DESIGN
Miriah Meyer
University of Utah
DESIGN

Miriah Meyer
University of Utah

slide acknowledgements:
Hanspeter Pfister, Harvard University
John Stasko, Georgia Tech
Josh Levine, Clemson
administrivia...
- sign-up for design critiques
  - they start next week!
  - also, register on the class forum
last time . . .
visualization

1. uses perception to point out interesting things.
2. uses pictures to enhance working memory.
VISUALIZATION GOALS

- record information

- analyze data to support reasoning

- confirm hypotheses

- communicate ideas to others
today . . .
- Four Levels of Visualization Design

- Tufte’s Principles
  - integrity
  - design

- Critiques
THE FOUR LEVELS OF VISUALIZATION DESIGN
NESTED MODEL
Munzner 2009

design model: describes levels of design inherent to, and that should be considered in, the creation of a visualization
domain situation

**domain situation**
describing a group of target users, their domain of interest, their questions, and their data
**NESTED MODEL**

Munzner 2009

---

**data/task abstraction**

abstracting the specific domain questions and data from the domain-specific form into a generic, computational form
encoding/interaction technique

decide on the specific way to create and manipulate the visual representation of the abstraction
algorithm

crafting a detailed procedure that allows a computer to automatically and efficiently carry out the desired visualization goal
NESTED MODEL
Munzner 2009

domain situation

data/task abstraction

encoding/interaction technique

algorithm
NESTED MODEL

Munzner 2009

- Threat: wrong problem
- Validate: observe and interview target users

- Threat: bad data/operation abstraction
- Validate: justify encoding/interaction design

- Threat: ineffective encoding/interaction technique
- Validate: analyze computational complexity
  - Implement system

- Validate: measure system time/memory
- Validate: qualitative/quantitative result image analysis
  - Test on any users, informal usability study

- Validate: lab study, measure human time/errors for operation
- Validate: test on target users, collect anecdotal evidence of utility

- Validate: field study, document human usage of deployed system
- Validate: observe adoption rates
design excellence

“Well-designed presentations of interesting data are a matter of substance, of statistics, and of design.”

Edward Tufte
Edward Tufte
every time you make a powerpoint

edward tufte kills a kitten
TUFTE’S LESSONS

**practice:** graphical integrity and excellence

**theory:** design principles for data graphics
1. GRAPHICAL INTEGRITY
Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity.
MISSING SCALES

OPERATING REVENUES

$3,594,385

($11,410)


NET INCOME (LOSS)

$397,747

$521,943


EXPLORATION & DEVELOPMENT EXPENDITURES

$351,341


Tufte 2001
MISSING SCALES

Tufte 2001
MISSING SCALES

baseline?

Tufte 2001
SCALE DISTORTION

---

### Scale Distortion Graph

- **Y-axis:** Volume
- **X-axis:** Year


The graph shows a trend where the volume increases from 1998 to 2000, drops in 2001, and then decreases sharply in 2002.
Did the stock market crash?

**SCALE DISTORTION**

![Graph showing volume over years]

- Volume: 500, 475, 450

Did the stock market crash?
SCALE DISTORTION

Did the stock market crash?
Did the stock market crash?

SCALE DISTORTION

volume

Did the stock market crash?

year

1998 1999 2000 2001 2002
Did the stock market crash?

SCALE DISTORTION

volume

Did the stock market crash?
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Did the stock market crash?
SCALE DISTORTION

Did the stock market crash?

volume

0 250 500


year
SCALE DISTORTION

Did the stock market crash?

volume

year

28

Did the stock market crash?
Tufte’s integrity principles

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity.

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.
Tufte’s integrity principles

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity.

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

The Lie Factor $= \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}$
This line, representing 18 miles per gallon in 1978, is 0.6 inches long.

This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

Fuel Economy Standards for Autos
Set by Congress and supplemented by the Transportation Department. In miles per gallon.
The Lie Factor = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}
The Lie Factor = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}

\text{GRAPHIC} \quad \frac{5.3 - 0.6}{0.6} \times 100\% = 783\%
The Lie Factor = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}

\text{GRAPHIC} \quad \frac{5.3 - 0.6}{0.6} \times 100\% = 783\%

\text{DATA} \quad \frac{27.5 - 18.0}{18} \times 100\% = 53\%
The Lie Factor = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}

\text{GRAPHIC} \quad \frac{5.3 - 0.6}{0.6} \times 100\% = 783\%

\text{DATA} \quad \frac{27.5 - 18.0}{18} \times 100\% = 53\%

\text{LIE FACTOR} = \frac{783}{53} = 14.8
REQUIRED FUEL ECONOMY STANDARDS:
NEW CARS BUILT FROM 1978 TO 1985

19.1 mpg, expected average for all cars on road, 1985

13.7 mpg, average for all cars on road, 1978

Tufte’s integrity principles

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity.

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

Show data variation, not design variation.
UNINTENDED SIZE CODING
UNINTENDED SIZE CODING
Baby Name Voyager: Names starting with 'M' per million babies

Share Info, Save Names, Get our Newsletter and Access Powerful Tools
Sign Up Now or Click Here to Find Out More

NameVoyager: Explore baby names and name trends letter by letter

What name do you love but are afraid to use? Tell us for a chance to win our Baby Shower Giveaway!

Baby Name > m

Click a name graph to view that name. Double click to read more about it.

For more options, click here to sign up for the Expert Name Voyager.

Like 8,248 people like this. Sign Up to see what your friends like.
2. GRAPHICAL EXCELLENCE
Excellence

• Graphical excellence is that which
  • gives the viewer the greatest number of ideas
  • in the shortest time
  • with the least ink
  • in the smallest space

A. Einstein, “An explanation should be as simple as possible, but no simpler.”
Anscombe’s Quartet

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TABLE. Four data sets, each comprising 11 (x, y) pairs.

Number of observations (n) = 11
Mean of the x’s (\(\bar{x}\)) = 9.0
Mean of the y’s (\(\bar{y}\)) = 7.5
Regression coefficient (\(b_1\)) of y on x = 0.5
Equation of regression line: y = 3 + 0.5 x
Sum of squares of x – \(\bar{x}\) = 110.0
Regression sum of squares = 27.50 (1 d.f.)
Residual sum of squares of y = 13.75 (9 d.f.)
Estimated standard error of \(b_1\) = 0.118
Multiple \(R^2\) = 0.667

3. DESIGN PRINCIPLES
(or how to achieve integrity and excellence)
maximize the \textbf{Data-ink Ratio} = \frac{\text{data-ink}}{\text{total ink used in graphic}}
Data-ink Ratio = \frac{\text{data-ink}}{\text{total ink used in graphic}}

maximize the

Data-ink Ratio

TRIGLYCERIDE LEVEL

Males

Females

0-$24,999  $25,000+  0-$24,999  $25,000+
maximize the

Data-ink Ratio = \frac{\text{data-ink}}{\text{total ink used in graphic}}

Tufte 2001
A User Study of Visualization Effectiveness Using EEG and Cognitive Load

E. W. Anderson¹, K. C. Potter¹, L. E. Matzen², J. F. Shepherd², G. A. Preston³, and C. T. Silva¹

¹SCI Institute, University of Utah, USA
²Sandia National Laboratories, USA
³Utah State Hospital, USA

Abstract
Effectively evaluating visualization techniques is a difficult task often assessed through feedback from user studies and expert evaluations. This work presents an alternative approach to visualization evaluation in which brain activity is passively recorded using electroencephalography (EEG). These measurements are used to compare different visualization techniques in terms of the burden they impose on users. In this paper, EEG signals and responses are monitored while viewers examine and explore data distributions. This information is processed to provide insight into the cognitive load imposed on the viewer. This paper describes the design of the user study performed, the extraction of cognitive load measures from EEG data, and how those measures are used to quantitatively evaluate the effectiveness of visualizations.

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: General—Human Factors, Evaluation, Electroencephalography

1. Introduction
Efficient visualizations facilitate the understanding of data sets through an appropriate choice of visual metaphors. This paper strives to evaluate visualization techniques objectively by using passive, non-invasive monitoring devices to measure the burden placed on a user's cognitive resources.
EXPERIMENT

- asked participants to choose box plot with largest range from a set
- varied representation
- measured cognitive load from EEG brain waves
EXPERIMENTAL RESULTS

- paper focused on cognitive load as an evaluation method
- studies showed that the simplest box plot is hardest to interpret
AVOID CHART JUNK
AVOID CHART JUNK
AVOID CHART JUNK
AVOID CHART JUNK
AVOID CHART JUNK
AVOID CHART JUNK
redesign exercise ...
Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts

Scott Bateman, Regan L. Mandryk, Carl Gutwin, Aaron Genest, David McDine, Christopher Brooks
Department of Computer Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
scott.bateman@usask.ca, regan@cs.usask.ca, gutwin@cs.usask.ca,
aaron.genest@usask.ca, dam085@mail.usask.ca, cab938@mail.usask.ca

ABSTRACT
Guidelines for designing information charts often state that the presentation should reduce the amount of embellishments that are not essential, but that left unrecognized is the effect of visual embellishments on comprehension. In contrast, others have argued that large images and visual embellishments enhance comprehension. Despite these minimalist guidelines, many designers present data in detailed and elaborate imagery, raising the question of whether this imagery is really as detrimental to understanding as has been proposed, and whether the visual embellishment may have other benefits. To investigate these issues, we conducted an experiment that compared embellished charts with plain ones, and measured both interpretation accuracy and long-term recall. We found that people's accuracy in describing the embellished charts was no worse than for plain charts, and that their recall after a two-to-three-week gap was significantly better. Although we are cautious about recommending that all charts be produced in this style, our results question some of the premises of the minimalist approach to chart design.

Author Keywords
Charts, information visualization, imagery, memorability.
1) whether visual embellishments do in fact cause comprehension problems

2) whether the embellishments may provide additional information that is valuable for the reader
EXPERIMENTAL RESULTS
EXPERIMENTAL RESULTS

1) **No significant difference** between plain and image charts for interactive **interpretation accuracy**
EXPERIMENTAL RESULTS

1) **No significant difference** between plain and image charts for interactive **interpretation accuracy**

2) **No significant difference** in recall **accuracy** after a five-minute gap
EXPERIMENTAL RESULTS

1) **No significant difference** between plain and image charts for interactive **interpretation accuracy**

2) **No significant difference** in **recall accuracy** after a five-minute gap

3) **Significantly better recall** for Holmes charts of both the chart topic and the details (categories and trend) after long-term gap (2-3 weeks).
EXPERIMENTAL RESULTS

1) **No significant difference** between plain and image charts for interactive **interpretation accuracy**

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3) **Significantly better recall** for Holmes charts of both the chart topic and the details (categories and trend) after long-term gap (2-3 weeks).

4) Participants **saw value messages** in the Holmes charts **significantly more often** than in the plain charts.
EXPERIMENTAL RESULTS

1) **No significant difference** between plain and image charts for interactive **interpretation accuracy**

2) **No significant difference** in **recall accuracy** after a five-minute gap

3) **Significantly better recall** for Holmes charts of both the chart topic and the details (categories and trend) after long-term gap (2-3 weeks).

4) Participants **saw value messages** in the Holmes charts **significantly more often** than in the plain charts.

5) Participants found the Holmes charts **more attractive**, **most enjoyed** them, and found that they were **easiest and fastest to remember**.
What Makes a Visualization Memorable?

Michelle A. Borkin, Student Member, IEEE, Azalea A. Vo, Zoya Bylinskii, Phillip Isola, Student Member, IEEE, Shashank Sunkavalli, Aude Oliva, and Hanspeter Pfister, Senior Member, IEEE

Abstract—An ongoing debate in the Visualization community concerns the role that visualization types play in data understanding. In human cognition, understanding and memorability are intertwined. As a first step towards being able to ask questions about impact and effectiveness, here we ask: “What makes a visualization memorable?” We ran the largest scale visualization study to date using 2,070 single-panel visualizations, categorized with visualization type (e.g., bar chart, line graph, etc.), collected from news media sites, government reports, scientific journals, and infographic sources. Each visualization was annotated with additional attributes, including ratings for data-ink ratios and visual densities. Using Amazon’s Mechanical Turk, we collected memorability scores for hundreds of these visualizations, and discovered that observers are consistent in which visualizations they find memorable and forgettable. We find intuitive results (e.g., attributes like color and the inclusion of a human recognizable object enhance memorability) and less intuitive results (e.g., common graphs are less memorable than unique visualization types). Altogether our findings suggest that quantifying memorability is a general metric of the utility of information, an essential step towards determining how to design effective visualizations.

Index Terms—Visualization taxonomy, information visualization, memorability
TAKE-AWAY

1) **intuitive findings**: color and human recognizable objects enhance memorability

2) **unintuitive findings**: common graphs are less memorable than unique visualization types
take away ...

CHART JUNK? IT DEPENDS

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<th>CONS</th>
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CHART JUNK? IT DEPENDS

- persuasion

PROS

CONS
take away …

CHART JUNK? IT DEPENDS

- persuasion
- memorability

PROS

CONS
take away …

CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement

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take away ...

CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement

PROS

CONS
CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement

- unbiased analysis

**PROS**

**CONS**
CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement
- unbiased analysis
- trustworthiness

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<td>engagement</td>
<td>interpretability</td>
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take away . . .

CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement

- unbiased analysis
- trustworthiness
- interpretability
- space efficiency

PROS

CONS
MULTIFUNCTIONING ELEMENTS
MULTIFUNCTIONING ELEMENTS

scented widgets
MULTIFUNCTIONING ELEMENTS

interactive legend
# LAYERING

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- New York: 12:10, 1:30, 3:45, 7:30, 4:33
- Newark, N. J.: 1:43, 10:30, 5:21, 8:50, 11:45
- North Elizabeth: ...
- Elizabeth: 3:33, 2:05
- Peekskill: 5:34, 6:40
- Edison, N. J.: 4:45, 5:20, 4:40, 2:10, 11:05
- Princeton, N. J.: 1:30
- Train No.: 3701, 3301, 3801, 3542, 3765

Tufte 2001
maximize the

**Data Density** = \[
\frac{\text{number of entries in data array}}{\text{area of data graphic}}
\]
SHRINK THE GRAPHICS
SHRINK THE GRAPHICS

**GRAPHIC PROBLEMSPOSED BY TIME SERIES**

Scale in years
With a scale in years, a two-year total (figure 1) should be divided by 2 (figure 2). A total for six months should be multiplied by 2.

Pointed curves
For overly pointed curves (figure 3), the scale of the Q should be reduced; optimum angular perceptibility occurs at around 70 degrees (figure 4).

If the curve is not reducible (large and small variations), filled columns can be used (figure 5).

Flat curves
For overly flat curves (figure 6), the scale of the Q should be increased (figure 7).

Small variations
For small variations in relation to the total (figure 8), the total loses its importance, and the zero point can be eliminated, provided the reader is made aware of this elimination (figure 9). The graphic can be interpreted as an acceleration if a precise study of the variations is necessary; here, we use a logarithmic scale (figure 10). (See also page 240).

Large range
For a very large range between the extremes numbers (figure 11), we must either:
1. Leave out the smallest variations;
2. Be concerned only with relative differences (logarithmic scale); without knowing the absolute quantities;
3. Select different parts (periods) within the ordered component and treat them on different scales above the common scale (figure 12).

Obvious periodicity
If there is obvious periodicity (figure 13), and the study involves a comparison of the phases of each cycle, it is preferable to break up the cycles in order to superimpose them (figure 14). A polar construction can be used, preferably in a spiral shape (figure 15), but we should not begin with too small a circle. As striving as it seems, it is less efficient than an orthogonal construction.

Annual curves
For annual curves of rainfall or temperature, if a cycle has two phases (figure 17), why depict only one (figure 36)?

A contrast
Unlike what we see in figure 18, the pertinent or “new” information must be separated from the background or “reference” information. The background involves: (a) the invariant, highlighted by a heading (Port St. Michels), (b) the highly visible identification of each component (tonnage and dates). The new information (the curve) must stand out from the background (figure 19).

Reference points
It is impossible to utilize a graphic such as figure 20, except in a general manner. There is confusion concerning the position of the points, and no potential comparison is possible, as it is in figure 21.

Precision reading
A precision reading (utilization on the elementary level, as in figure 24) is difficult in figure 22, which results in a poor reading of the order of the points, and in figure 23, where there is ambiguity concerning the position of the points. On the other hand, figure 22 does favor overall vision (correlation).

Null boxes
Curves accommodate null boxes poorly (figure 25). Columns (figure 26) are preferable.

Unknown boxes
The drawing must indicate the unknowns of the information in an unambiguous way (figures 28 and 30). The reader might interpret figure 27 as a change in the structure of the curve and figure 29 as involving null values.

Very small quantities
Except in seeking a correlation (quite improbable here) the number of ships entering into a port is represented better by figure 33 than by figures 31 or 32. The reader can perceive the numerical values at first glance.

Positive-negative variation
This is in fact a problem involving three components O, Q, and it must be visually treated as such. Figure 34 can be improved by utilizing a retinal variable (in figure 35 a value difference: black-white) to differentiate the P component and thus highlight positive-negative variation.
**SHRINK THE GRAPHICS**

*Dequantification*  In exchange for an enormous increase in graphical resolving power, the wordlike size of sparklines precludes the overt labels and scaling of conventional statistical displays. Most of our examples have, however, depicted *contextual methods* for quantifying sparklines: the gray bar for normal limits and the red encoding to link data points in sparklines to exact numbers glucose 6.6; global scale bars and labels for sparkline clusters; and, probably best of all, surrounding a sparkline with an implicit data-scaling box formed by nearby numbers that label key data points (such as beginning/end, high/low) 1.1025 1.1907 1.0783 1.2858. And now and then sparklines might be scaled by very small type:

*Production methods*  Data lines produced by conventional statistical graphics programs must be gathered together, rescaled, and resized into sparklines. Sometimes this can be quickly done by cutting and pasting data lines, then resizing the printed output to sparkline resolutions. To produce and export all this data is a painstaking process; however, currently requires elaborate graphic design program that gives complete control over type, tables, line work, and (3) a statistical analysis program to generate hundreds of chartjunk–free sparklines for export into design and layout operations. Once the basic templates for sparklines are worked out, then ongoing production and
Steve Chappel and Reebe Garofalo in Rock 'N' Roll is Here to Pay: The History and Politics of the Music Industry, 1977

MAXIMIZE AMOUNT OF DATA SHOWN
On the road to a digital society

Computer technology is an ubiquitous element of our world, and fast networks are spanning the globe. This is changing the way we live and work and communicate. A new digital world is emerging, an environment in which creativity and innovation can flourish in many new ways. As a result, science and research have a greater influence on our life in the 21st century than ever before. This is attributable to massive investments in research and development, but also to intensive cooperation and tough competition. The convergence of nano-, bio-, information- and neurotechnologies facilitates completely new applications.

Taking its place beside the more traditional factors of land, capital and employment, knowledge is fast becoming the decisive factor for prosperity — and also for the resolution of global problems. In this, the appropriate balance between digital freedom and digital security must be maintained.

Science 2020: Systematically surveying the world

Millions of scientists are getting to the bottom of the secrets of our world, across the whole spectrum of space, time, energy and complexity. Fundamentally new knowledge is emerging from research into interdisciplinary topics or extreme states of matter. Science long ago escaped the constraints of working only in the realm of our natural living conditions and our perceptions. Considerable investment is flowing into efforts to decode the smallest building blocks of our world and to understand how their interplay produces brand new qualities. The drivers of innovation in research today are data capture via digital sensors; storage, analysis and visualisation via computer and software; and the global exchange of information and knowledge.

The cost of new knowledge is rising

There is now no part of our life that is not the subject of research. At the same time, it is becoming ever more difficult to generate new knowledge. These days, new research methods and technologies enable us to study even the farthest frontiers of the world; extremely fast or slow processes, the tiniest building blocks or the largest structures, extreme cold or extreme heat.

Networked knowledge takes on global challenges

Thanks to worldwide information and communication networks, the challenges our civilisation faces in the long term are known to us sooner and more clearly than ever before. We can start developing solutions together at an earlier stage. Research on many topics is global — taking place in close cooperation or in international competition for the fastest and best solutions. National boundaries are becoming irrelevant. Millions of scientists work across countries, continents and time zones in thousands of labs. Their global networking enhances the diversity and efficiency of science and technology. And this, in turn, reinforces globalisation and networking. In a world changing at such a pace, each country must redefine its place.

The end of distance

Mankind faces enormous challenges both locally and globally — the challenge of using resources sustainably and of organising a global economy. Across the globe, complex processes are being recorded in detail, collated in databases and analysed in computer networks. New visualisation techniques make it possible to analyse larger and larger data records and to draw conclusions from the results.

Global networking as the driving force of science

In the early days, the Internet linked up scientists, large-scale equipment and information; now it networks computational power and enormous amounts of data through grid and cloud computing. A global Semantic Web is emerging, bringing together data, expertise and knowledge that had previously been distributed among virtual libraries and observatories. The information is being intelligently developed, new forms of cooperation are arising, and research is becoming more productive.
Unseen and Unaware: Implications of Recent Research on Failures of Visual Awareness for Human–Computer Interface Design

D. Alexander Varakin and Daniel T. Levin
Vanderbilt University

Roger Fidler
Kent State University

ABSTRACT

Because computers often rely on visual displays as a way to convey information to a user, recent research suggesting that people have detailed awareness of only a small subset of the visual environment has important implications for human–computer interface design. Equally important to basic limits of awareness is the fact that people often over-predict what they will see and become aware of. Together, basic failures of awareness and people’s failure to intuitively understand their perceptual limitations must be taken into consideration when designing human–computer interfaces.
ILLUSIONS OF VISUAL BANDWIDTH

people over-predict what they will see and become aware of
overestimate of breadth
belief that viewers can take in all (or most) of the details of a scene at once
adding extra visual features makes it harder to find specifics bits of information
- overestimate of breadth
  - belief that viewers can take in all (or most) of the details of a scene at once
  - adding extra visual features makes it harder to find specifics bits of information

- overestimate of countenance
  - belief that user will attend to a higher proportion of the display than they do
  - users typically have expectations about where in a display to look
- **overestimate of breadth**
  - belief that viewers can take in all (or most) of the details of a scene at once
  - adding extra visual features makes it harder to find specifics bits of information

- **overestimate of countenance**
  - belief that user will attend to a higher proportion of the display than they do
  - users typically have expectations about where in a display to look

- **overestimate of depth**
  - belief that attending to an object leads to more complete and deep understanding than is the case
Tufte’s design principles

- maximize the data-ink ratio
- avoid chart junk (sometimes)
- use multifunctioning elements
- layer information
- maximize the data density
  - shrink the graphics
  - maximize the amount of data shown (sometimes)
CRITIQUES
U.S. SmartPhone Marketshare

- RIM: 39.0%
- Apple: 19.5%
- Palm: 9.8%
- Motorola: 7.4%
- Nokia: 3.1%
- Other: 21.2%
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Five Minutes With Eric Garcetti
Mayor of Los Angeles

Eric Garcetti envisions a Los Angeles where you don’t need a car to live well. No race or ethnicity is separate from the concept of origin; 48 percent of respondents identified themselves as “Hispanic or Latino” but fall into one of the above groups.

Source: United States Census Bureau, 2012 estimates. Note: The concept of race is separate from the concept of origin; 48 percent of respondents identified themselves as “Hispanic or Latino” but fall into one of the above groups.

L3. Perception

REQUIRED READING
VISUAL THINKING for DESIGN
Colin Ware
active vision, attention, visual queries, gist, visual skills, color, narrative, design