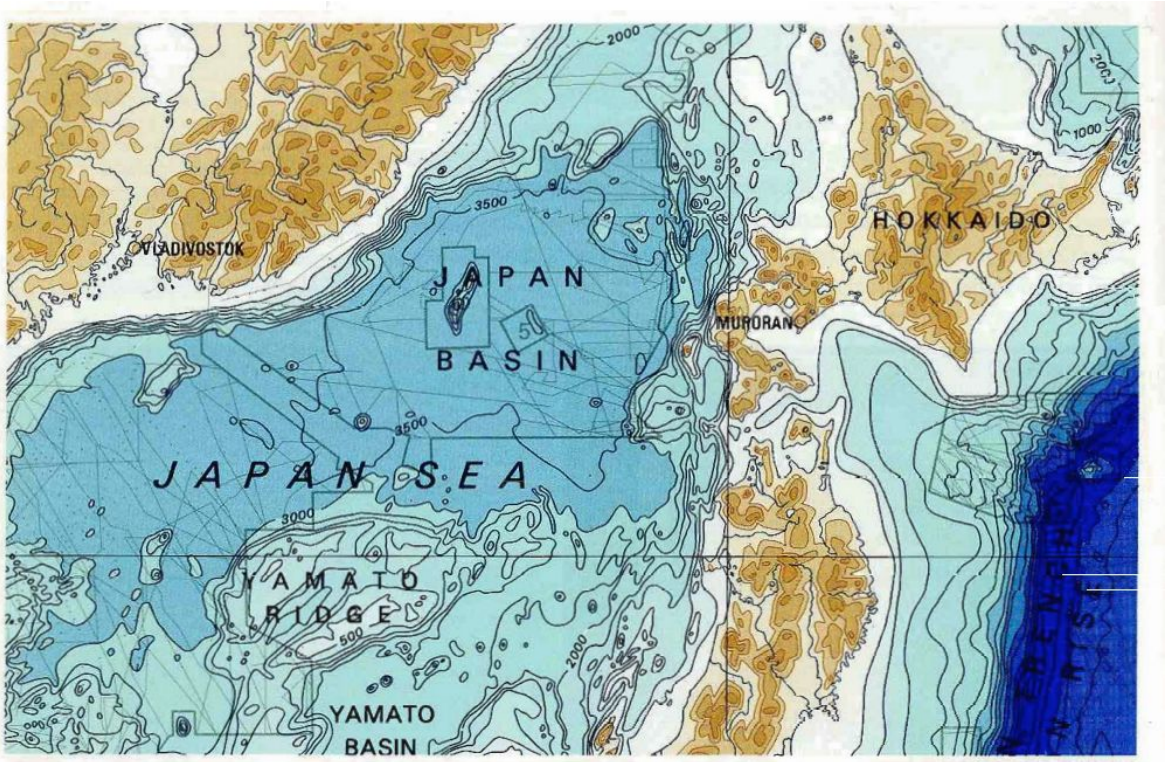
- Helps in designing the various secondary and structural elements in displays of information- arrows, pointer lines, dimension lines, scales, grids, meshes, rules, underlines, boxes, legends, highlights, accents, shadows, fills defining areas and surfaces, etc. - *muting* these secondary elements will often reduce visual clutter - thus help clarify primary information

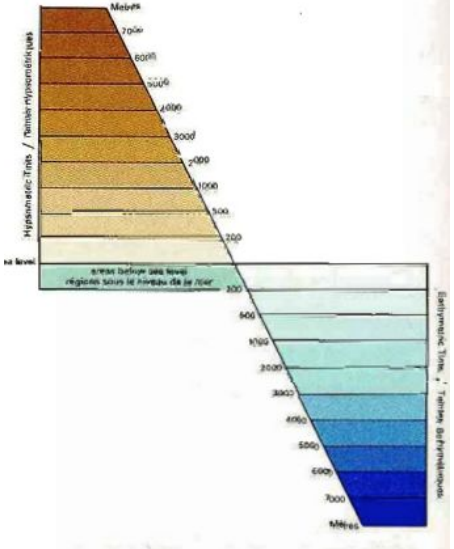
- When *everything* (background, structure, content) is emphasized, *nothing* is emphasized - design will be noisy, cluttered, informationally flat



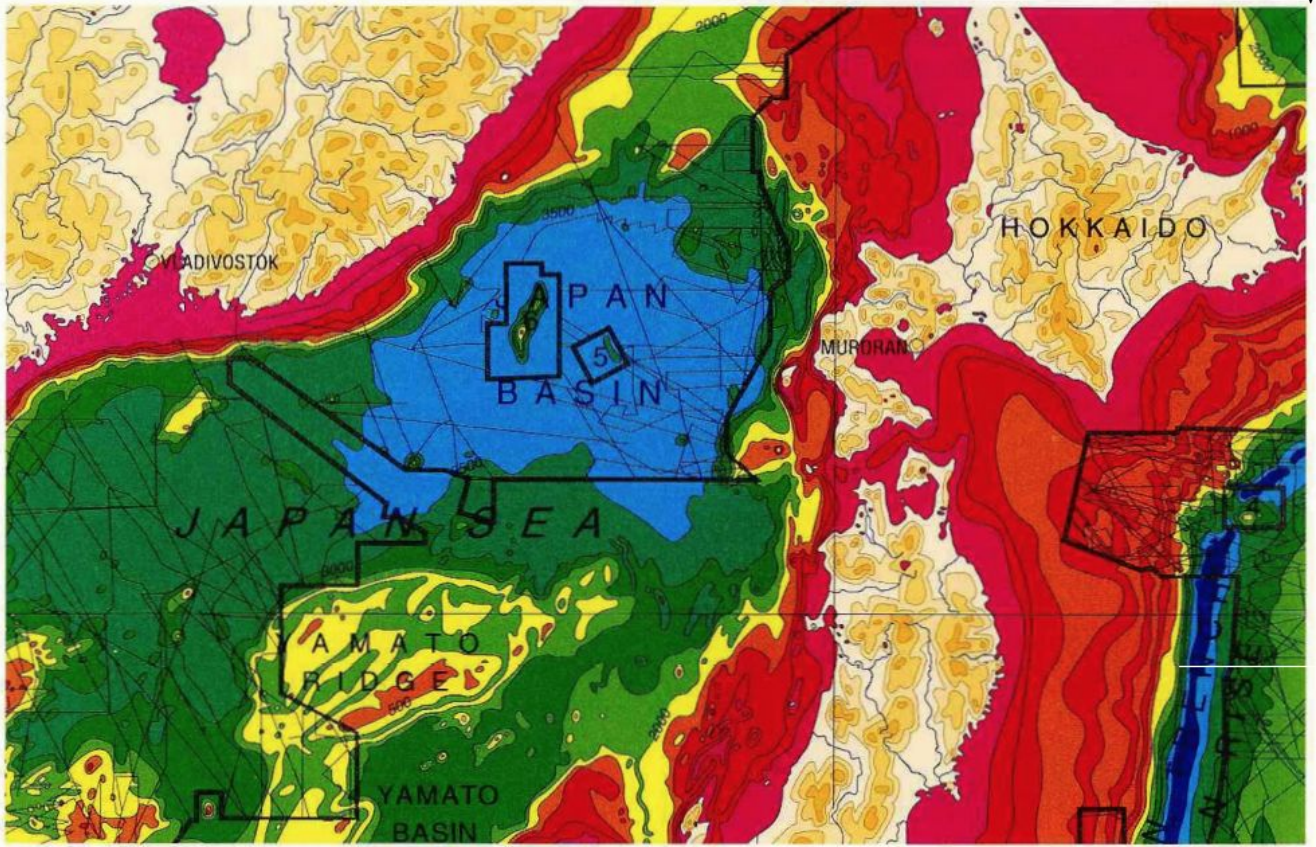
Strong contrasts between secondary elements and background will visually activate the background. In the original ear (left), white striped show up between the dominant pointer- lines. A redrawing (right) minimizes the pointers - there by clarifying the ear itself- and also replaces the coded list of parts with direct labels.

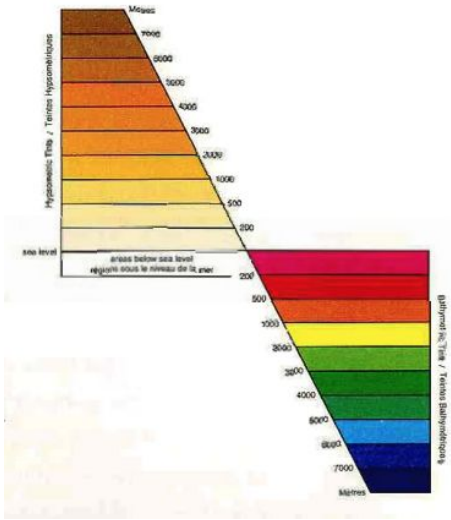
VISUAL EXPLANATIONS - EDWARD TUFTE





Tufte considers this an example with extraordinary use of small effective differences.
- ocean depth indicated through blues, altitude through tans
- contour lines are labeled by numbers, nearly eliminates any need to refer to the legend
- every color tint signals four variables: latitude, longitude, sea or land, and depth/altitude measured in meters
- gray lines trace out the routes of ships
- all information is readable, minimal differences allow the viewer to observe more differences





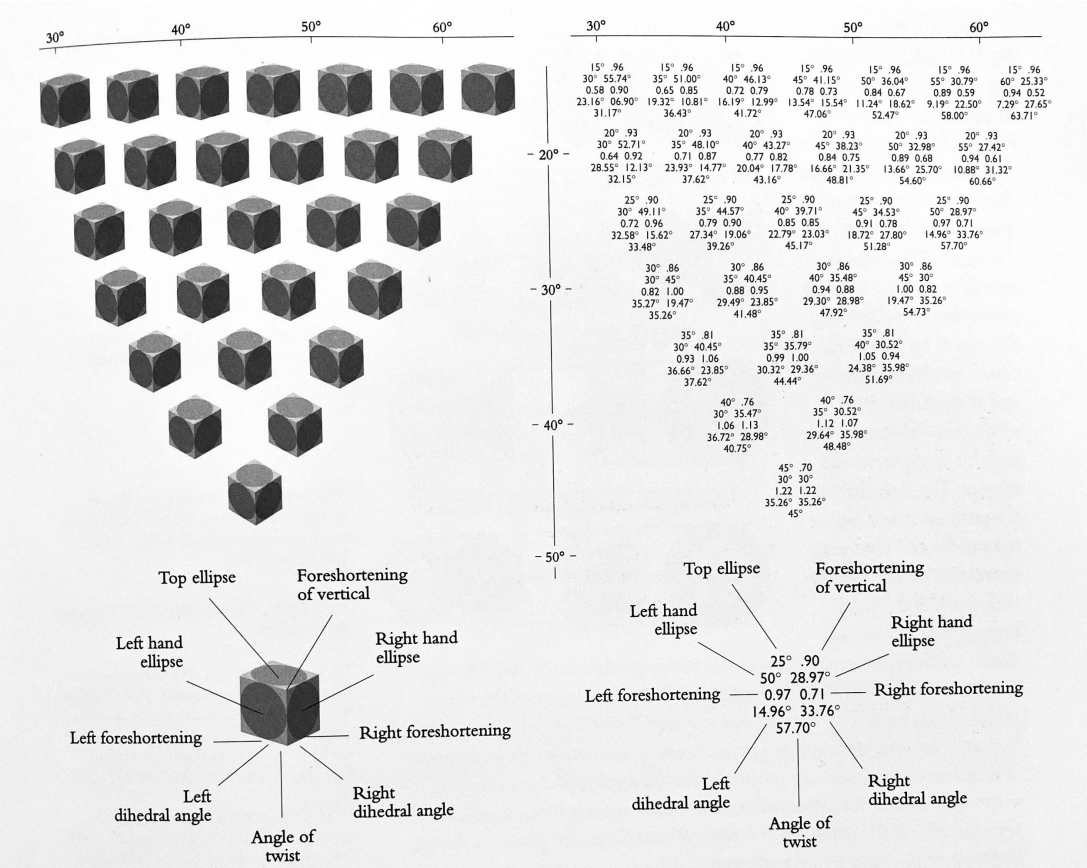
Tufte considers this a ghastly contrast to the previous graph.
- aggressive colors are unnatural and un-quantitative, render the map incoherent
- “the original data now lost in the soup”

Conclusions: Smallest Effective Difference

- Minimal distinctions reduce visual clutter
- Small contrasts work to enrich the overall visual signal by increasing the number of distinctions that can be made within a single image
- Thus increasing the resolution of an image
- Appropriate size of small contrasts depends on context, priority of particular elements in the overall visual story, number of differentiations made within an image, and characteristics of those viewing the image

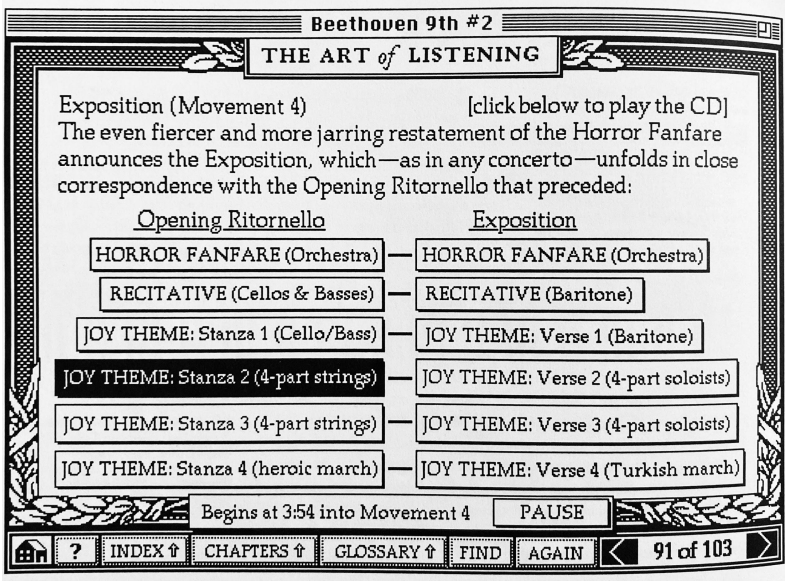
Parallelism: Repetition and change, comparison & surprise.

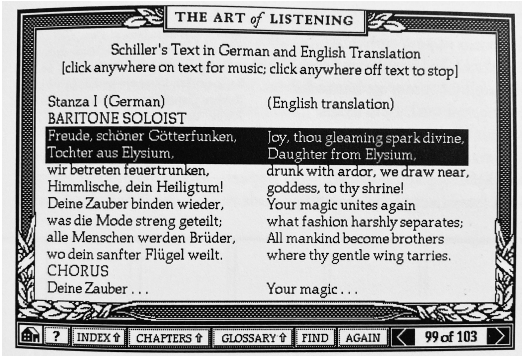
+ Spatial Parallelism relies on our ability to compare and contrast images that share the same space, our ability to understand complex images can be quickened when they are spatially parallel.
+ Parallelism allows us to generate links between variations in data, because we connect things naturally by position, orientation, overlap, synchronization, and similarities in content.
+ **Parallelism creates the foundation for coherent organization of visuals**.

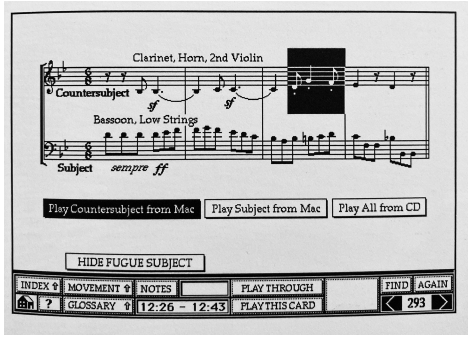


Successful parallelism in this diagram is apparent in many ways.

The similarities in shape, layout, scale, and position, allow a viewer to easily digest the connection between the cubes and the numbers on the right.



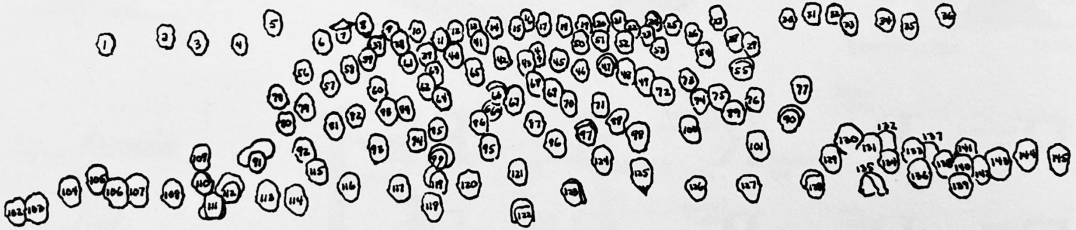




In this example, Tufte talks about **parallelism that combines visuals and sound.** A person listening to this music will interact with this visual in order to hear and understand the many interpretations of the music at their own speed.

Here, the use of **superimposed parallelism enhances the slight variation** of the complex letterforms of the trajan inscription.

Edward M. Catich



1. Dimitroff
2. Cameron
3. Adams
4. Layzer
5. Irwin
6. Binnendijk
7. Rieber
8. Smiley
9. Dyer
10. Keller
11. Vysotsky
12. Mitchell
13. Protheroe
14. Deutsch
15. Matthews
16. T. G. Cowling
17. Wildt
18. Sitterly
19. Orral
20. Hoag
21. Wyller
22. Mrs. Merrill
23. Mrs. Henry Smith
24. McKrosky
25. Merrill
26. Henry Smith
27. Bestul
28. Scott
29. Savedoff
30. Yeagley
31. R. H. Wilson
32. Ashbrook
33. Sutton
34. Alden
35. Schopp
36. Heines
37. Weston
38. Harlan Smith
39. Mrs. Harlan Smith
40. Keenan
41. Stearns
42. Sarah Lee Lippincott
43. Munch
44. Mrs. Stearns
45. Miss Roman
46. King
47. Mrs. Gossner
48. Davis
49. Streeter
50. Cuffey
51. Mrs. Sitterly
52. Naqvi
53. Gossner
54. Mrs. Savedoff
55. Mrs. Lewis
56. Leavitt
57. Brouwer
58. Federer
59. Miss Morrow
60. Miss Hutzler
61. Huffer
62. Malitosky
63. Wood
64. Seyfert
65. Blitzstein
66. Miss Reilly
66a. Miss Allen
67. Haddock
68. Hagen
69. Thomas
70. Whipple
71. Harris
72. Eggen
73. Miss Williams
74. Mrs. Mayall
75. Hall
76. Miss Jones
77. Owren
78. Wolff
79. Rabinowitz
80. Hynek
81. Eckert
82. Mrs. Eckert
83. Omer
84. Yoss
85. Miss Weber
86. Miss Underhill
87. Allan Cook
88. Mrs. Whipple
89. Ice
90. Mrs. Menzel
91. Mrs. van de Kamp
92. Mrs. Baker
93. Aller
94. Mrs. Federer
95. Schlitt
96. Miller
97. McLaughlin
98. Mrs. Woodward
99. Mrs. Deutsch
100. Goldberg
101. Menzel
102. Barton
103. Whitford
104. Duke
105. Green
106. van de Kamp
107. Baker
108. Chamberlin
109. Spitzer
110. Chester Cook
111. Mrs. Chamberlin
112. Miss Damkoehler
113. Hertz
114. Kameny
115. Kiess
116. Warwick
117. Joy
118. Toni Federer
119. Miss Schwartzman
120. Nassau
121. Robertson
122. Barbara Federer
123. Mrs. Miller
124. Millman
125. Edmondson
126. Miss Barney
127. Schwarzschild
128. Mrs. Schwarzschild
129. Gingrich
130. Miss Swope
131. Stuecklen
132. Kerr
133. Clemence
134. Miss Hill
135. Miss Wright
136. Olivier
137. Bappu
138. Miss Johns
139. Zinszer
140. Yowell
141. Milford
142. Mrs. Owren
143. Epstein
144. Wrubel
145. de Jonge

A mix of a photograph, drawing, numbers, and words creates a complex relationship of parallels. The detached head drawings are difficult to understand but can help a viewer understand the figures in the photo faster.

Multiples in space and time.

MULTIPLE images reveal repetition and change, pattern and surprise—the defining elements in the idea of *information*.

Multiples directly depict comparisons, the essence of statistical thinking.

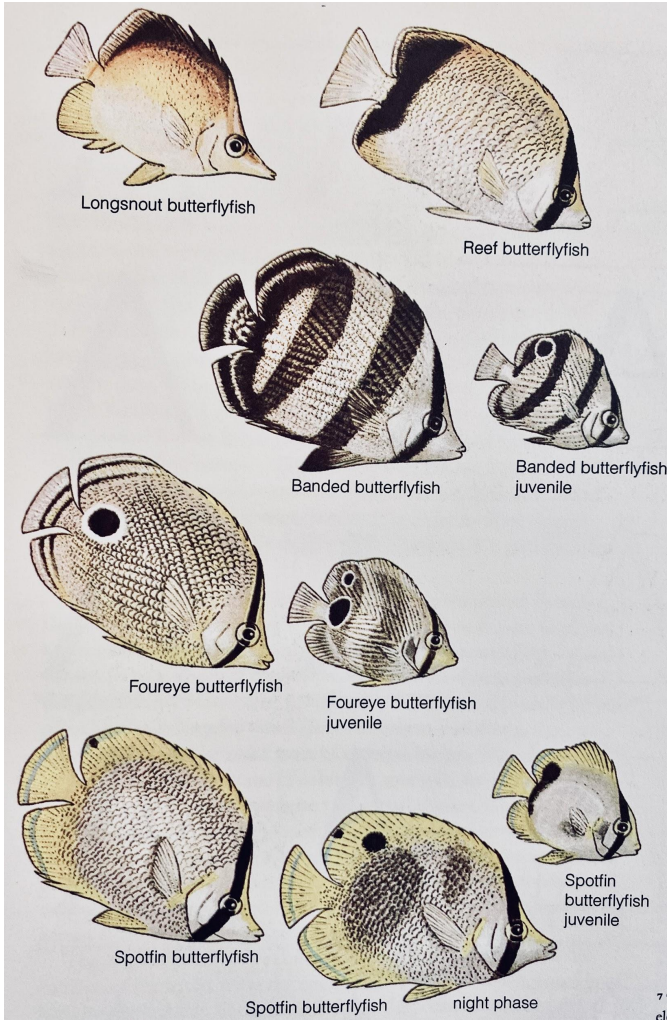
Multiples enhance the dimensionality of the flatlands of paper and computer screen, giving depth to vision by arraying panels and slices of information.

Multiples create visual lists of objects and activities, nouns and verbs, helping viewers to analyze, compare, differentiate, decide—as we see below with 12 hands in 12 positions for making 12 sounds.

Multiples represent and narrate sequences of motion.

Multiples amplify, intensify, and reinforce the meaning of images.

This images uses stills figures that change to when read horizontally to **describe and depict motion**. Using multiples to show motion can be problematic because it can have difficulties showing the actual passage of time, and rhythms of the motion.

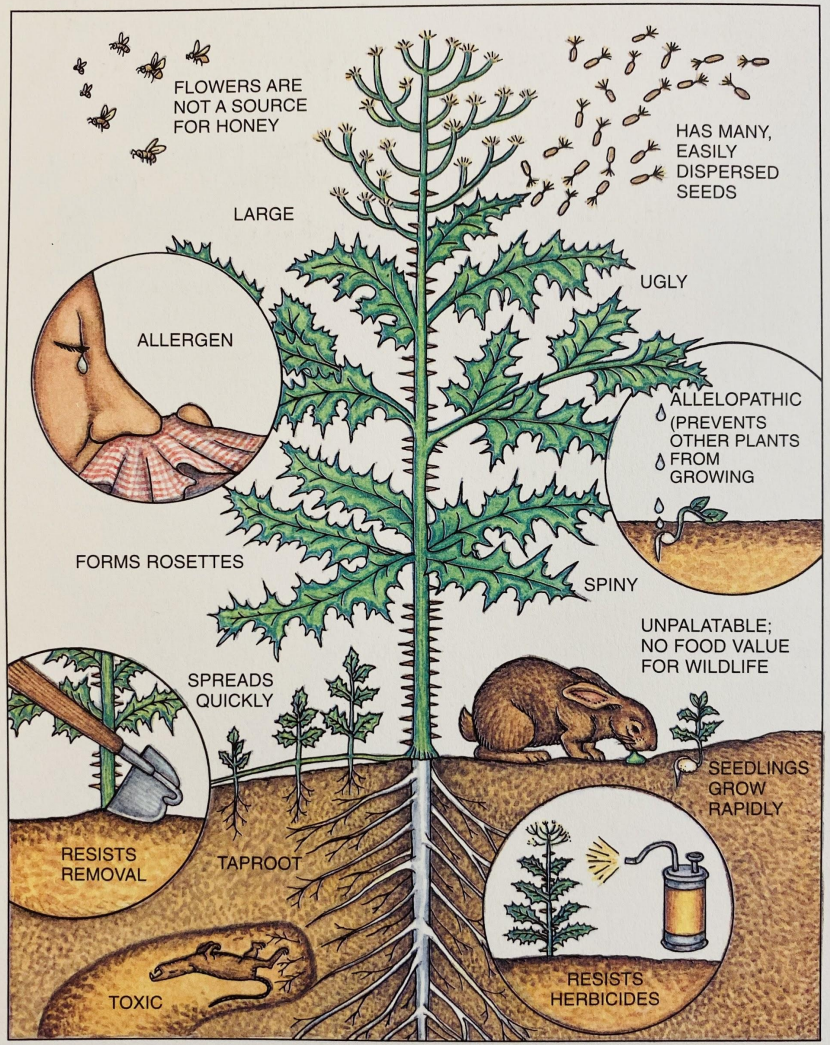


Multiples here are used to help a viewer make **fine distinctions and close comparisons between similar nouns**. The **generic** fish images are in relation with each other to enhance scale difference and color difference. The underwater book is designed to make the diver find fish as simply as possible.

This diagram depicts multiples used to show the different styles of art **when applied to one object**. Use of **multiples enhances the approaches of each style.**

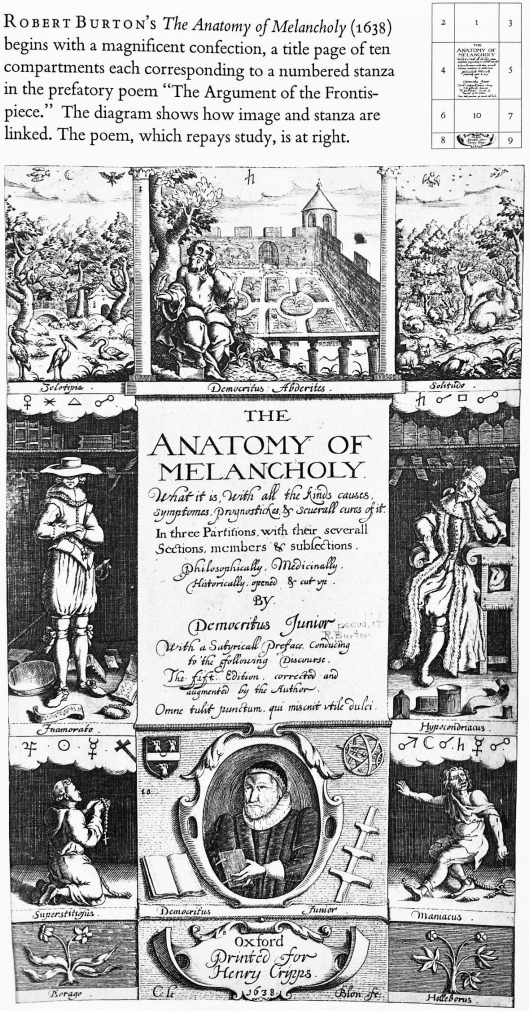
Visual Confections: Juxtapositions from the ocean of the streams of story.

+ Confections are non direct representations of scenes. They are a collection of gathered images displayed in compartments and existing in imagined scenes.
+ Confections describe a story, and can combine many different images to get the story and meaning across.
+ **Confections illustrate an argument, present and enforce visual comparisons, combine the real and imagined, and tell us yet another story.**



This confection uses illustration to reinterpret what could be a list or inventory. The diagram blends words and images into a memorable piece. **The drawing is about acts, verbs, and consequences.**

ROBERT BURTON'S *The Anatomy of Melancholy* (1638) begins with a magnificent confection, a title page of ten compartments each corresponding to a numbered stanza in the prefatory poem "The Argument of the Frontis-piece." The diagram shows how image and stanza are linked. The poem, which repays study, is at right.



TEN distinct Squares here seene apart,
Are joyn'd in one by Cutters art.

1 *Old* Democritus *under a tree,*
Sits on a stone with book on knee;
About him hang there many features,
Of Cats, Dogs and such like creatures,
Of which he makes Anatomy,
The seat of black choler to see.
Over his head appears the sky
And Saturn *Lord of melancholy.*

2 *To th' left a landscape of* Jealousy,
Presents it self unto thine eye.
A Kingfisher, a Swan, an Hern,
Two fighting Cocks you may discern,
Two roaring Bulls each other hie,
To assault concerning Venery.
Symbols are these; I say no more,
Conceive the rest by that's afore.

3 *The next of* Solitariness,
A portraiture doth well express,
By sleeping dog, cat: Buck and Doe,
Hares, Conies in the desert go:
Bats, Owls the shady bowers over,
In melancholy darkness hover.
Marke well: If 't be not as't should be,
Blame the bad Cutter and not me.

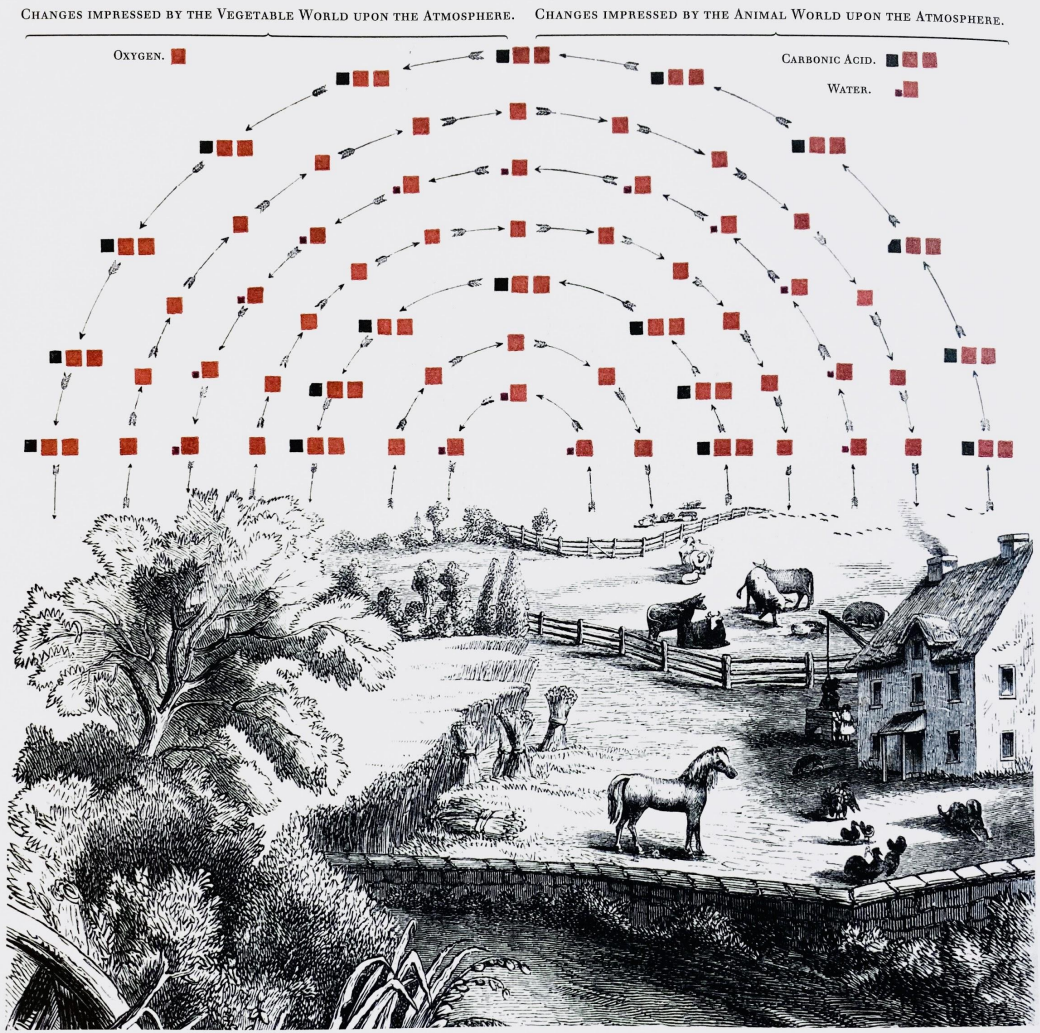
4 *I' th' under Columne there doth stand*
Inamorato *with folded hand;*
Down hangs his head, terse and polite,
Some dittie sure he doth indite.
His lute and books about him lie,
As symptomes of his vanity.
If this do not enough disclose,
To paint him, take thy self by th' nose.

5 Hypocondriacus *leans on his arm,*
Winde in his side doth him much harm,
And troubles him full sore God knows,
Much pain he hath and many woes.
About him pots and glasses lie,
Newly brought from's Apothecary.
This Saturn's *aspects signify,*
You see them portray'd in the sky.

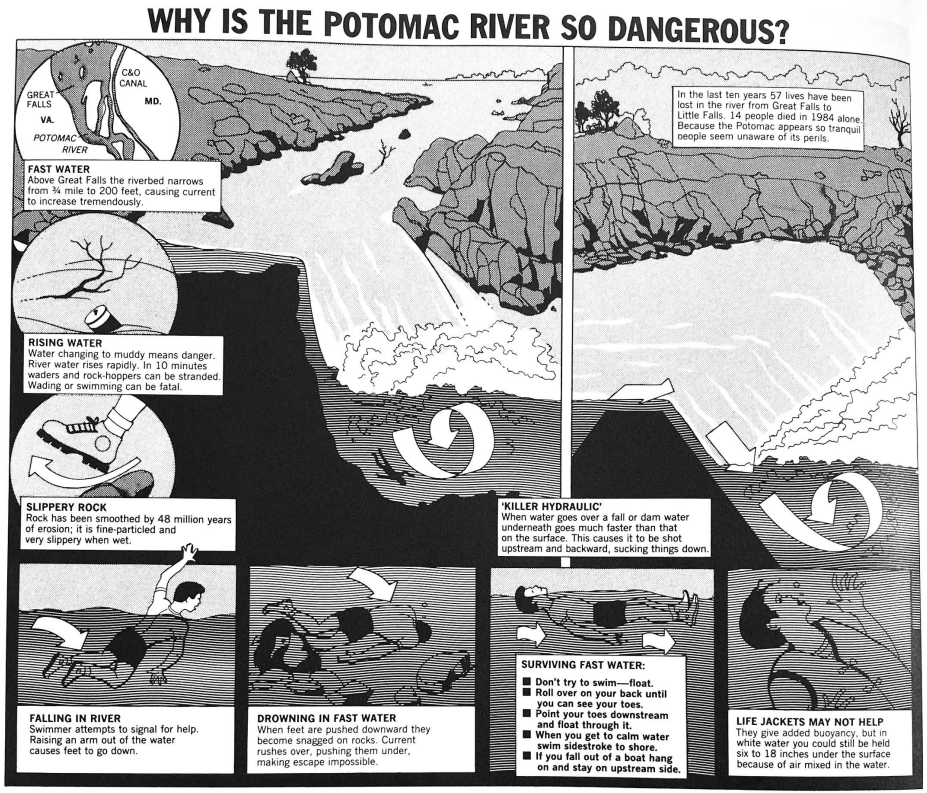
6 *Beneath them kneeling on his knee,*
A Superstitious *man you see:*
He fasts, prays, on his Idol fixt,
Tormented hope and fear betwixt:
For hell perhaps he takes more pain,
Then thou dost Heaven it self to gain.
Alas poor Soul, I pity thee,
What stars incline thee so to be?

7 *But see the* Madman *rage down right*
With furious looks, a gastly sight.
Naked in chains bound doth he lie,
And roars amain he knows not why?
Observe him; for as in a glass,
Thine angry portraiture it was.
His picture keep still in thy presence;
Twixt him and thee, ther's no difference.

Robert Burton's piece uses a diagram to link images to each stanza, this reduces space and is a linear way to digest images.



In this confection, the artist merges abstract color squares and a detailed drawing of a farm.



Great Falls Park Rangers Pray for Rain, to Save Lives

By Mary Jordan
Washington Post Staff Writer

Great Falls National Park rangers said they prayed it would rain today, not so much to keep people away but to keep them alive.

On each of the past two cloudless Sundays, a person who swam or slipped into the Potomac River near the park died.

If the sun shines as brilliantly as predicted today—drawing as many as 5,000 people to the park—authorities said, the chances that another person would drown would be as chilling as the cascading waterfalls themselves.

"There's a 1-in-11 chance that someone drowns [today]," said Howard E. McCurdy, an American University professor who has analyzed the 57 drownings that have occurred between Great Falls and Little Falls on the Potomac since 1975 for the National Park Service.

"A sunny, June Sunday when the water level is at a medium height makes the park service very nervous," McCurdy said Friday. "These tragedies aren't as random as we tend to think."

The study explains four factors contributing to a higher probability of drownings: weather, season, day of week and water level.

"Danger days" are what Joan Anzelmo, the park service site manager at Great Falls, calls warm, spring Sundays when the water level is between three and five feet.

On these days, when visitors sunbathe, climb rocks and picnic along the park's shoreline, Anzelmo said, the risk of drowning peaks, particularly because the water level is not high enough to alert people to the river's deadly undercurrents.

There are only five park rangers and two park police officers on each side of the 11-mile stretch of river between Great Falls and Little Falls in Virginia and Maryland.

For Earl V. Kittleman, the chief National Park spokesman, that means "I'm praying for clouds, drizzle or rain . . . , anything until we get past June weekends."

Anzelmo said that by July and August, news of the annual spring drownings scares more people away from the slippery rocks edging the Potomac, and fewer people visit Great Falls because many spend weekends at the beach or vacation elsewhere.

Yesterday, despite posted warnings and widespread news reports of the six drownings that have occurred this year, dozens of Great Falls patrons climbed perilously close to the river's edge.

Paul Galison, a 16-year-old Langley High School sophomore, stood a few yards from a sheer 50-foot drop into the Potomac yesterday. "I know it's dangerous," he said. "But the

See FALLS, C5, Col. 1

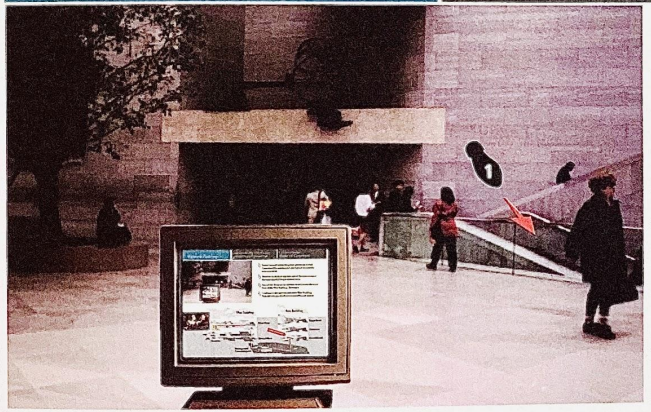
This informative confection effective shows the dynamics between verbs and causes.

The printed page allows the reader to absorb the information at their own rate, to fully understand the risks involved with the river.

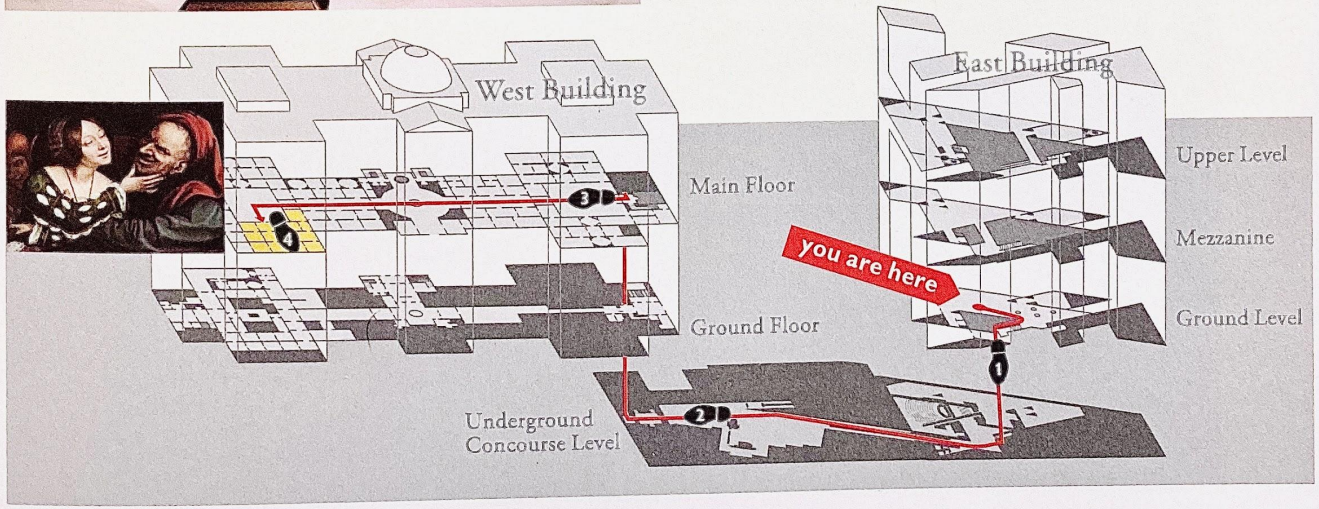
Flemish Paintings

touch here, then turn around for your
picture and printout

touch here to return to
table of contents



1. Locate yourself within the gallery picture on the left. Cross the lobby and descend one flight of stairs to the concourse level.
2. Travel to the farthest opposite end of the concourse past the concourse buffet and the bookstore.
3. Ascend two floors on the elevator or escalator to the main floor of the West Building. Turn right.
4. Continue to the opposite end of the West Building. Turn left to begin the Netherlandish/Flemish exhibit.



Computers are capable of assembling and displaying one time confections designed to serve immediate, local, unique purposes.