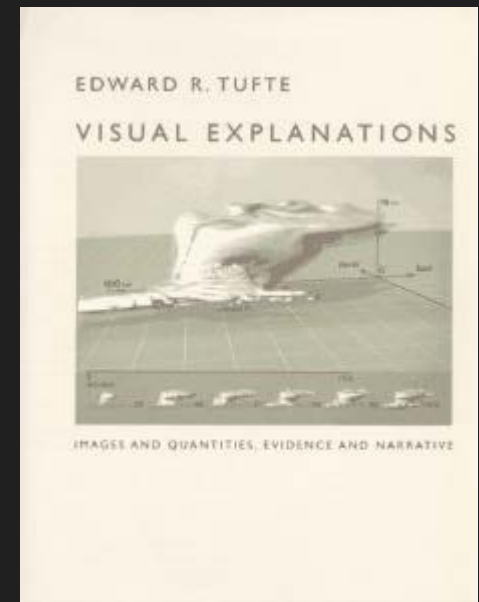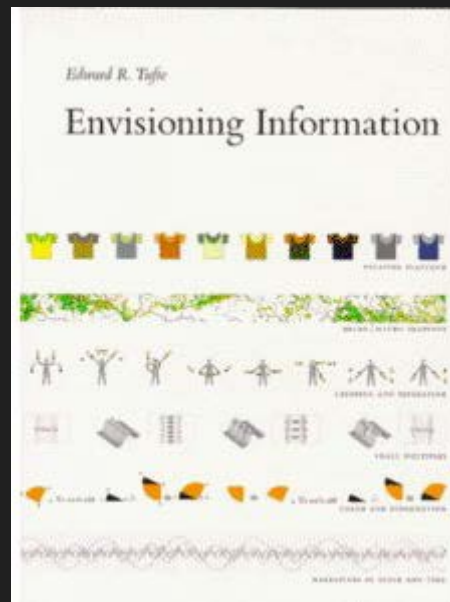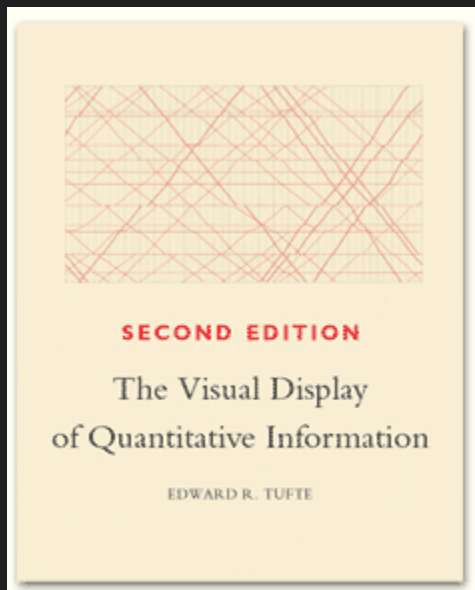# Design Principles

Alark Joshi

Announcements

- Assignment 1 is due today
- Reading responses due by Thursday before class

Design Excellence

- "Well designed presentations of interesting data are a matter of substance, of statistics, and of design."
    - Edward Tufte

Tufte's Principles for Graphical Integrity

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

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

3. Write out explanations of the data on the graphic itself. Label important events in the data.

Tufte's Principles for Graphical Integrity

4. In time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.

5. Show data variation not design variation

6. The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data
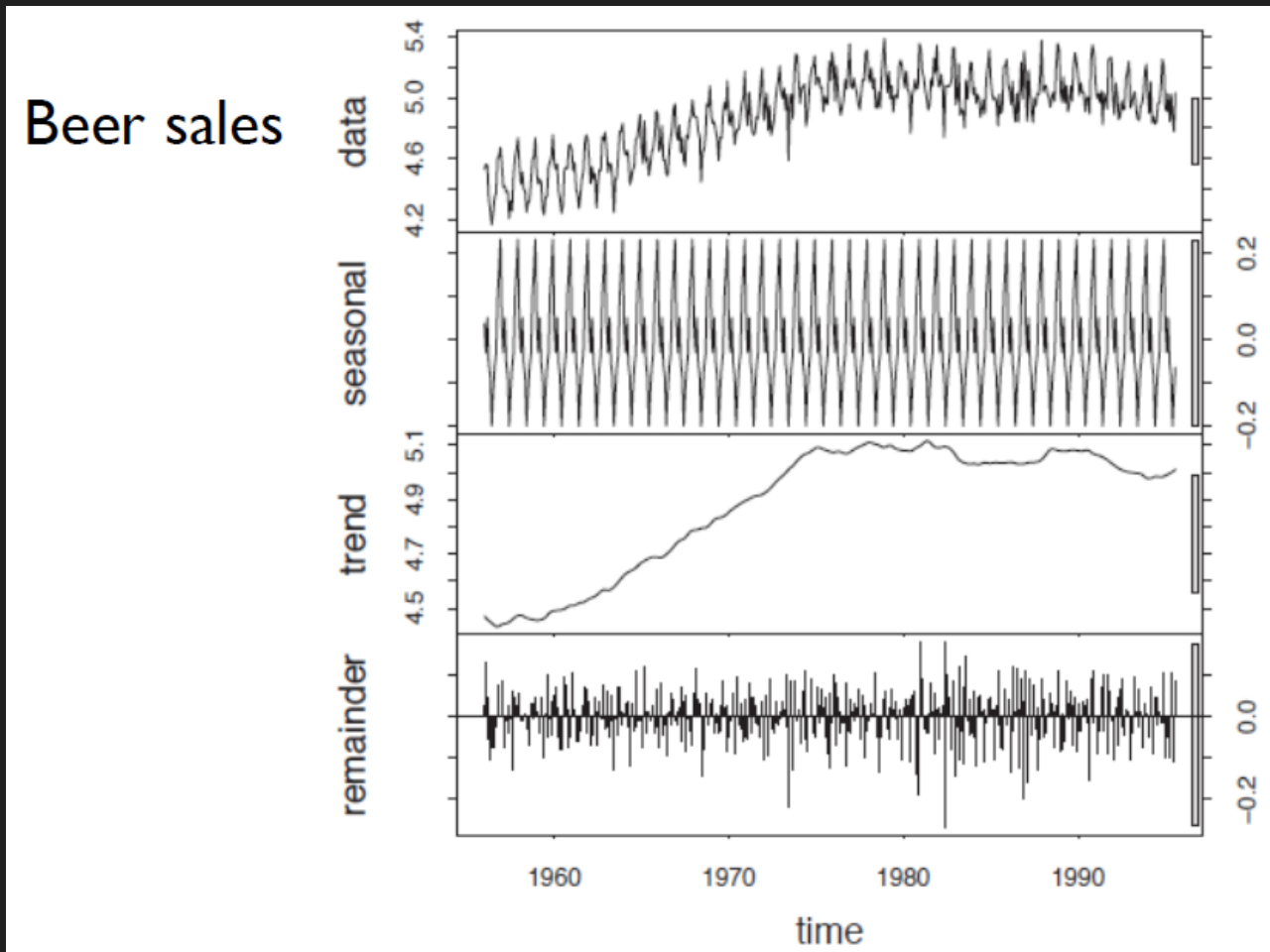
every time you make a powerpoint

mrow

edward tufte kills a kitten
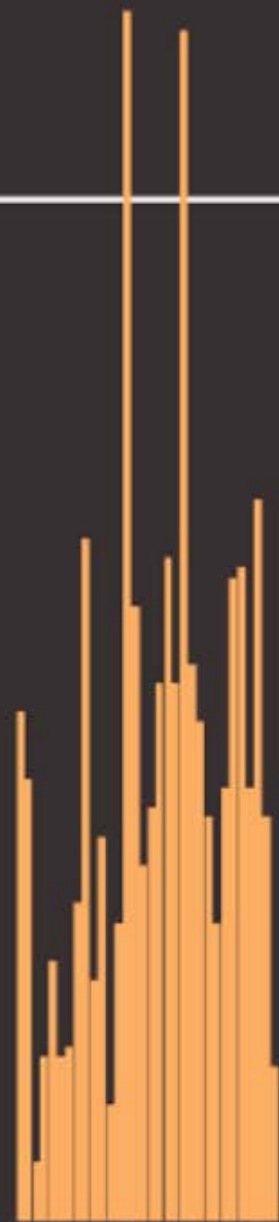
Mark Goetz

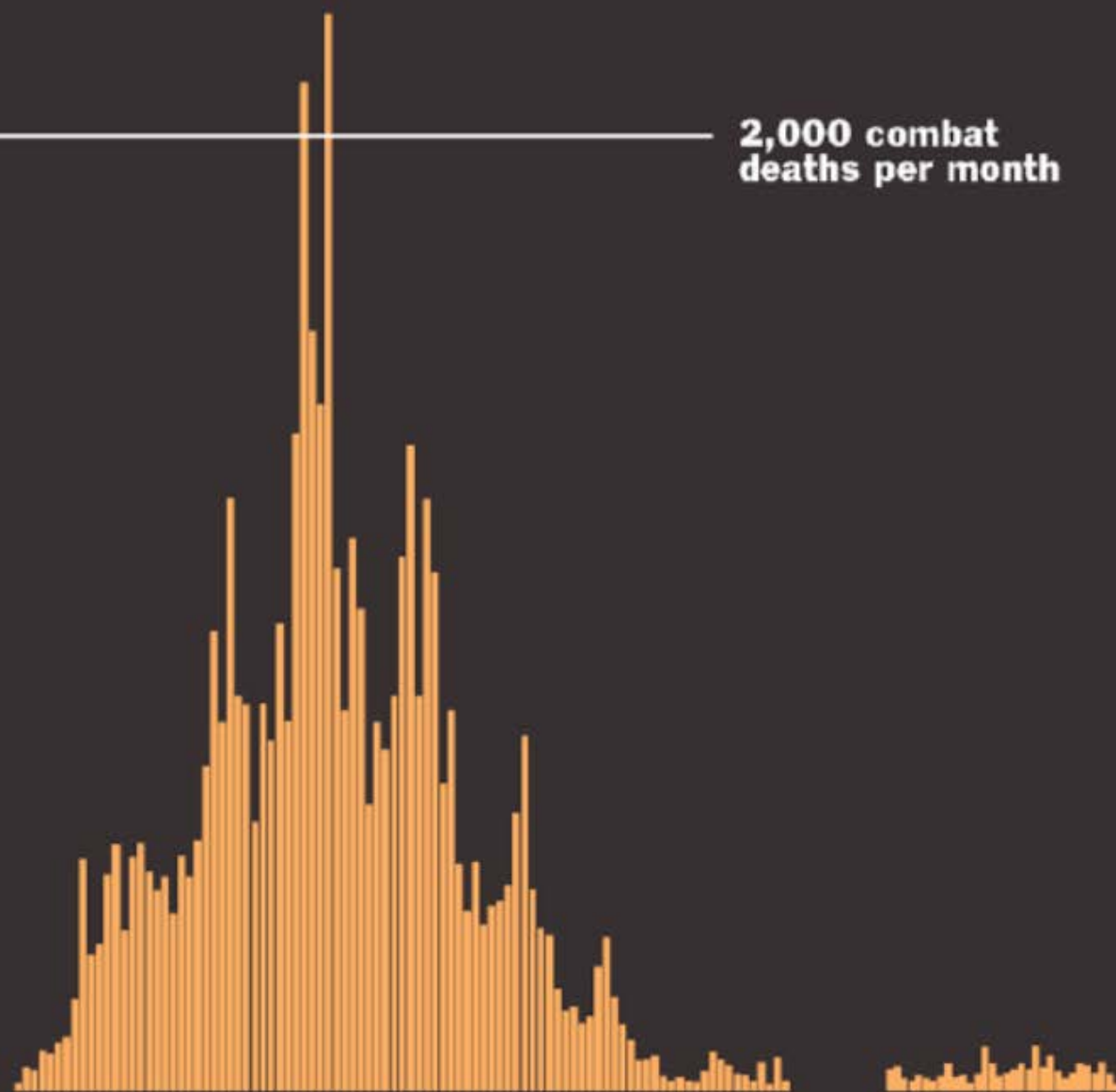# Design Principles

- Use Decomposition

Hierarchical Display
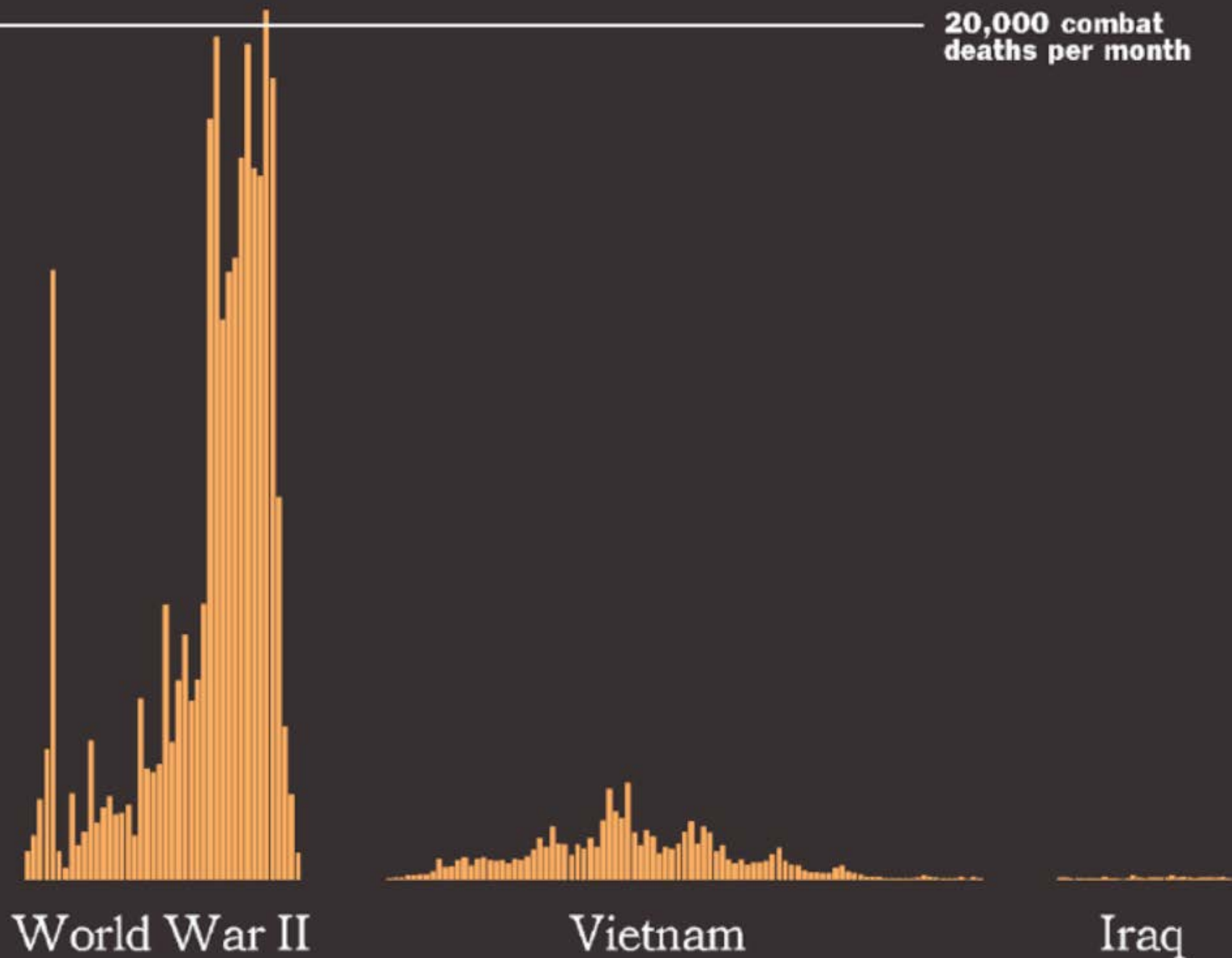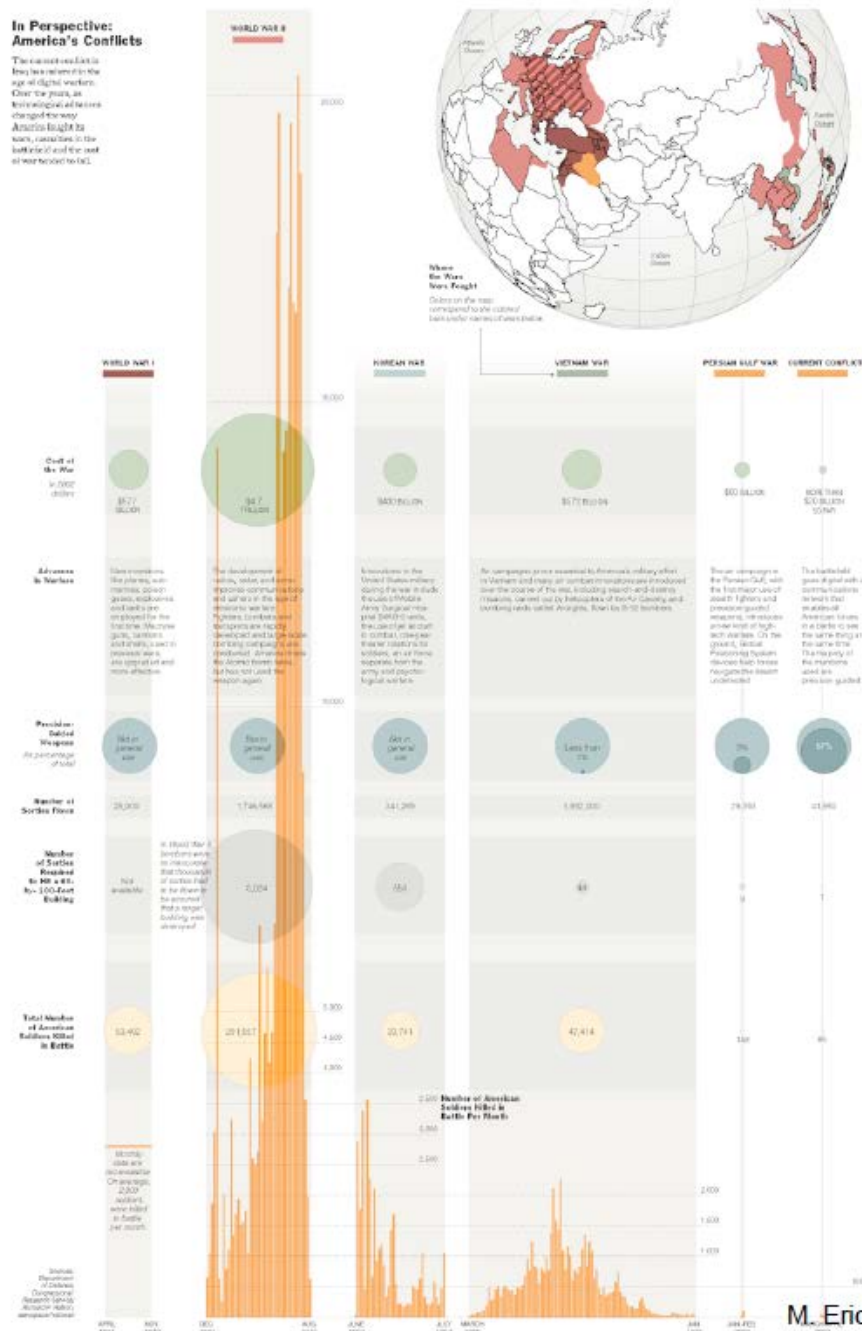
Show Context

100 combat
deaths per month

Iraq

2,000 combat
deaths per month

Vietnam

Iraq

M. Ericson, NY Times

20,000 combat deaths per month

World War II

Vietnam

Iraq

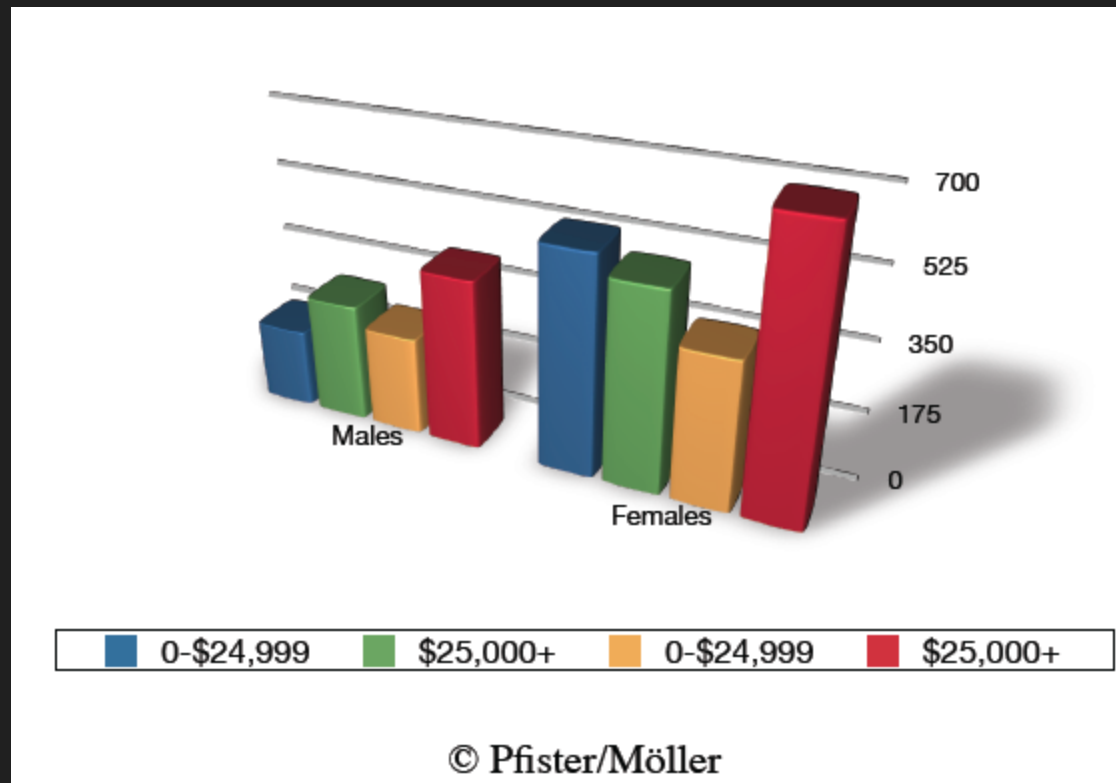M. Ericson, NY Times

In Perspective: America's Conflicts

The current conflict in Iraq has ushered in the age of digital warfare. Over the years, as technological advances changed the way America fought its wars, casualties in the battlefield and the cost of war tended to fall.
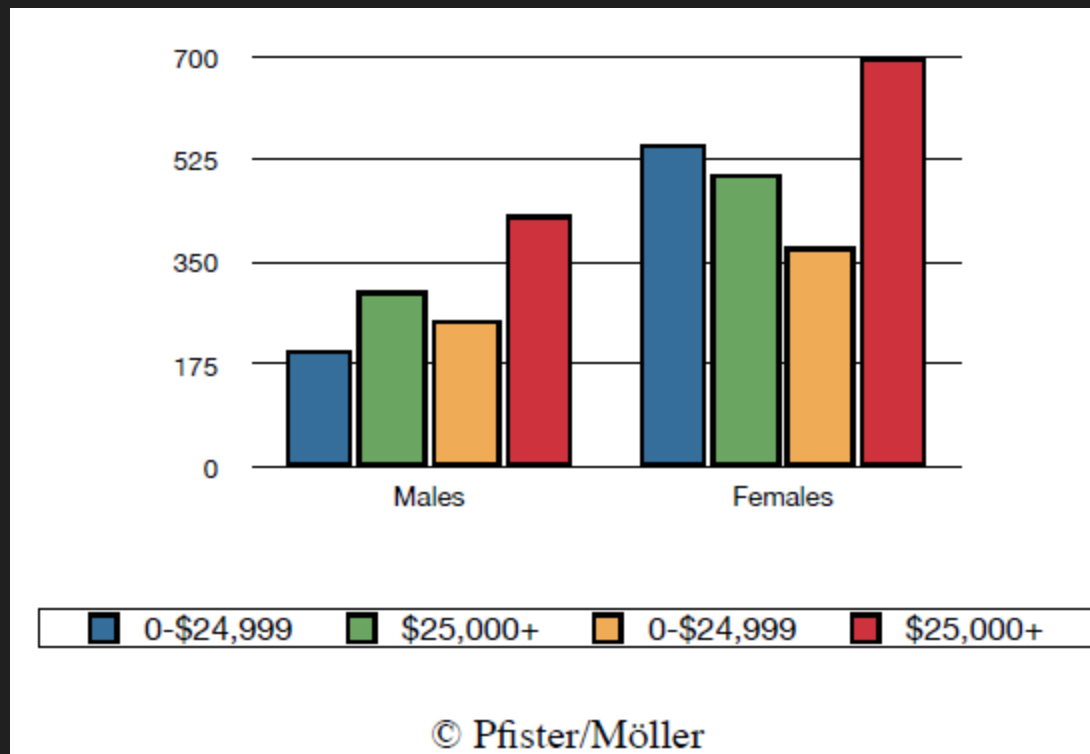
WORLD WAR II

Where the Wars Were Fought

Colors on the map correspond to the colored bars under names of wars below.

WORLD WAR I · KOREAN WAR · VIETNAM WAR · PERSIAN GULF WAR · CURRENT CONFLICT

Cost of the War
In 2002 dollars

Advances in Warfare

Precision-Guided Weapons
As percentage of total

Number of Sorties Flown

Number of Sorties Required to Hit a 60- by-100-foot Building

Total Number of American Soldiers Killed in Battle

Number of American Soldiers Killed in Battle Per Month

M. Ericson, NY Times

Maximize Data-Ink Ratio

- Data-ink = ink used to show data
- Data-ink ratio = data-ink/ total ink used

700
525
350
175
0

Males

Females

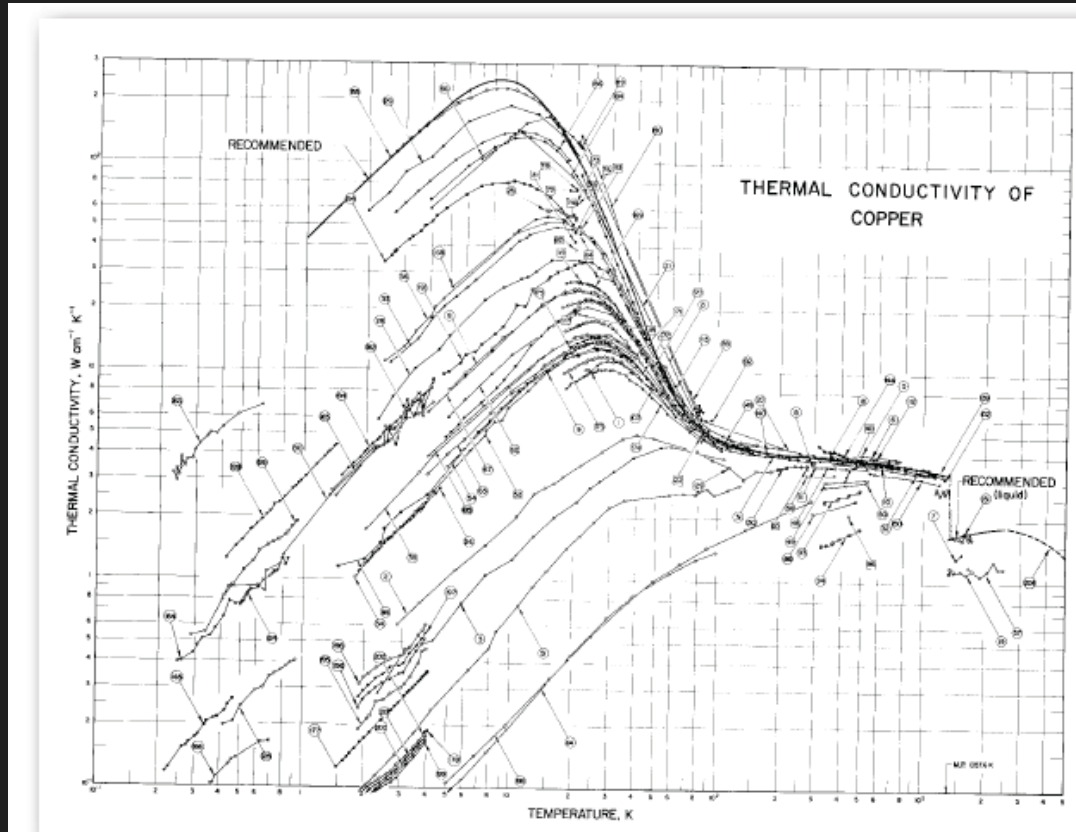| ■ 0-$24,999 | ■ $25,000+ | ■ 0-$24,999 | ■ $25,000+ |

© Pfister/Möller

Maximize Data-Ink Ratio

- Data-ink = ink used to show data
- Data-ink ratio = data-ink/ total ink used

© Pfister/Möller

Data Density

- Data density = $\dfrac{\text{number of entries in data array}}{\text{area of data graphic}}$

Ho et al., "Thermal Conductivity of the Elements: A Comprehensive Review" J. Phys. Chem. 1974

Data Density - Sparklines

- Sparklines are simple, word-sized graphics
- Show trends and allow users to understand the presented data better

glucose 128

glucose 128
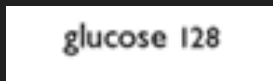
Shows past 80 readings

glucose 128
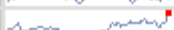
Highlights specific data element

glucose 128

Shows normal range of glucose

glucose 128

respiration 16

temperature 99.2

WBC 8,800
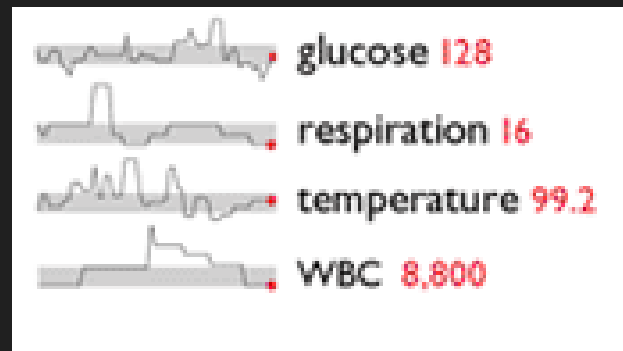
Sparklines – Spreadsheets & Dashboards

		Close	Max	Min
AT&T		40,28	41,34	33,30
Boeing		98,15	100,59	84,79
Citigroup		53,98	55,20	48,27
Exxon Mobil		85,94	85,94	69,56
General Electric		38,12	38,12	34,09
General Motors		34,66	36,20	28,85
Intel		24,24	24,24	18,76
Microsoft		30,49	31,11	26,63

Top 10 Application Software Companies by Market Cap

1/2/2009 - 12/7/2009		low	high	open	close	Market Cap ($B)
MSFT		15.28	29.98	20.33	29.57	264.5
ORCL		14.47	22.86	18.41	21.91	112.7
SAP		31.81	51.75	36.62	44.47	54
ADBE		16.7	36.51	23.02	36.08	19
CA		15.95	23.71	18.9	21.91	11.7
INTU		22.65	30.39	24.4	29.32	9.5
CRM		26.05	66.13	34.02	64.14	8.2
BMC		25.33	39.13	27.65	38.16	7.1
RHT		13.43	28.63	13.99	27.73	5.3
VRSN		18.05	24.26	20.62	22.11	4.3

Summary	Properties	Reports

Sparkline

|	Actual	Target	Sparkline
⊟ Sales Revenue		✓	
All Sales Territories	$3,362,565.46	$3,104,562.22 ✓	
Australia	$398,989.78	$263,560.01 ✓	
Canada	$450,095.43	$590,987.62 ✗	
France	$130,303.49	$140,774.25 ⚠	
Germany	$308,813.36	$43,772.81 ✓	
United Kingdom	$271,794.91	$158,806.94 ✓	
United States	$1,802,568.48	$1,906,660.59 ⚠	

Avoid Chartjunk

- Extraneous visual elements that distract from the message
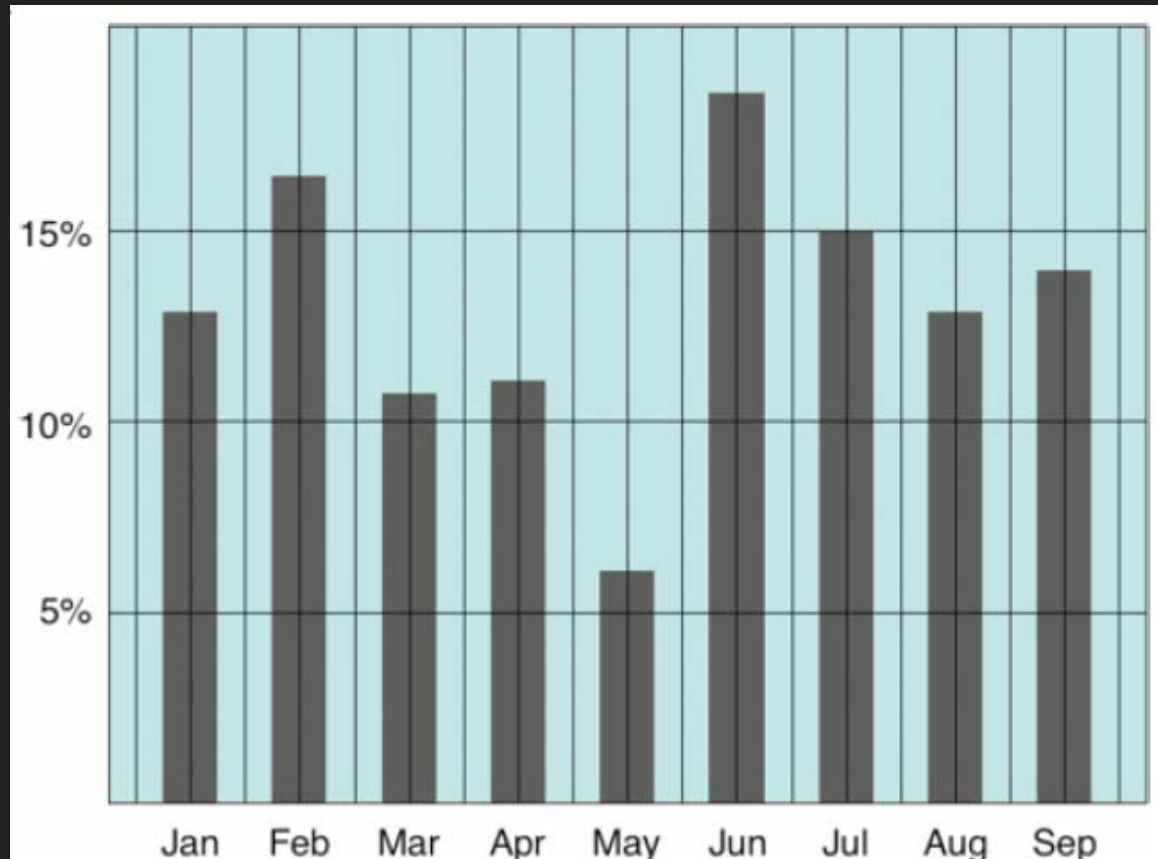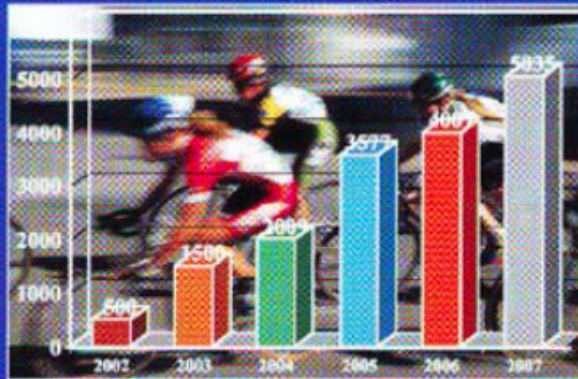
Avoid Chartjunk
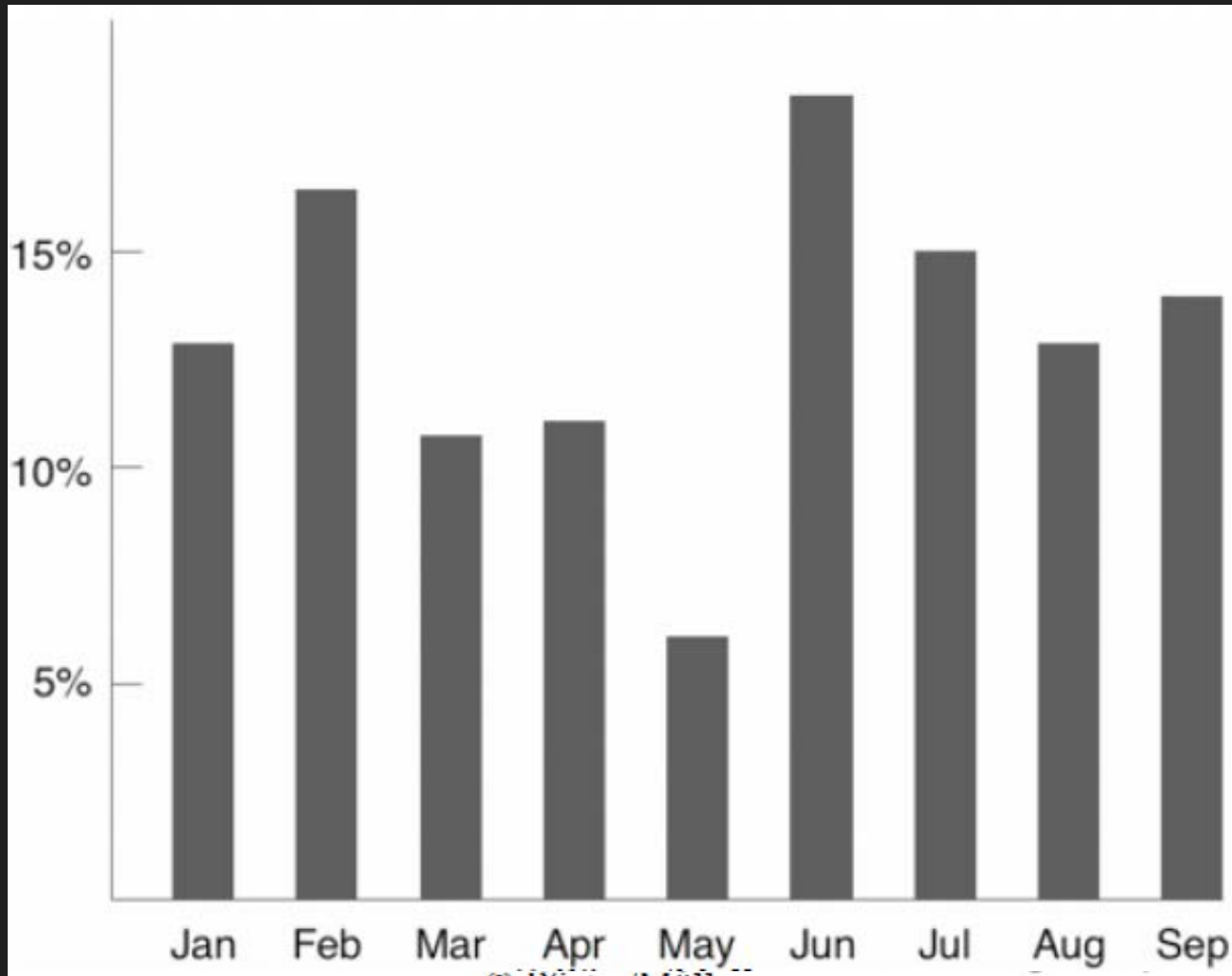
Avoid Chartjunk
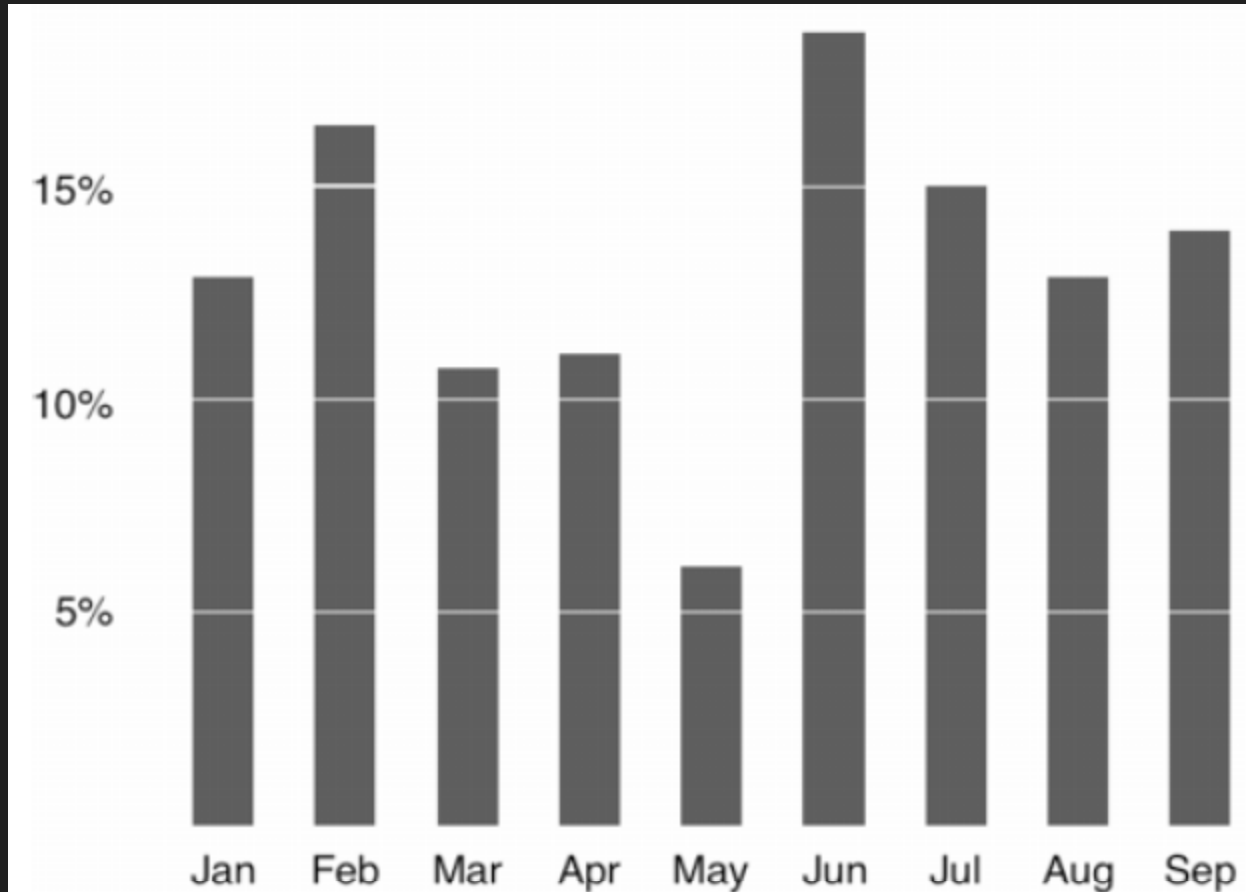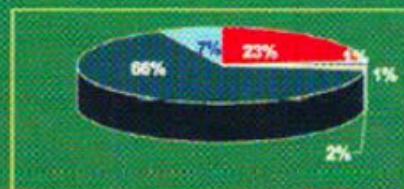
Before

After

Number of bikes sold (2002-2007)

Over **5,000** bikes sold in 2007
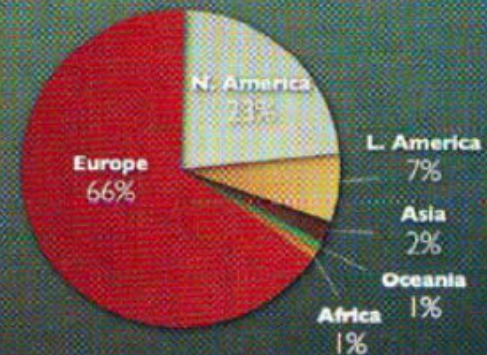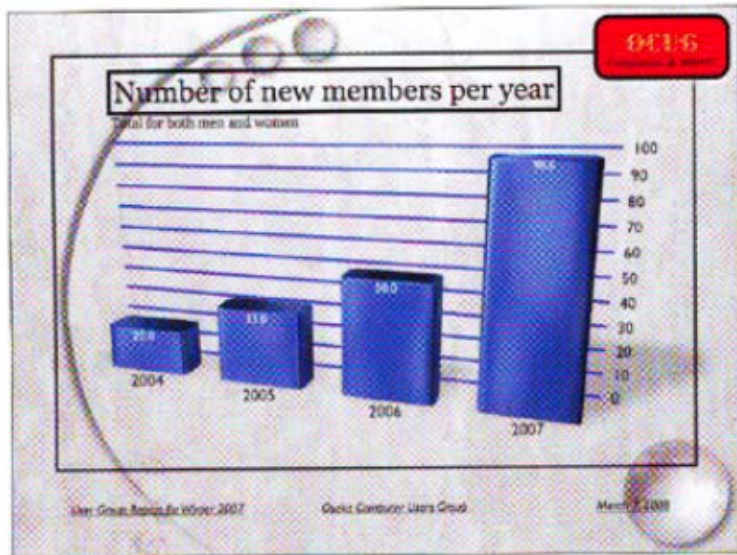

Arable land in organic production

Source: SOEL–FiBL Survey '07

Arable land in organic production

G. Reynolds, Presentation Zen

Before

After

Number of new members per year

Nearly 100 new members in '07

Smoking rates for 2002

Smoking rates for 2002

G. Reynolds, Presentation Zen
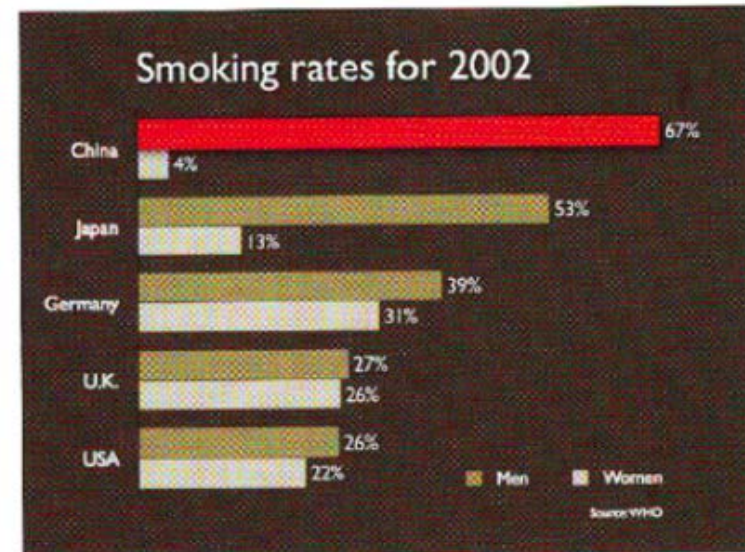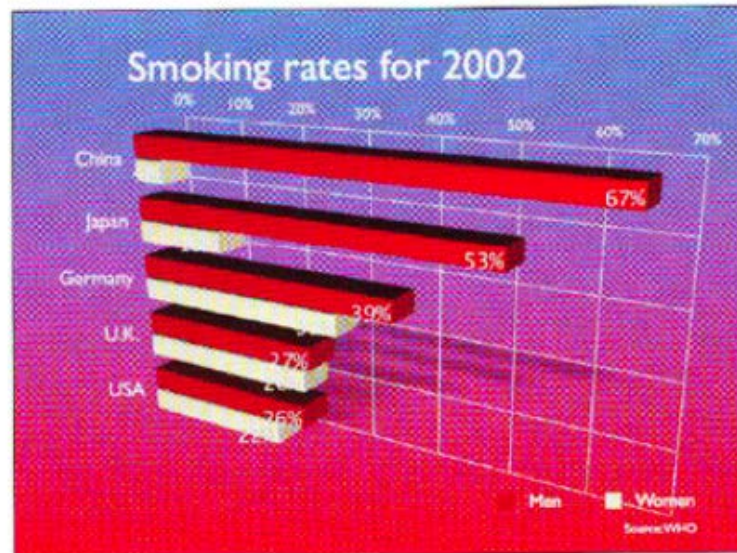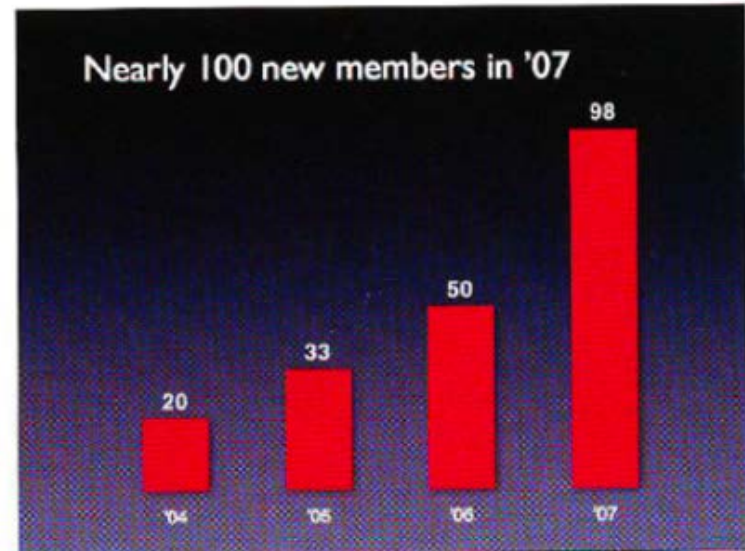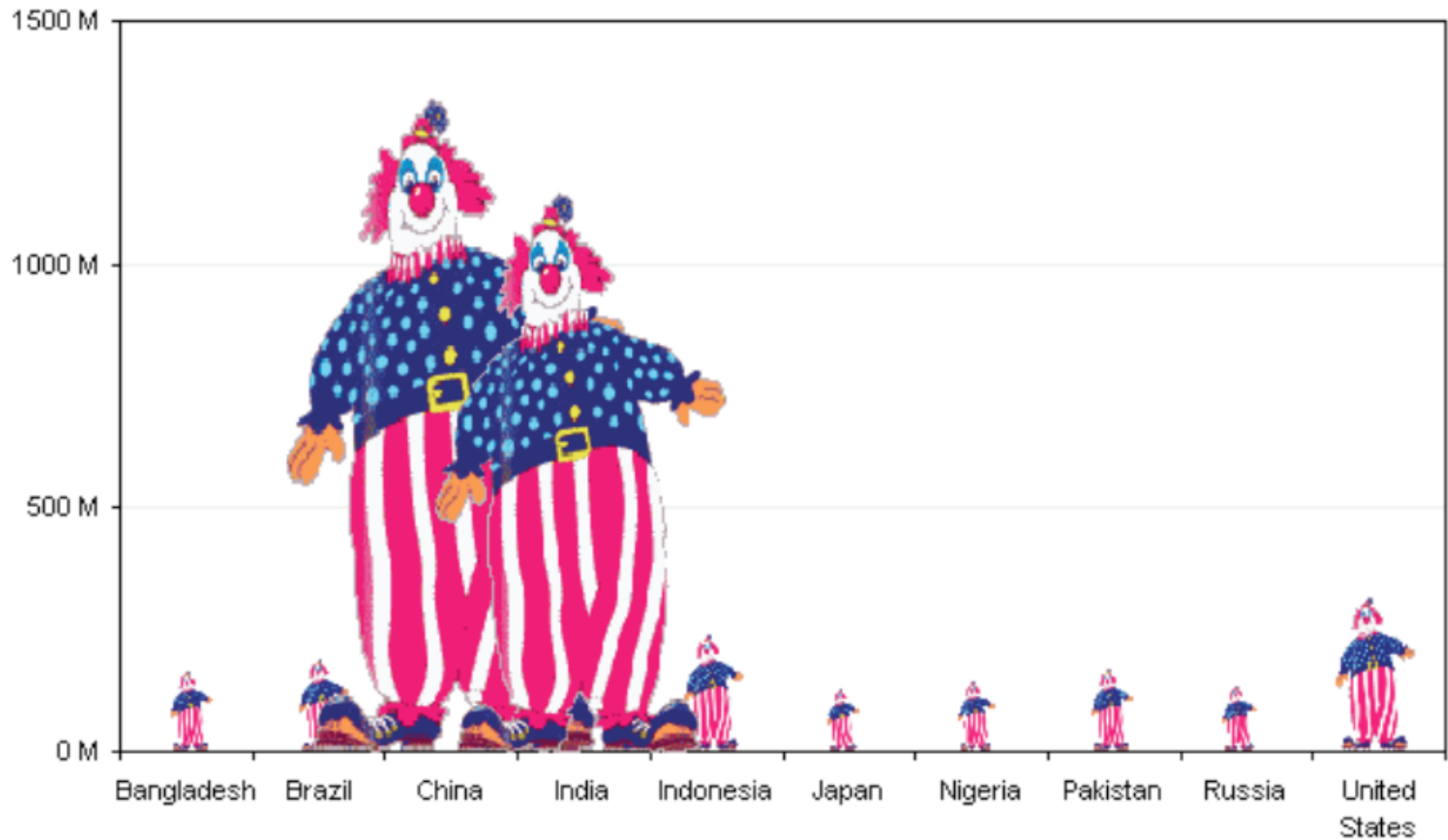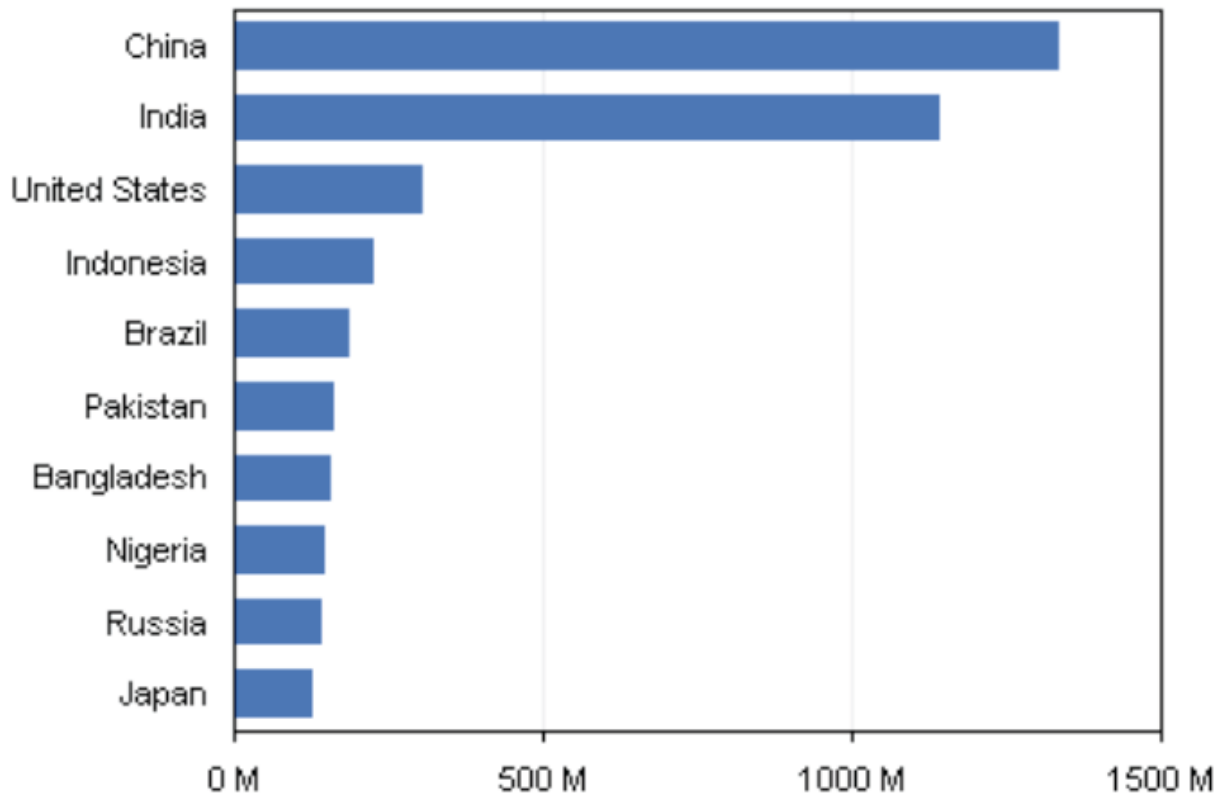
Bring in the Clowns

World Population in 2008

A better representation

World Population in 2008

Tufte's Design Principles

- Above all else show the data
- Maximize data-ink ration
- Eliminate non-data ink
- Eliminate redundant data ink
- Revise and Edit

Subjective Dimensions

- Aesthetics – Attractive things are perceived as more useful than unattractive ones

- Style – Communicates brand, process, who the designer is

- Playfullness – Encourages experimentation and exploration

- Vividness – Can make a visualization more memorable

Design Elements

CRAP

Contrast
Repetition
Alignment
Proximity

Contrast

Before

After

Credits: Presentation Zen, G. Reynolds

Contrast

Credits: Presentation Zen, G. Reynolds

Repetition

http://www.nytimes.com/interactive/us/faces-of-the-dead.html

Alignment

Credits: Stephen Few

Proximity

Credits: Stephen Few

Data analysis questions

- Who is the intended audience?
- What information does this visualization represent?
- How many data dimensions does this encode?
- List several tasks, comparisons or evaluations it enables
- What principles best describe why it is good/bad?
- Can you suggest any improvement?

Fourteen Ways to Say Nothing With Scientific Visualization

- Al Globus , Eric Raible, Fourteen Ways to Say Nothing With Scientific Visualization, Computer, v.27 n.7, p.86-88, July 1994.
- Negative rhetoric to convey message
- Very interesting read
- Thoughts

Fourteen ways..

- Include a color legend – Class
- Annotate – (Labeling and Annotation) – Class
- Mention Error Statistics
- Don't smooth/alter your data
- Provide performance comparisons
- Be faithful to your representation – Class
- Learn about the data domain-

Fourteen ways..

- Compare results with other vis techniques
- Use visualization systems if available
- Cite references to data – Class
- Show multiple datasets to convince reader
- Be fair to your vis technique (don't show viewing angle that hides blemishes)
- Don't try fancy graphics stunts to hide ugliness - C
- Be fair about extension to 3D - Class

How NOT to Lie with Visualization,

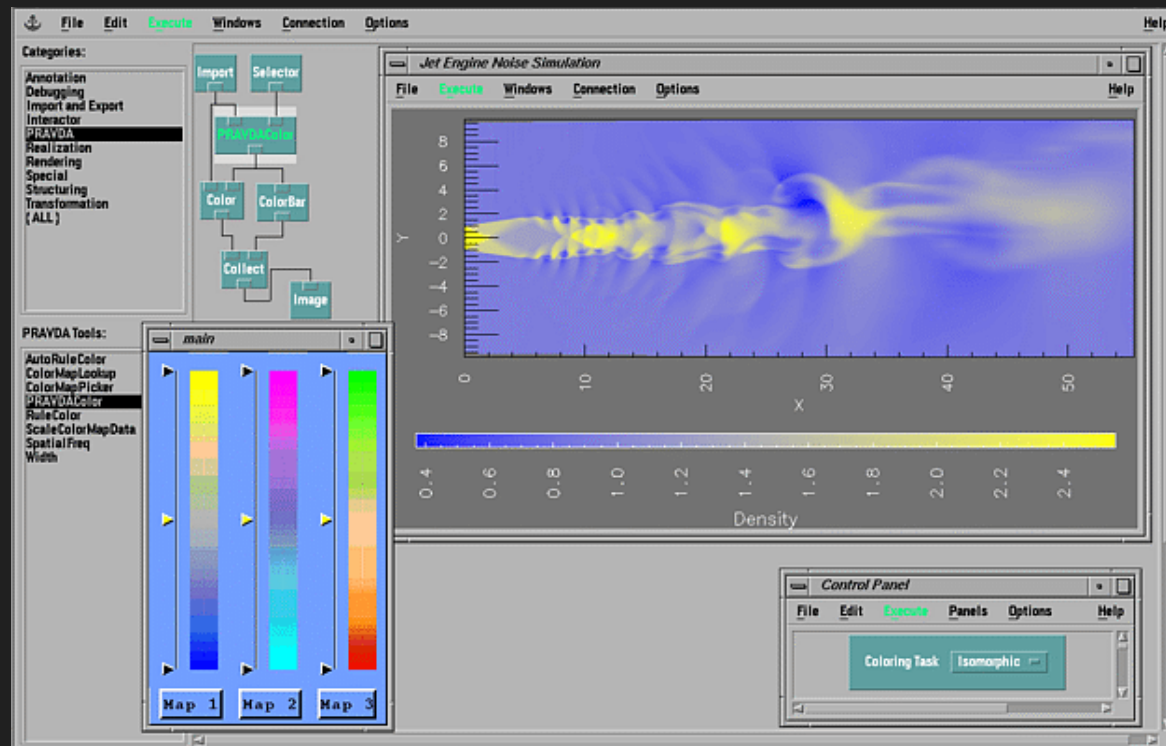- Rogowitz and L. Treinish, How NOT to Lie with Visualization, Computers in Physics, pp. 268-274, May/June 1996.

Color Maps – Rogowitz et al.

- Impact of appropriate colormap on perceived representation
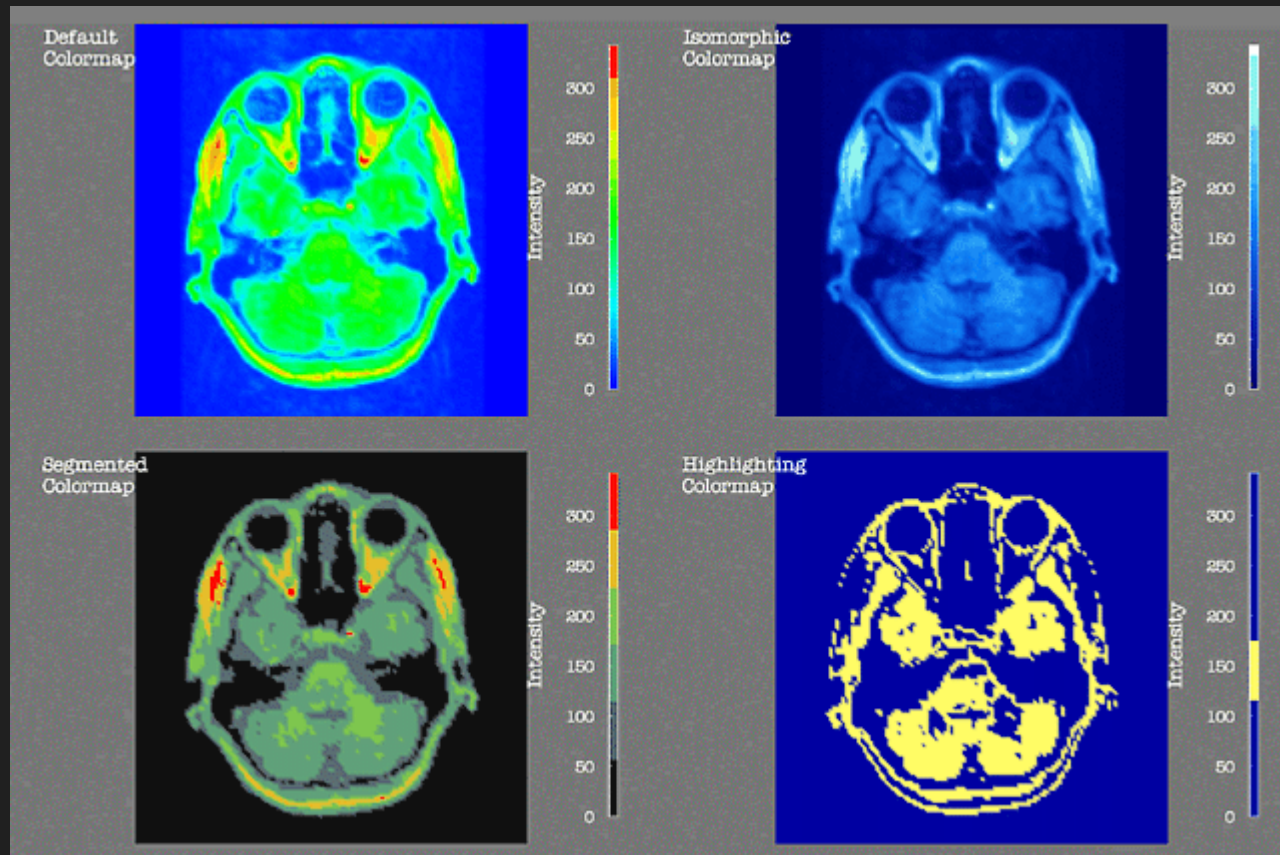
Color Maps – Rogowitz et al.

- Rule-based colormap selection tool that analyzes the data and provides a smaller subset of available options

Color Maps – Rogowitz et al.

- Raises important concerns
- Do not trust the default colormap
- Identify the reason/aim of the visualization
- Think about the kind of data and pick an appropriate colormap