

Design Principles

Cmpt 767 Visualization

Steven Bergner

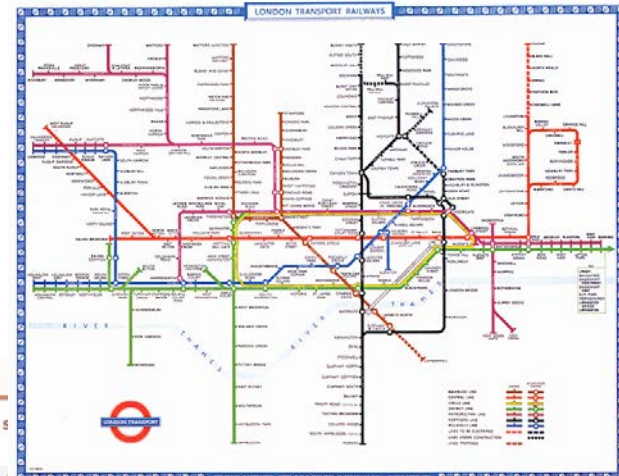
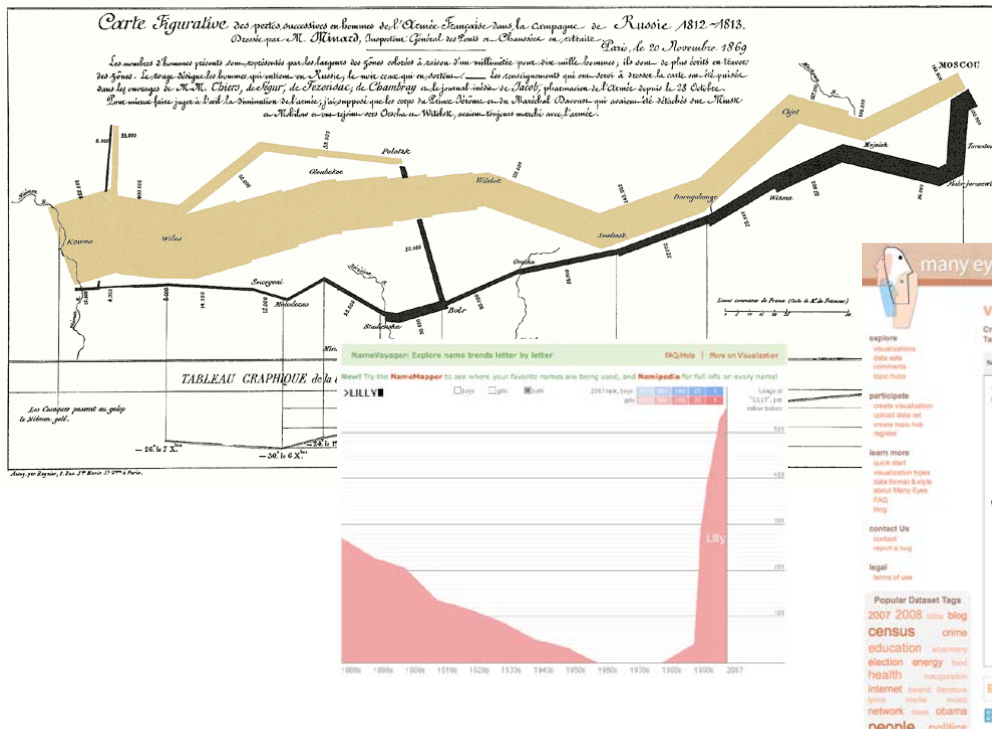
sbergner@sfu.ca

[Slides by Pfister/Möller]

Last Time

Visualization

To convey information through visual representations



many eyes

Visualizations : Obama Inauguration 5

Creator: vanderlei
Tags: inauguration obama

Search: web will

we will

- act - not only to create new jobs , but to lay a new foundation for growth .
- build the roads and bridges , the electric grids and digital lines that feed our commerce and bind us together .
- restore science to its rightful place , and wield technology's wonders to raise health care's quality and lower its cost .
- harness the sun and the winds and the soil to fuel our cars and run our factories .
- transform our schools and colleges and universities to meet the demands of a new age .
- do
- not give them up for expedience's sake .
- apologize for our way of life , nor will we waver in its defense , and for those who seek to advance their aims by inducing
- begin to responsibly leave Iraq to its people , and forge a hard - earned peace in Afghanistan .
- work tirelessly to lessen the nuclear threat , and roll back the specter of a warming planet .
- defeat you .
- extend a hand if you are willing to unclench your fist .

Popular Dataset Tags

2007 2008 census crime education election energy food health immigration internet internet literature music network news obama nonna

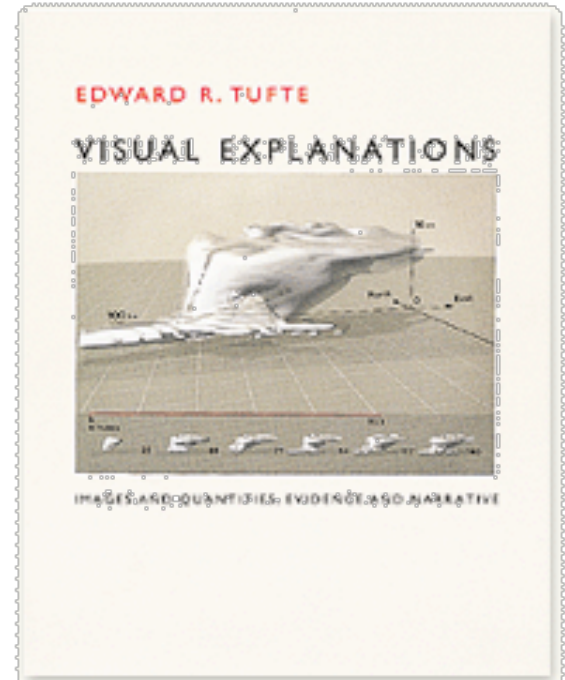
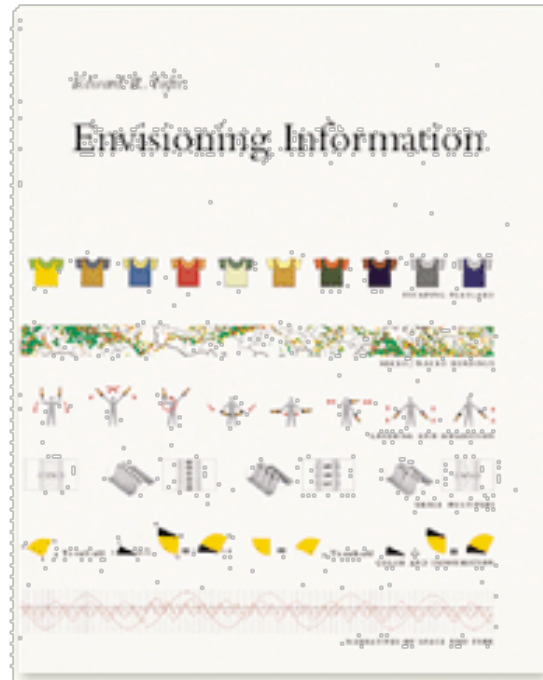
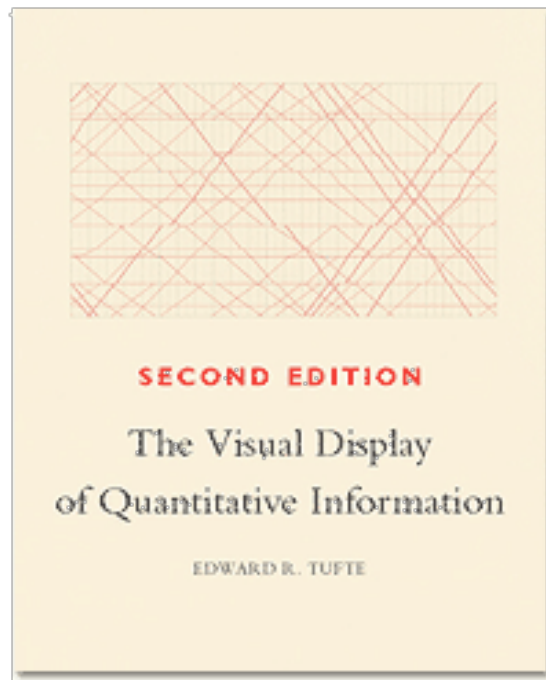
Design Excellence

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

E. Tufte



Edward Tufte

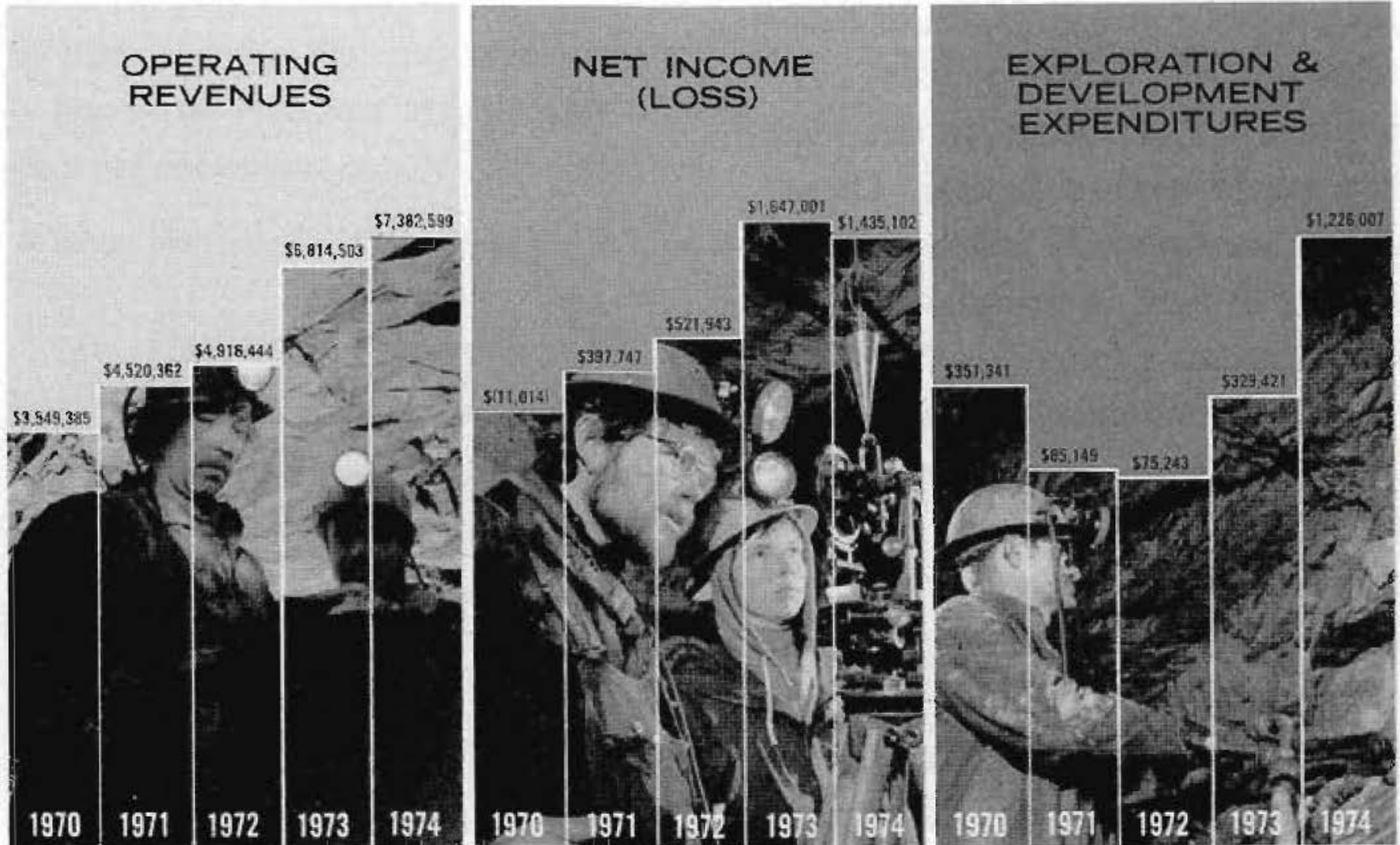


Outline

- Graphical Integrity
- Design Principles
- Design Elements

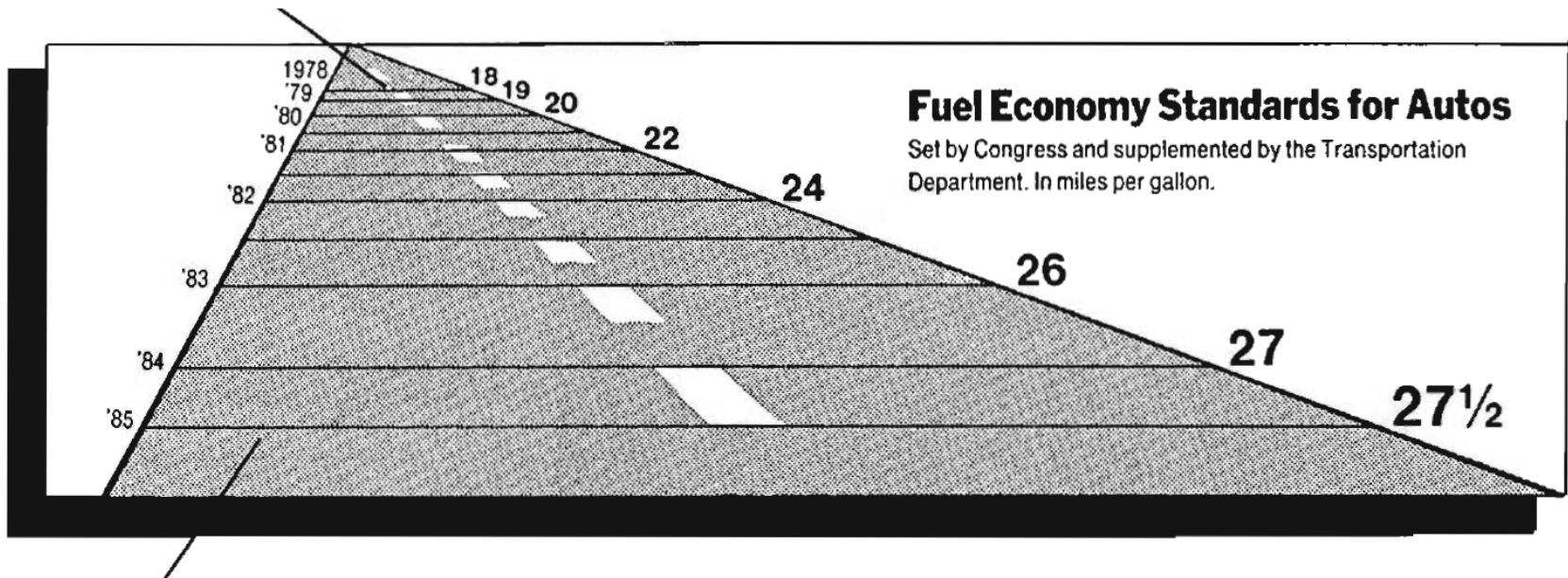
Graphical Integrity

Missing Scales



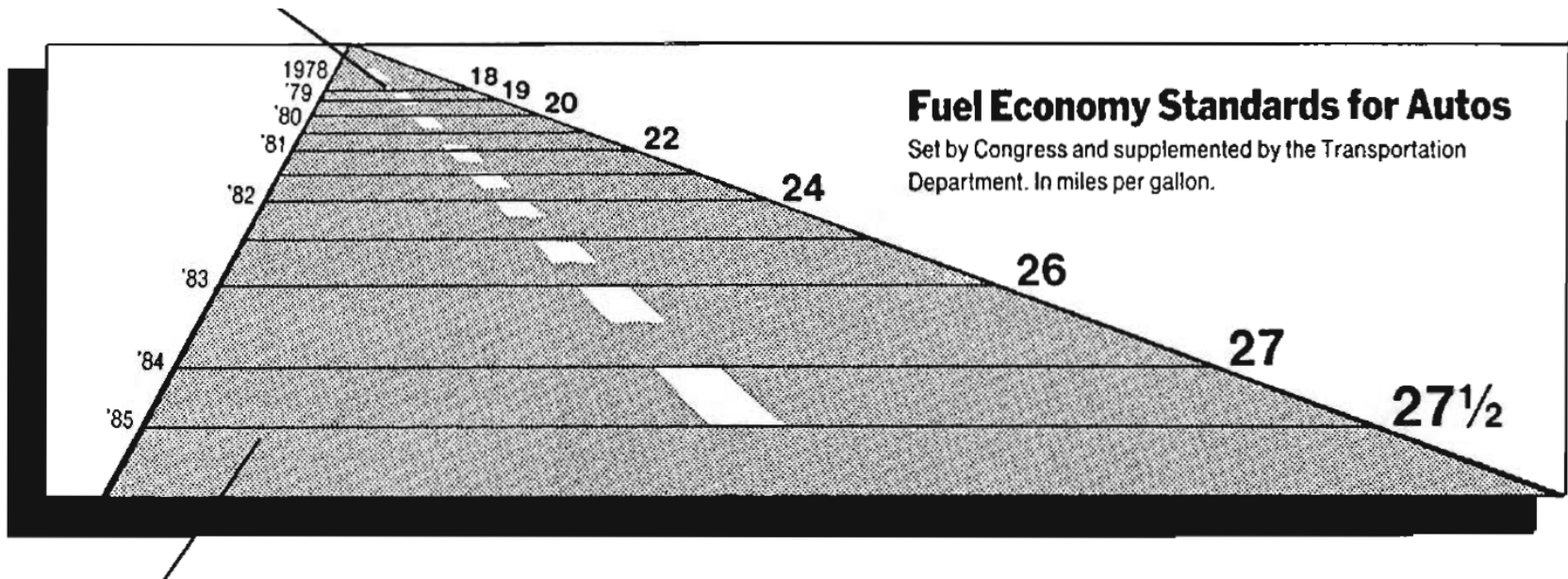
The Lie Factor

- (Size of effect in graphic)/
(size of effect in data)

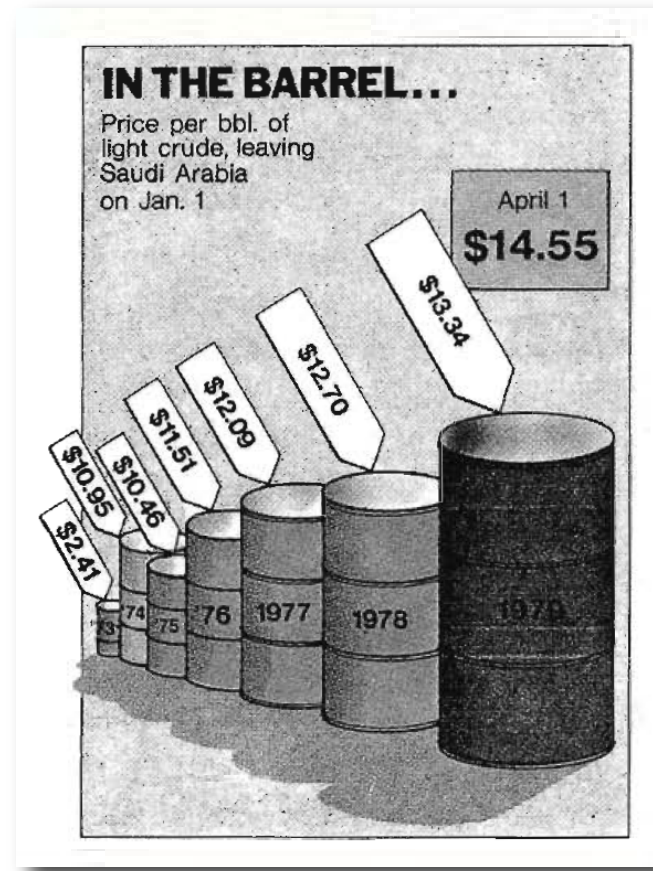
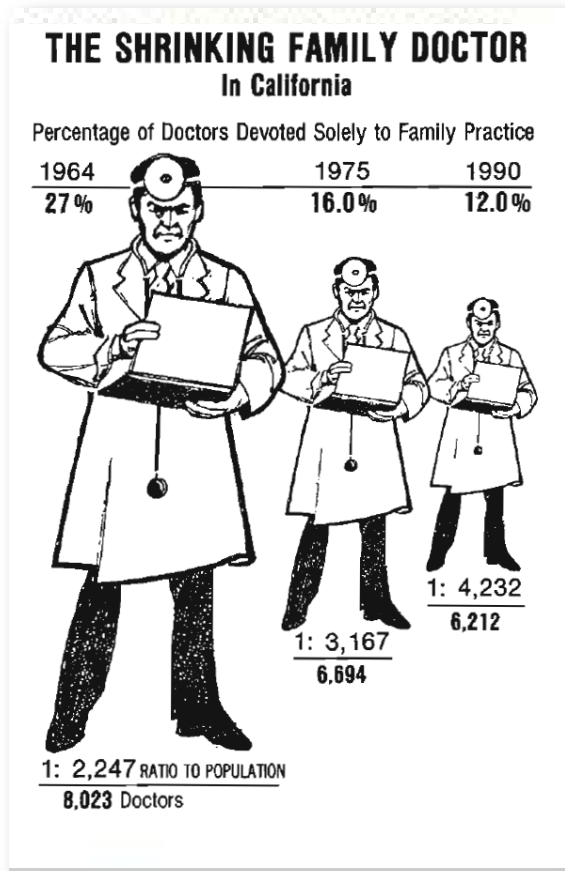


The Lie Factor

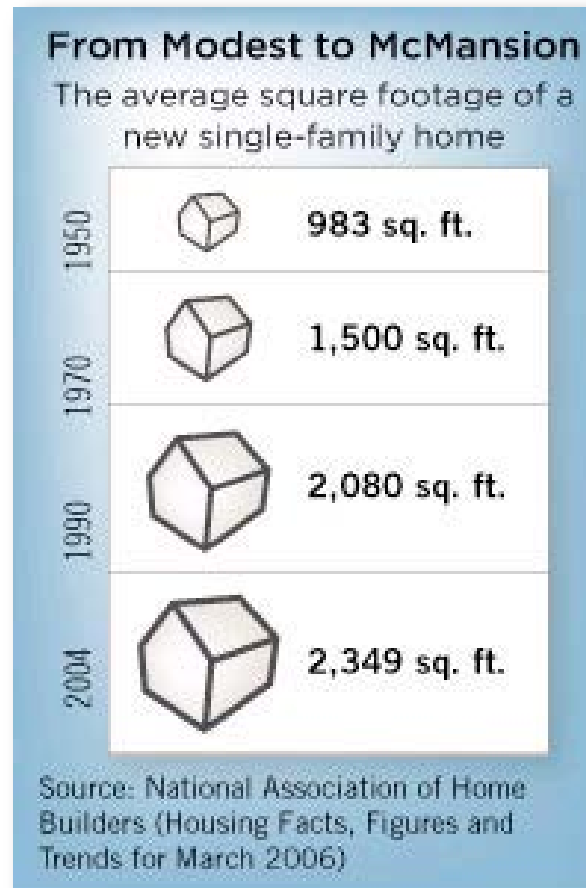
$$\frac{5.3 - 0.6}{0.6} \div \frac{27.5 - 18}{18} = 14.8$$



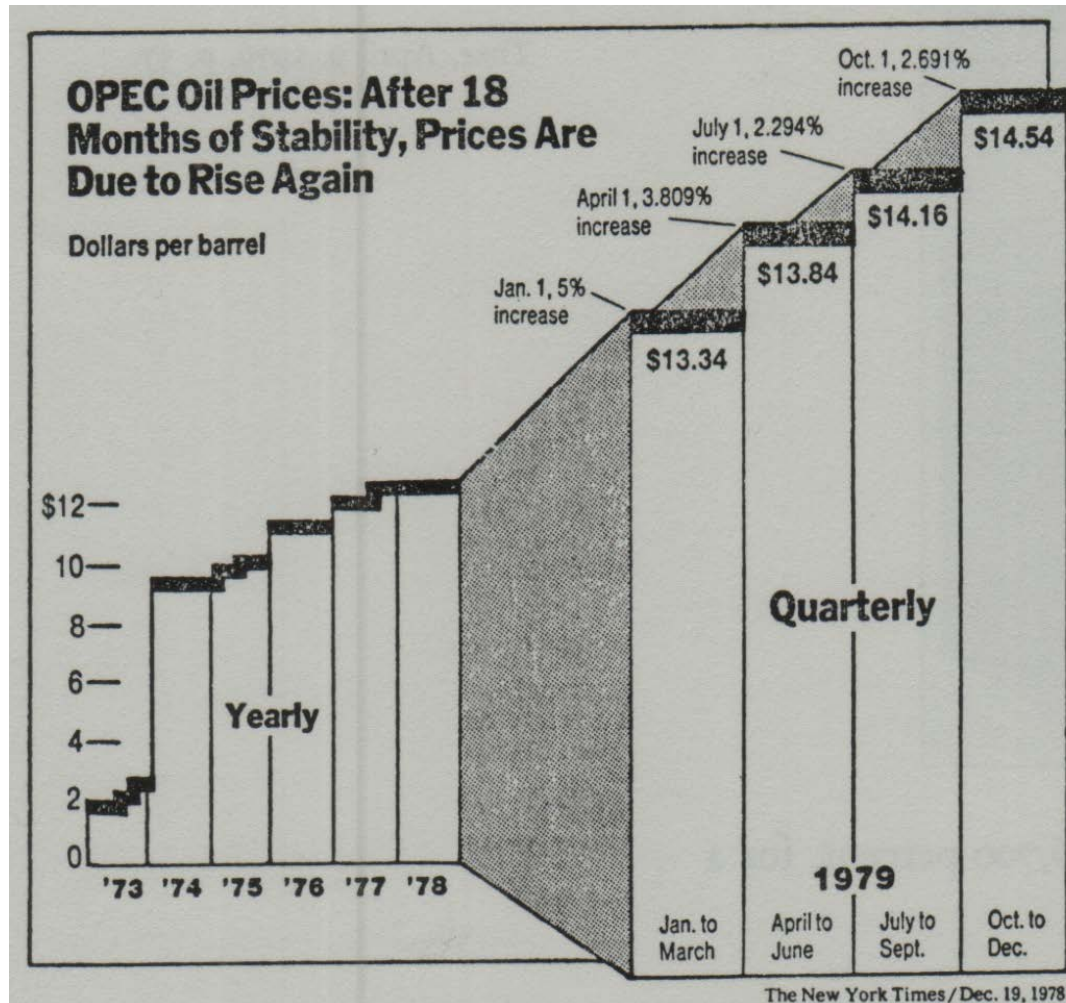
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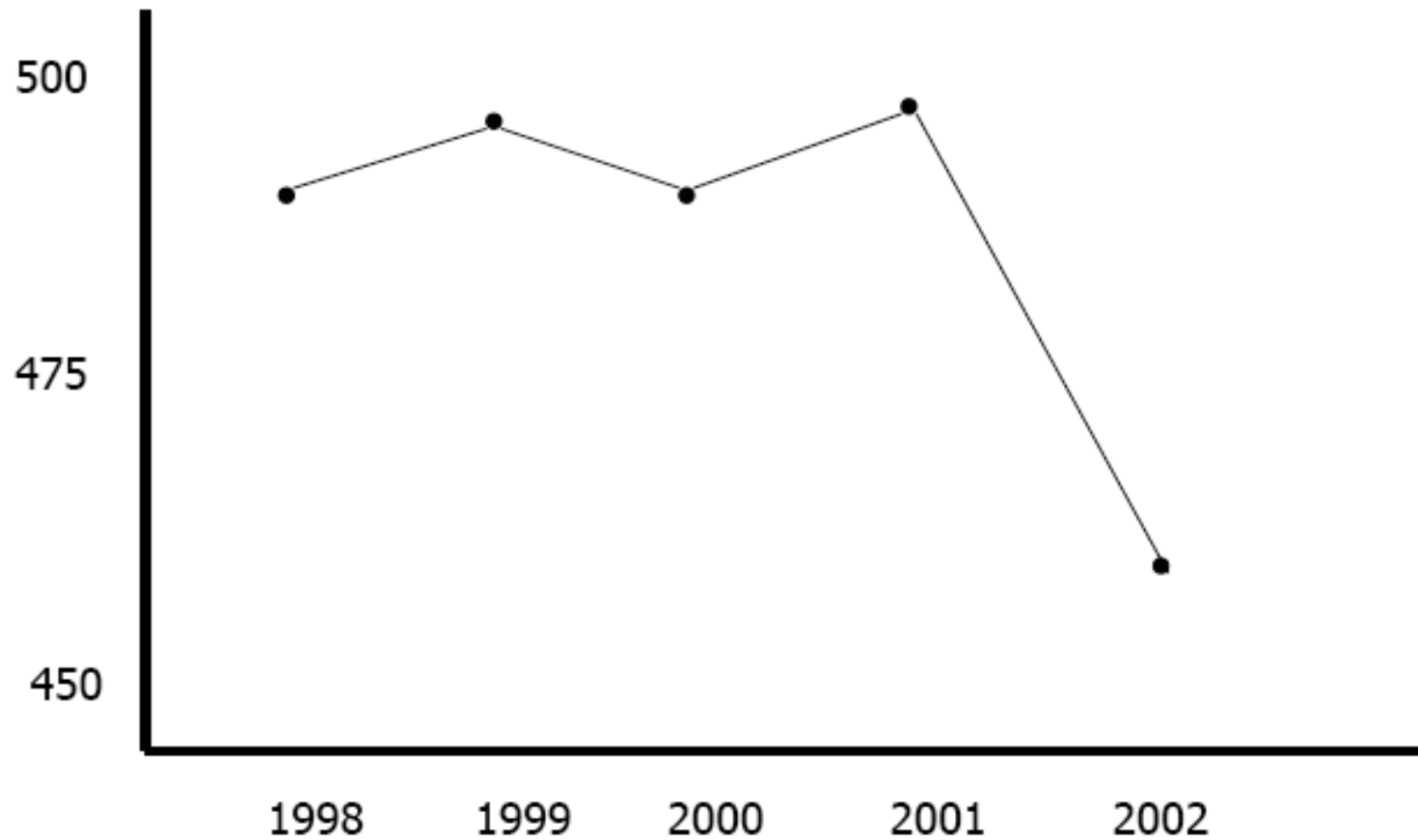
The Lie Factor



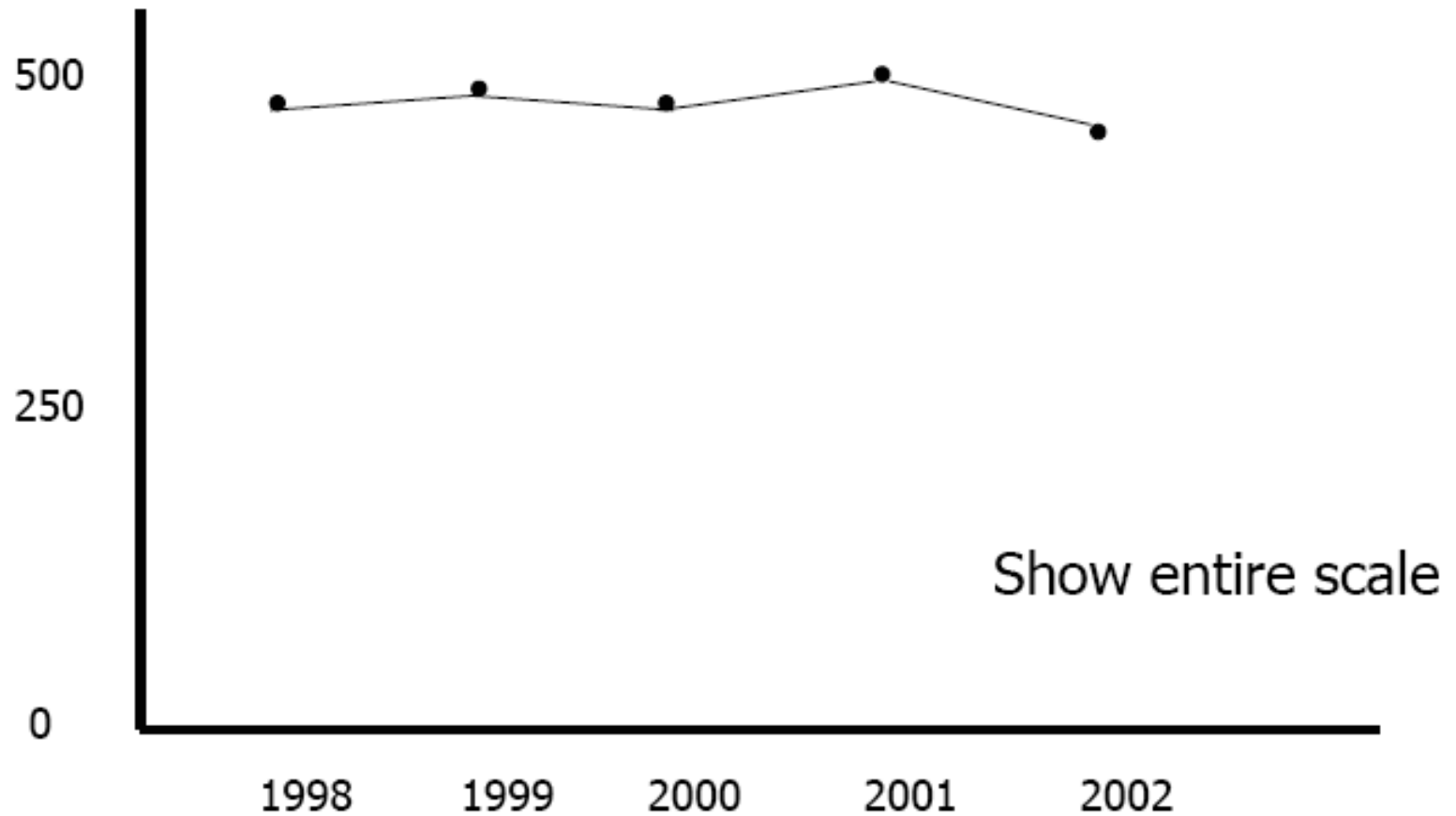
Design Distortions



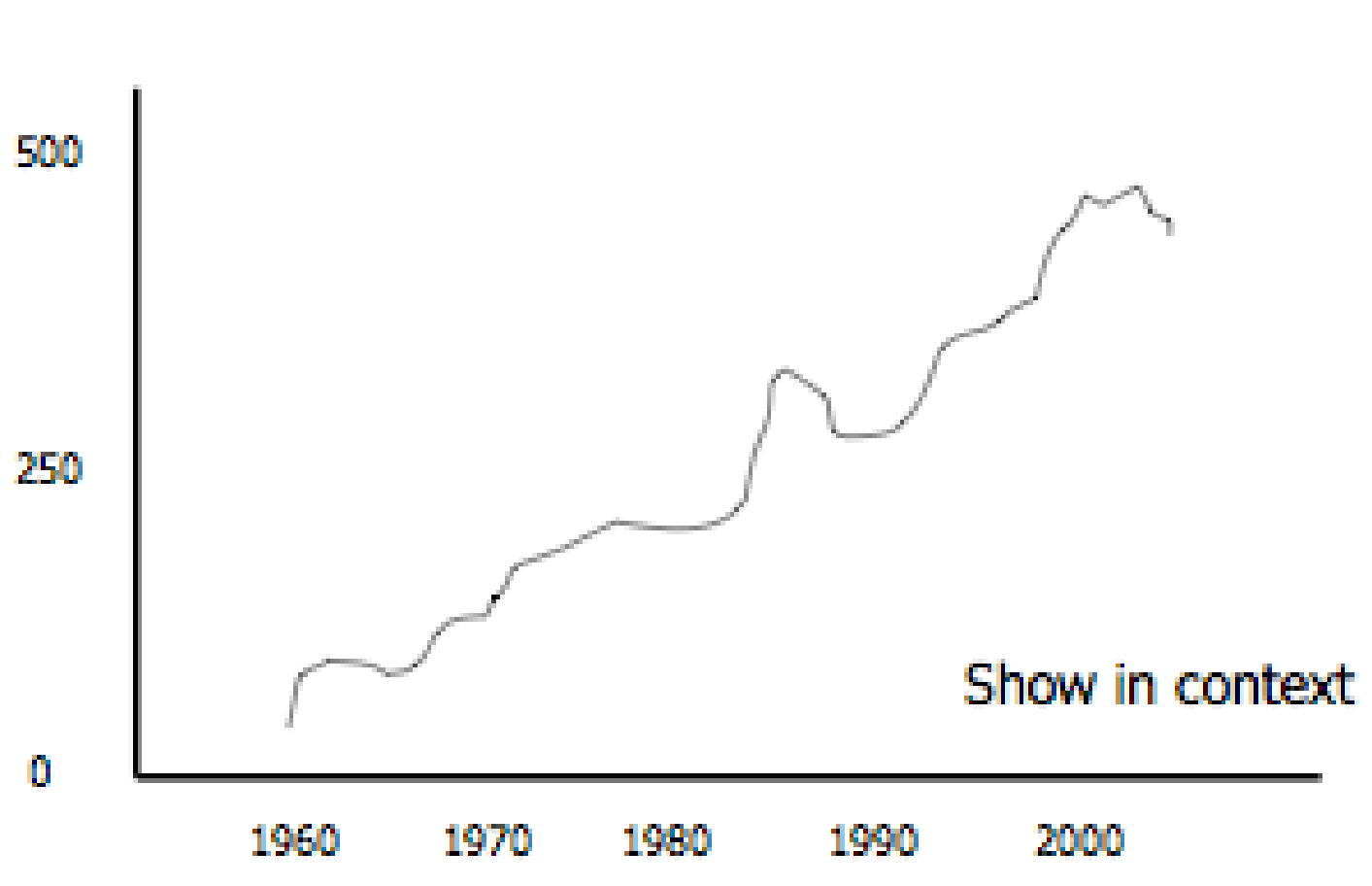
Scale Distortions



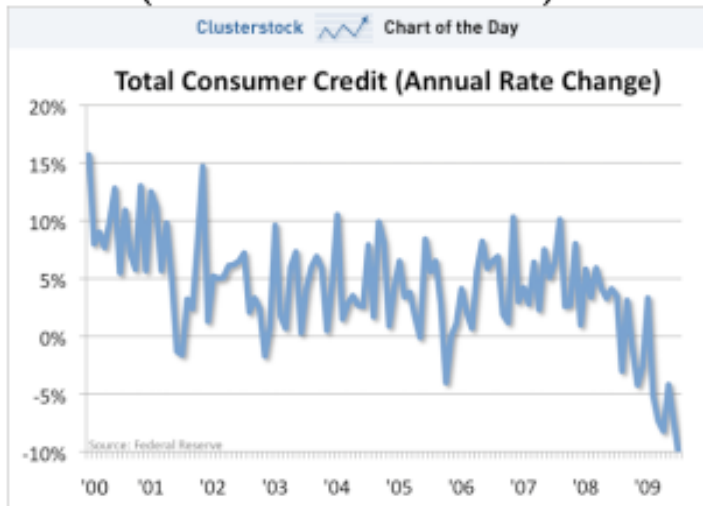
Scale Distortions



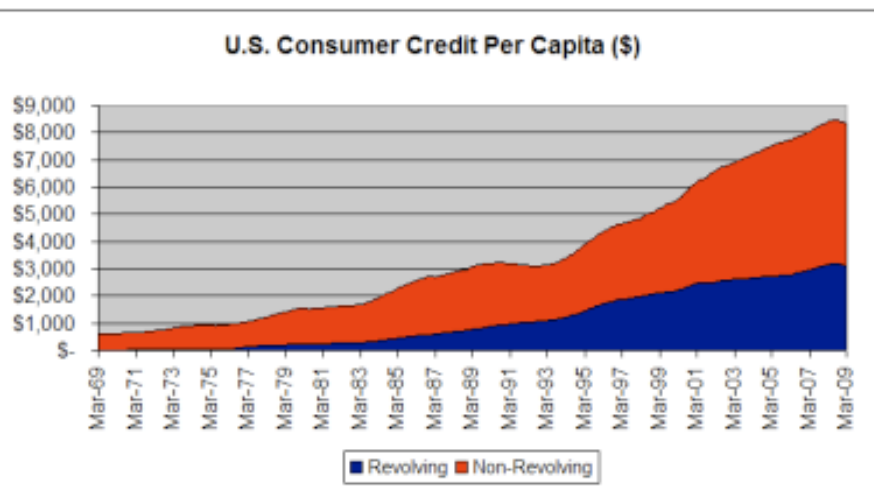
Scale Distortions



“the latest data shows total consumer credit collapsing at an accelerating rate”
(businessinsider.com)



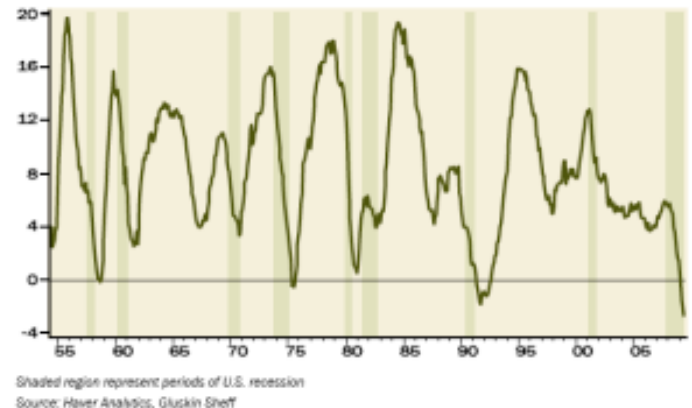
“Per capita is better than total”
(chartingtheeconomy.com)



“have to compare credit to something like disposable income.” (Rolfe Winkler, reuters blog)

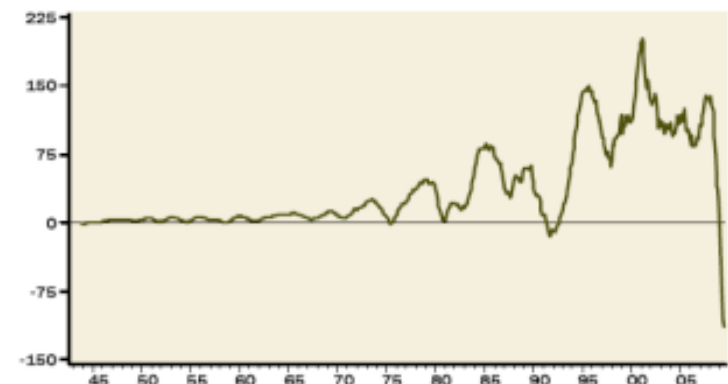
CHART 1: STEEPEST CONSUMER DELEVERAGING IN OVER 50 YEARS

United States: Consumer Credit Outstanding
(year-over-year percent change)



“on-going credit contraction– it’s astonishing”
(ritholtz.com – The Big Picture)

United States: Consumer Credit Outstanding
(year-over-year difference, US\$ bins)





Total Consumer Credit (Annual Rate Change)

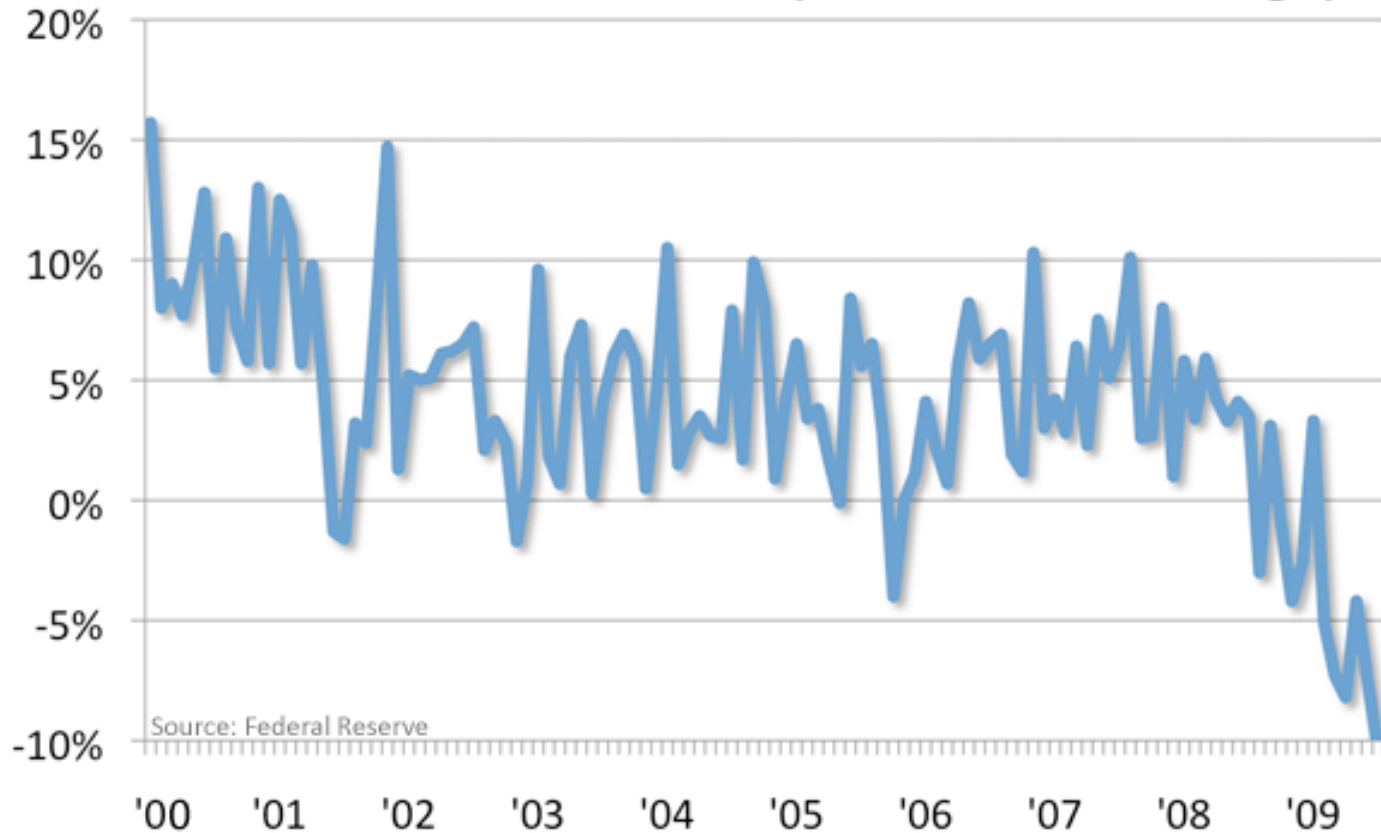
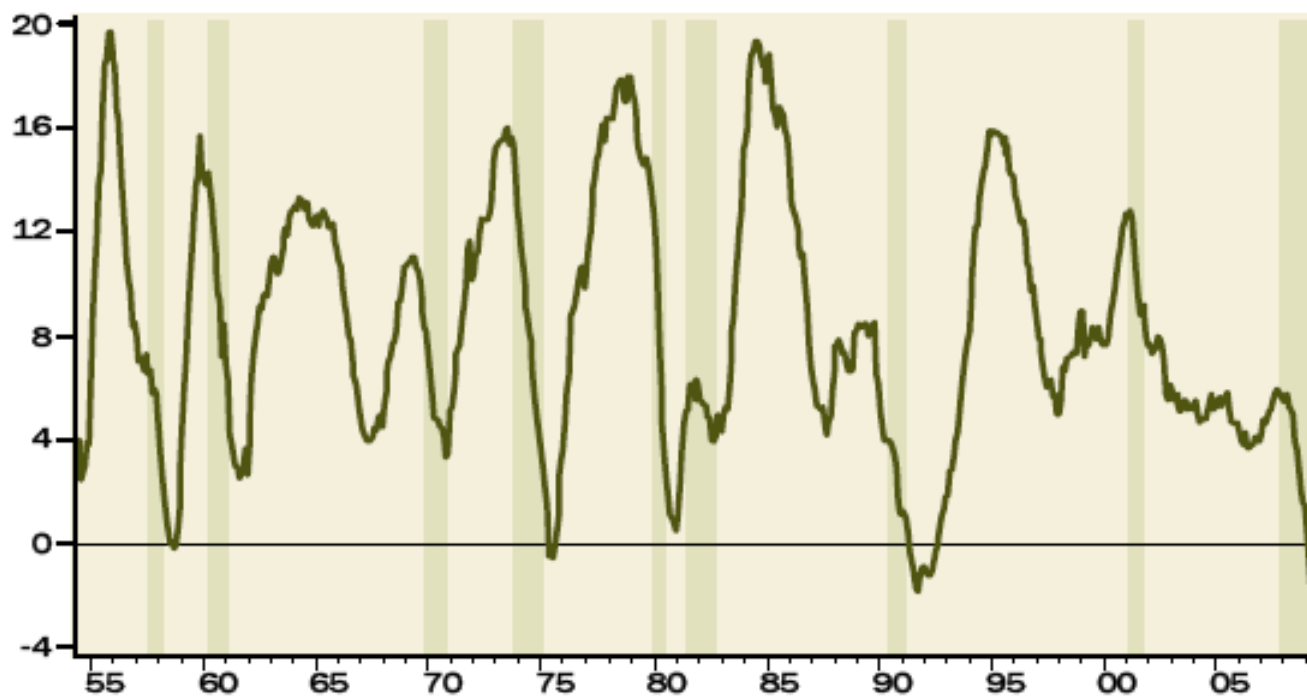


CHART 1: STEEPEST CONSUMER DELEVERAGING IN OVER 50 YEARS

United States: Consumer Credit Outstanding

(year-over-year percent change)

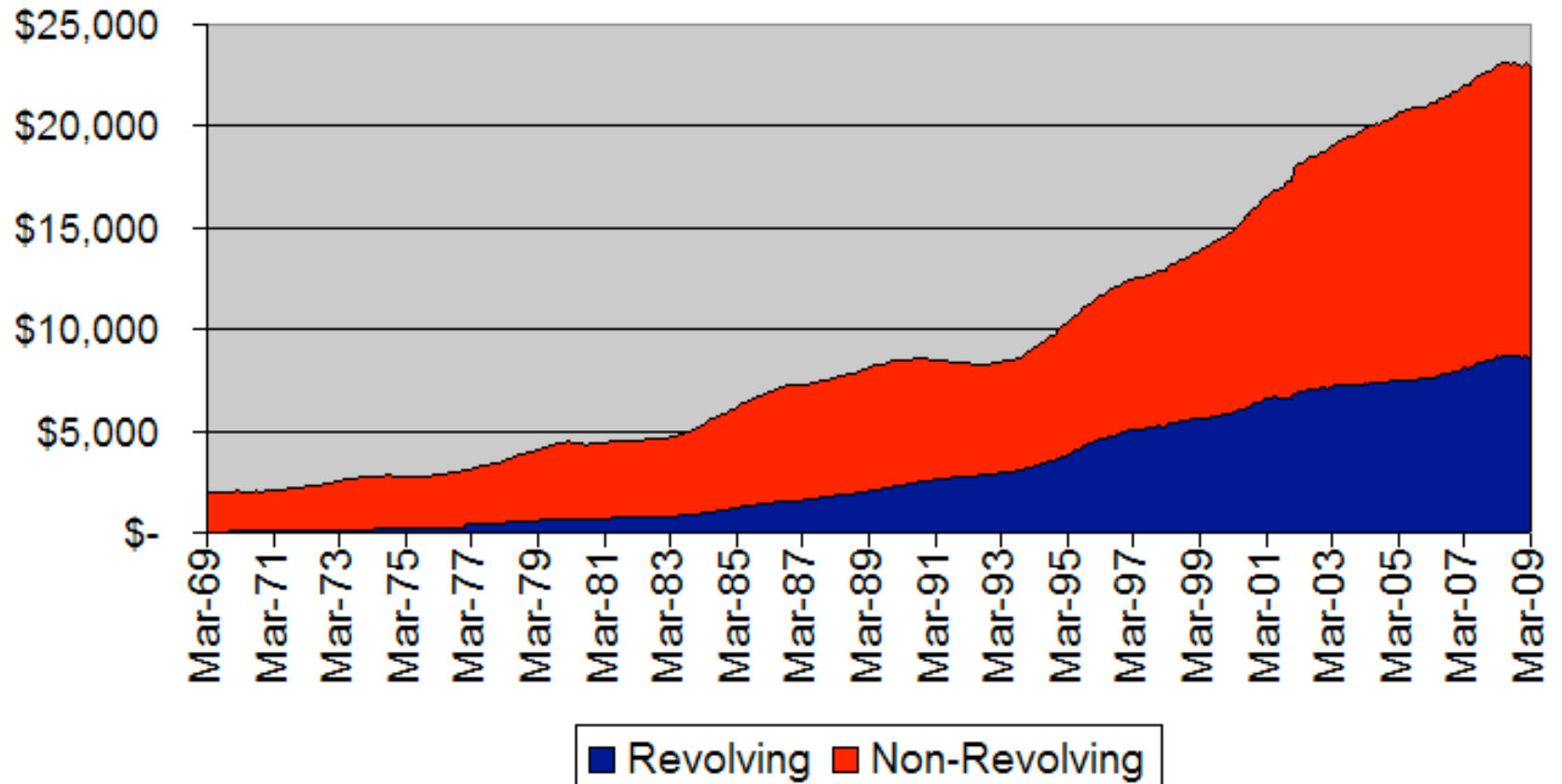


Shaded region represent periods of U.S. recession

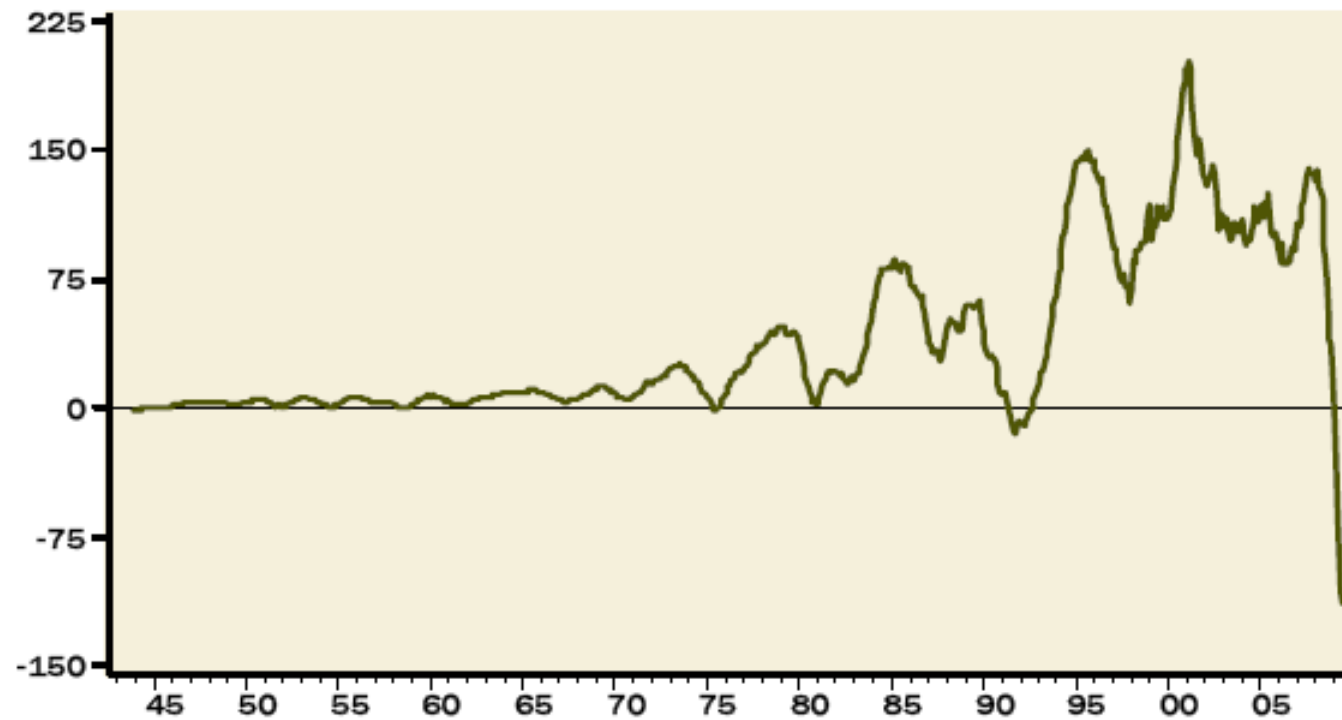
Source: Haver Analytics, Gluskin Sheff

[Rolfe Winkler](#)

U.S. Consumer Credit Per Household (\$)



United States: Consumer Credit Outstanding
(year-over-year difference, US\$ blns)

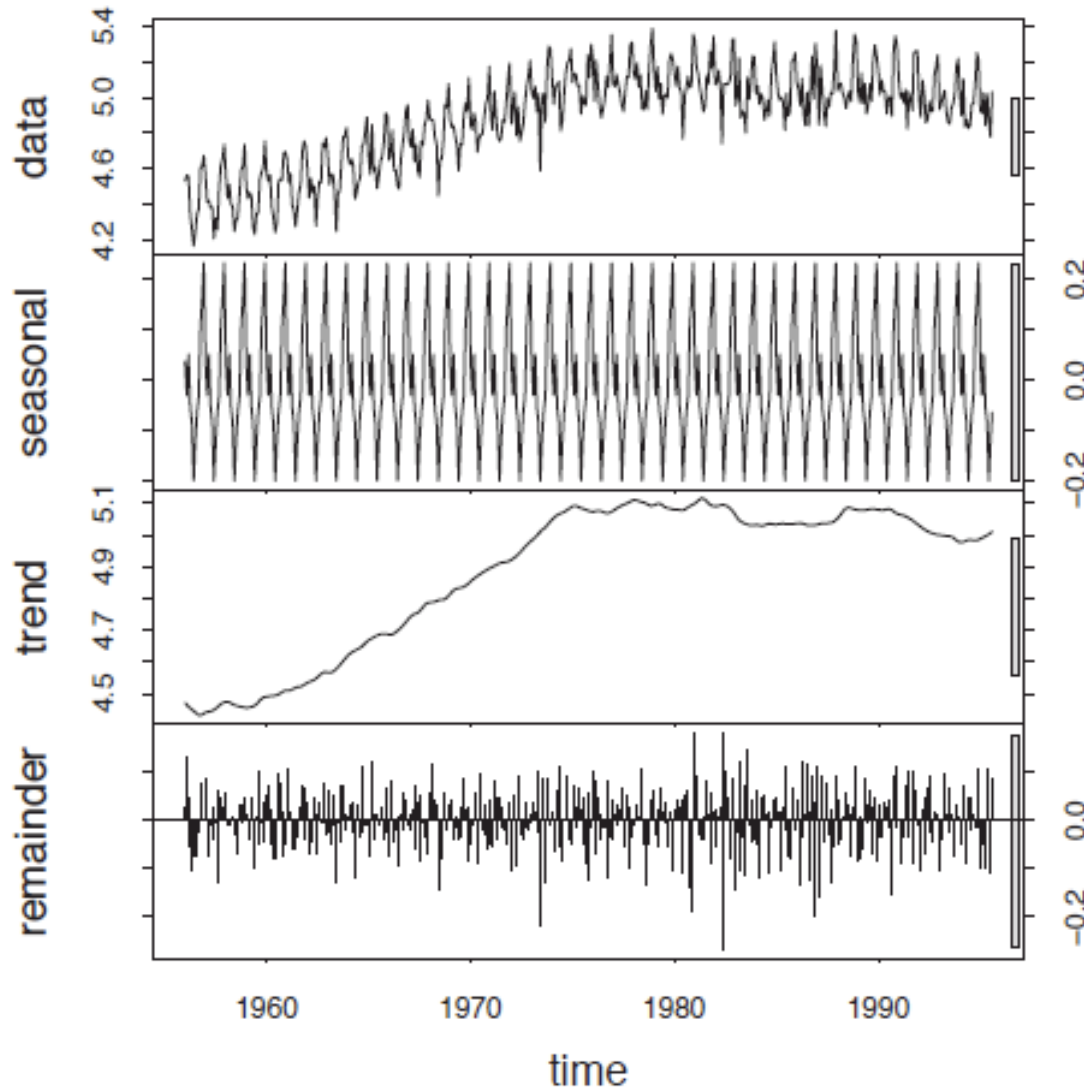


[The Big Picture](#)

Design Principles

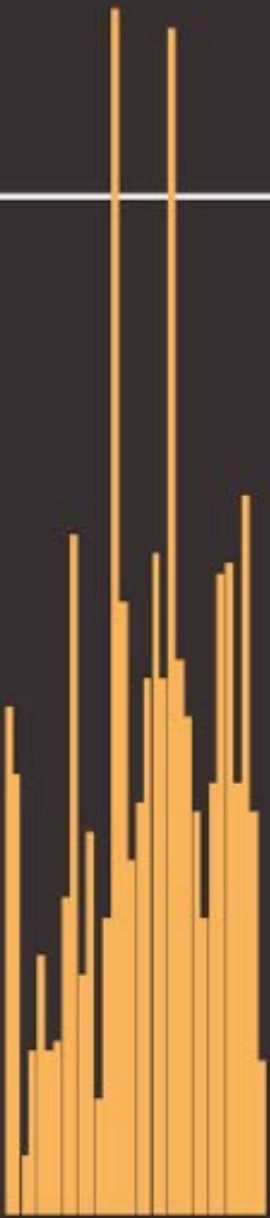
Use Decomposition

Beer sales

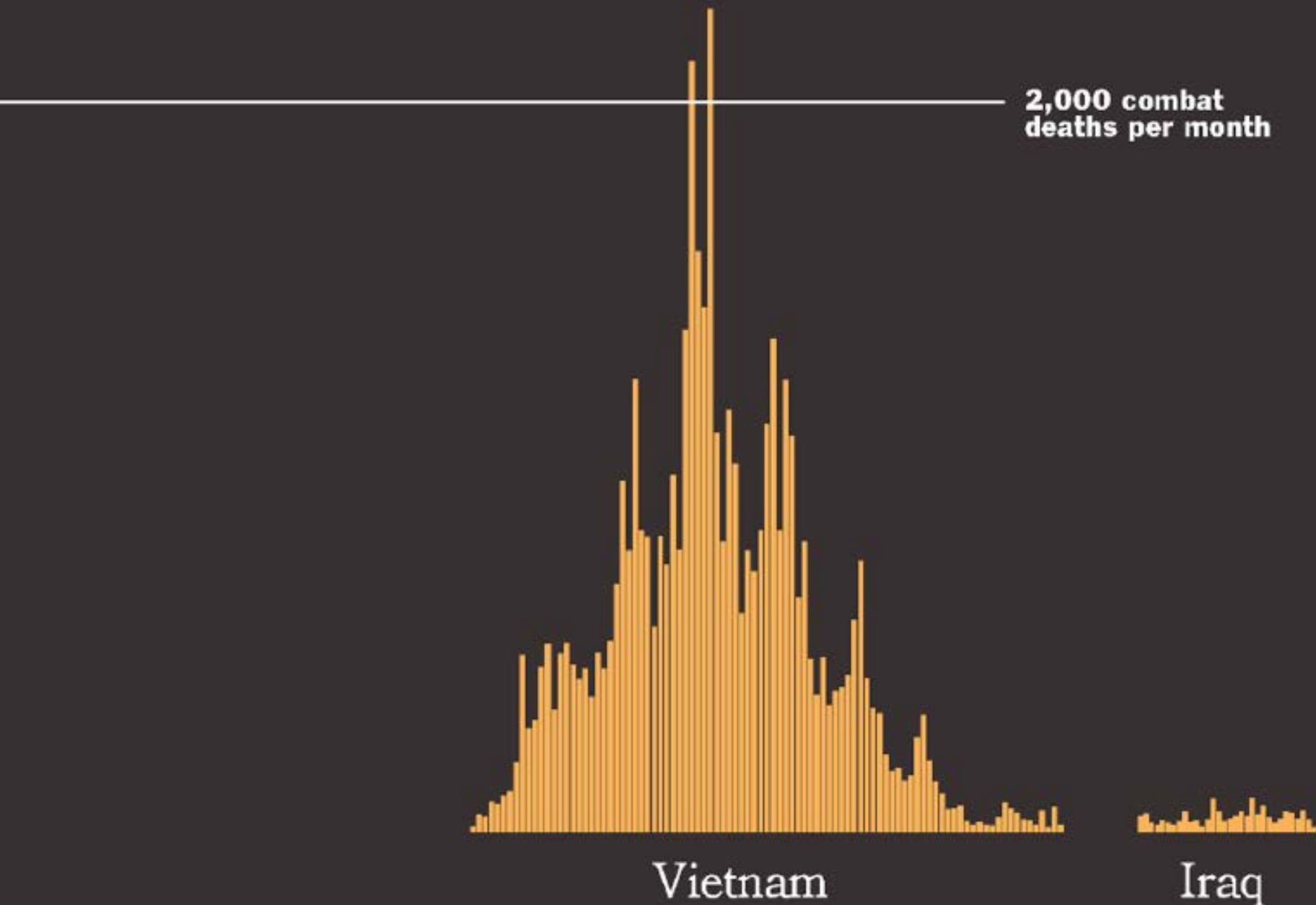


Show Context

100 combat
deaths per month



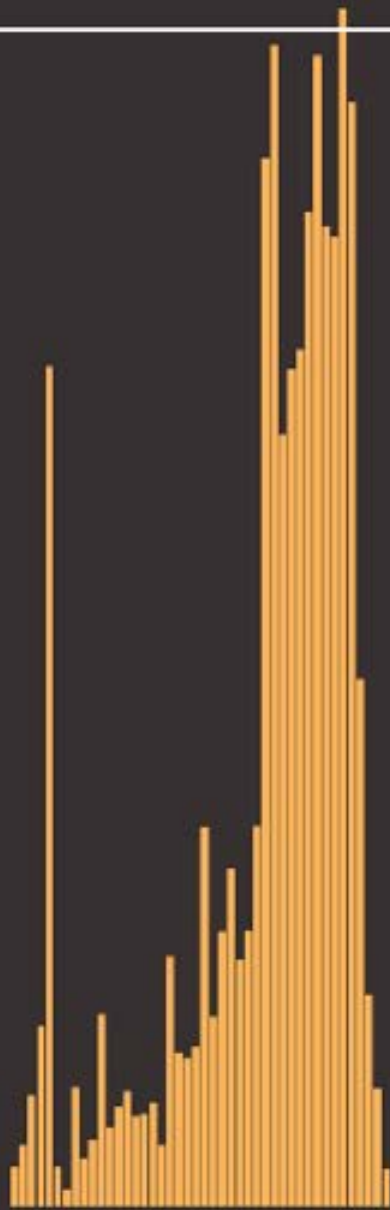
Iraq



Vietnam

Iraq

20,000 combat
deaths per month



World War II



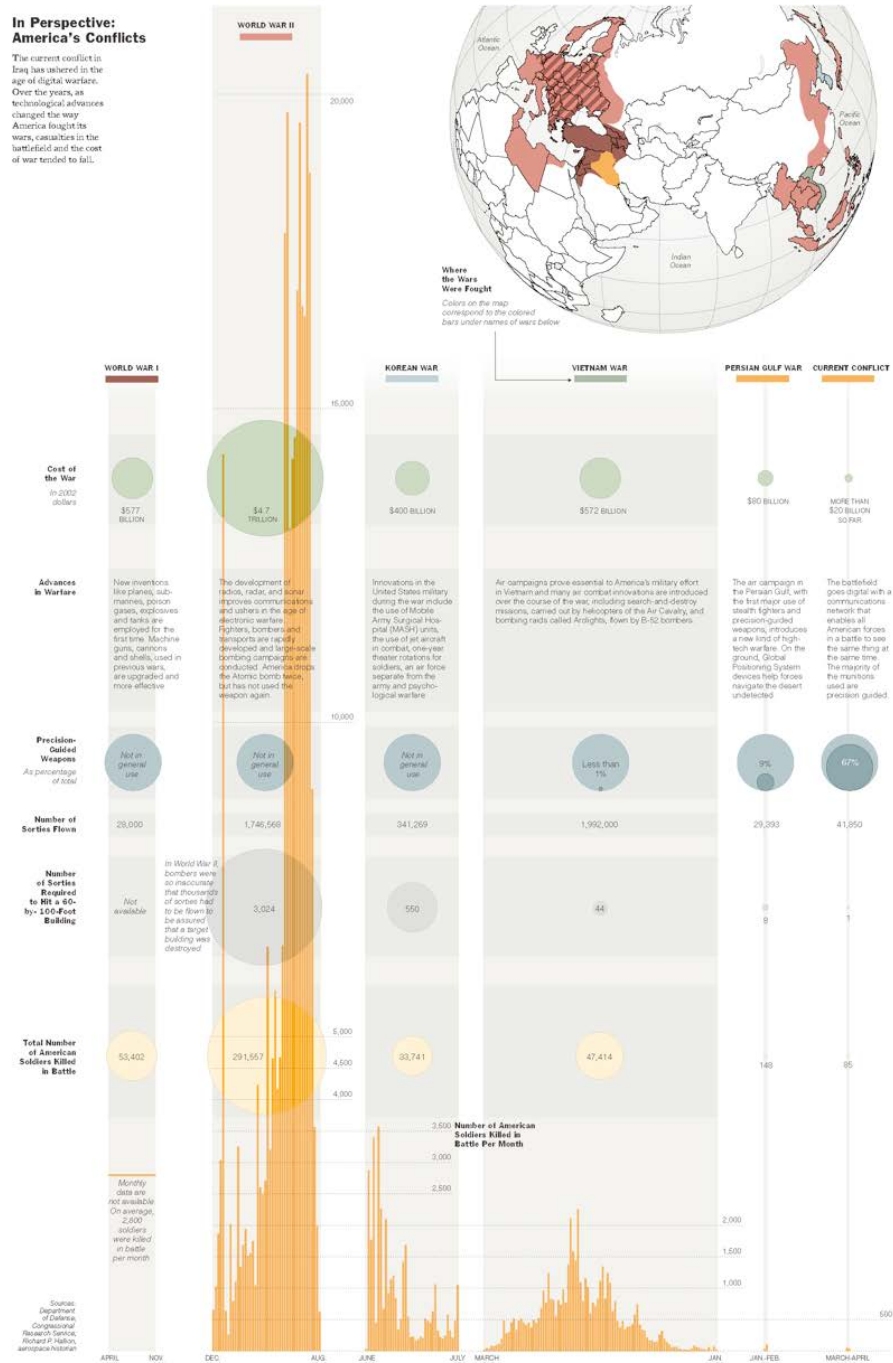
Vietnam



Iraq

**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.



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Search Business

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Novartis advertisement: Novartis symposium debates the global financial crisis. Includes image of a man and Novartis logo. Text: Pharmaceuticals, Vaccines and Diagnostics, Generics, Consumer Health. www.us.novartis.com

Toyota Halts Sales of Eight Models After Recall

By NICK BUNKLEY Published: January 26, 2010

Toyota Motor, still struggling to resolve a problem with accelerator pedals, said Tuesday it would temporarily stop selling and building eight models in the American market, including the popular Camry and Corolla sedans.

The unusual move has the potential to further damage Toyota, whose reputation for quality has been battered by two recalls of millions of vehicles in the last two months for a problem that the company has described as a "rare" condition in which the gas pedal can stick, and

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Gas Pedal Flaw Leads Toyota To Stop Building 8 Models

[Toyota Motor](#), still struggling to resolve a problem with accelerator pedals, said Tuesday it would temporarily stop selling and building eight models in the American market, including the popular Camry and Corolla sedans.

The unusual move has the potential to further damage Toyota, whose reputation for quality has been battered by two recalls of millions of vehicles in the last two months for a problem that the company has described as a “rare” condition in which the gas pedal can stick, and cause a vehicle to speed up unintentionally.

“This action is necessary until a remedy is finalized,” Robert S. Carter, a Toyota group vice president, said in a statement. “We’re making every effort to address this situation for our customers as quickly as possible.”

Toyota said it would immediately stop selling the Camry, Corolla and Avalon sedans, Matrix wagon, RAV4 crossover, Tundra pickup, and Highlander and Sequoia sport utility vehicles.

It will also stop building those models the week of Feb. 1. All of the vehicles are assembled in the United States or Canada, at a total of five plants.

The models affected accounted for more than a million sales in 2009, 57 percent of Toyota’s American total for the year.

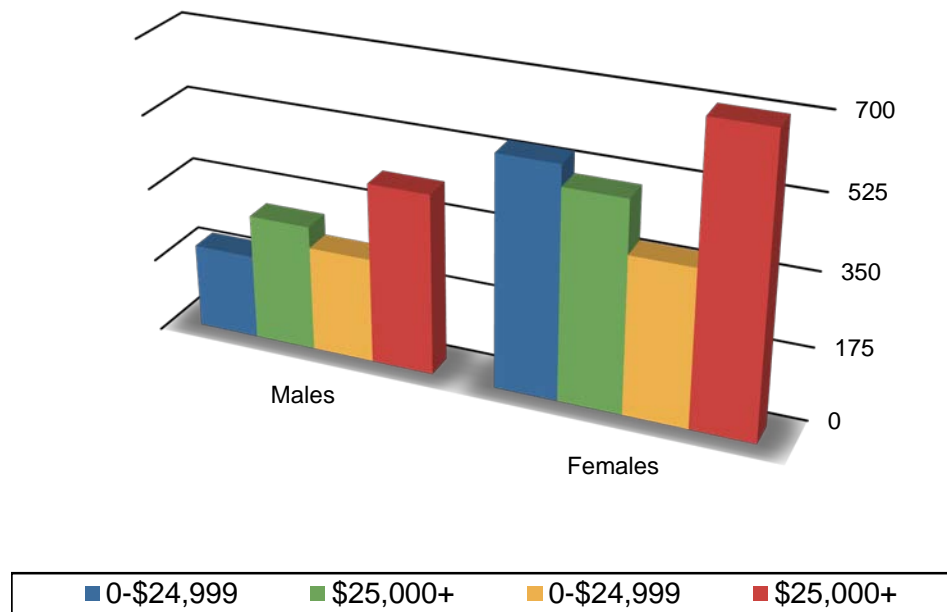
The company said the move was intended to restore confidence in the automaker, and the safety of its products. One analyst said many consumers may have a different reaction.

[Readability](#)

“The problem seems to be getting larger than anyone was led to believe at first,” said Erich Merkle, an

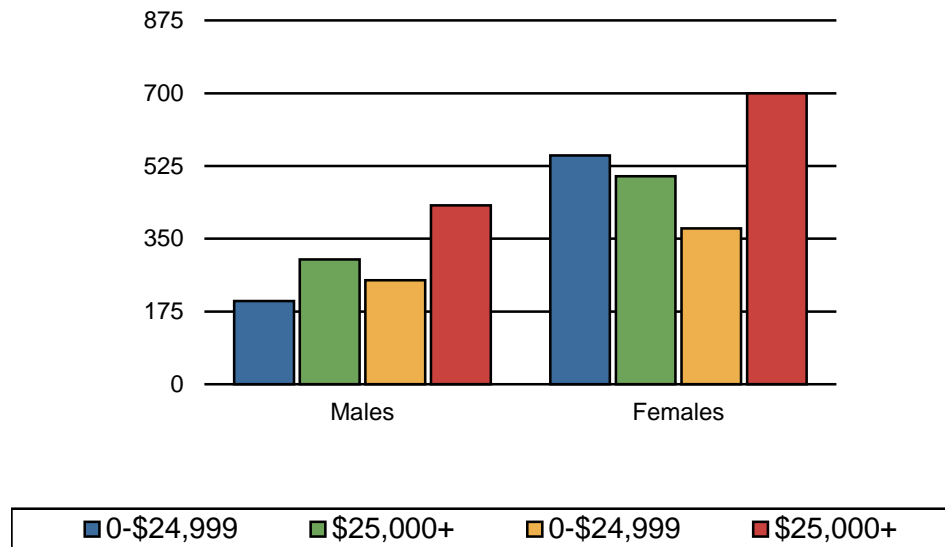
Maximize Data-Ink Ratio

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



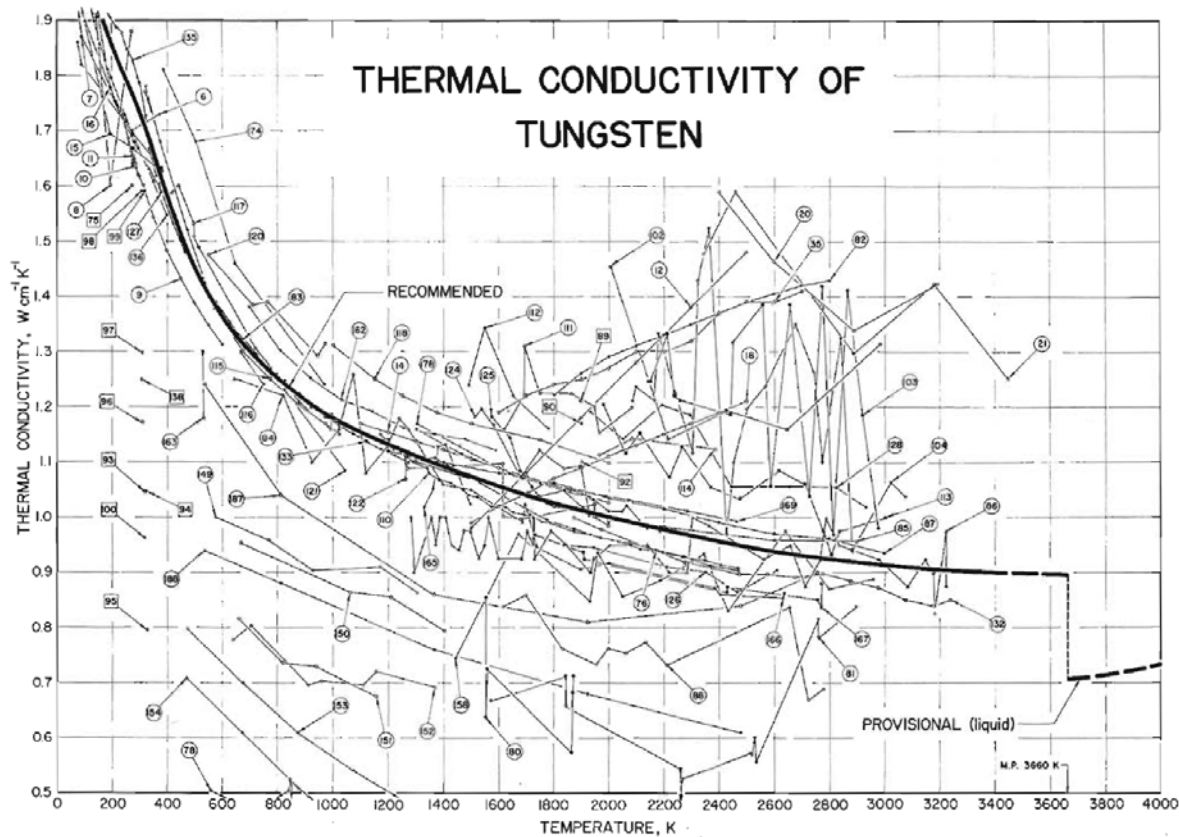
Maximize Data-Ink Ratio

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Data Density

$$\text{data density} = \frac{\text{number of entries in data array}}{\text{area of data graphic}}$$

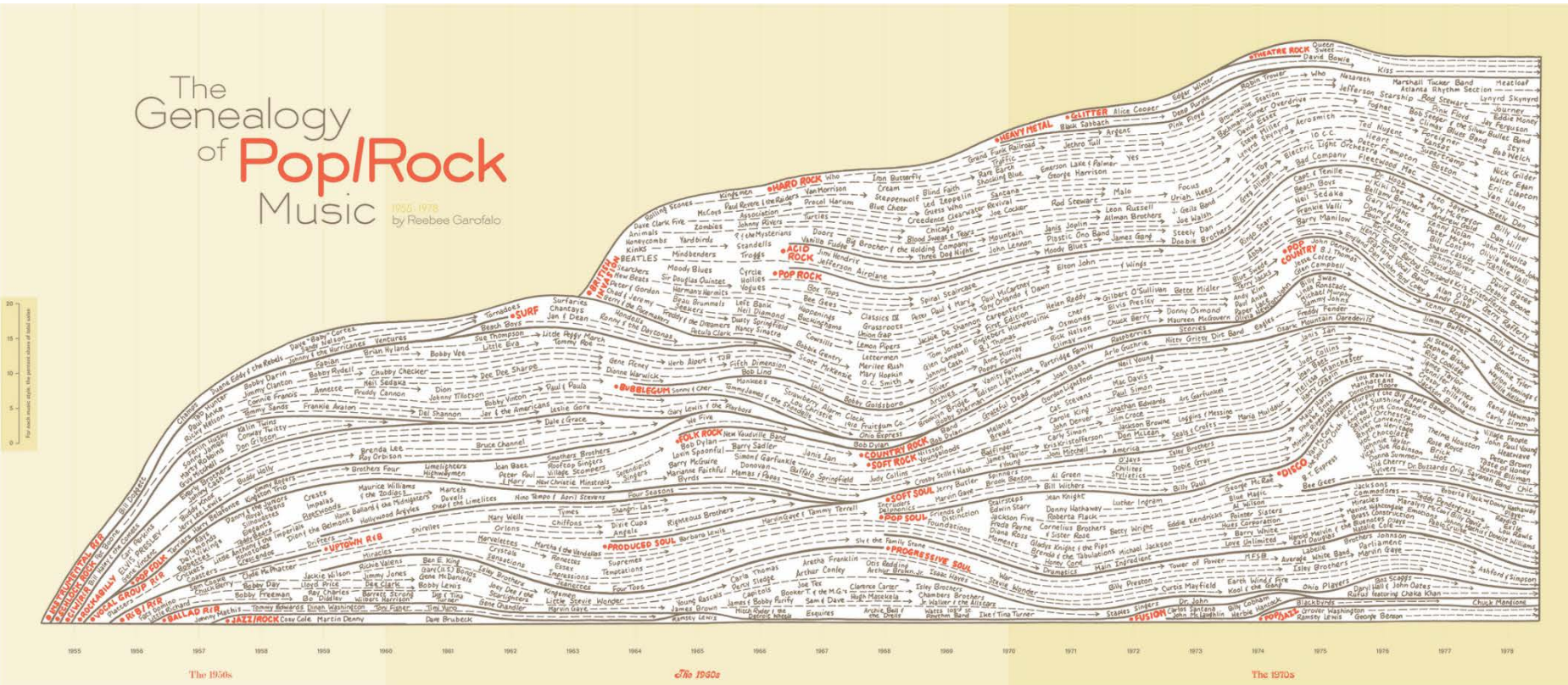


Ho et al., "Thermal Conductivity of the Elements: A Comprehensive Review" J. Phys. Chem. 1974

Escaping Flatland

The Genealogy of Pop/Rock Music

1955-1979
by Reebee Garofalo



This graphic chronicles the growth and development of pop, rock, and soul music and their top selling artists.

More than 700 artists and 30 styles of music are mapped in flowing currents in this chart. It includes almost every performer who sold records in the pop/rock market and whose name appeared on the year-end top 50 album or singles charts.

An arrow extending from a performer's name shows the length of time that he/she remained a major hit maker. The width of each stylistic category is a rough estimate of its share of the market according to the scale on the left.

Categorizing music is clearly a subjective process and in some cases it may even appear to be arbitrary. The performers shown here represent only the top of the commercial bubble — the major hit makers of a given year. Their music is the most lucrative; it may or may not be the most influential or artistically important. Such are the vagaries of the marketplace in a commodity system.

Concept and design: Reebee Garofalo
 Revised and updated from the book *Rock N' Roll is Here to Stay: The History and Politics of the Music Industry* by Steve Chagnon and Reebee Garofalo
 Graphics assisted: Dennis Henry and Jack Hecox
 Special thanks to: Sam Roggen, Alan McDiagall, Beverly May, Terry O'Connor, Robert Pinner and Patrice Thomas
 Sources: *Billboard*, *Cashbox*, *Chart*'s *The Sound of the City*, *Rock*, *Entertainment Weekly*, and *Who's in the House*'s *Top Pop Records*



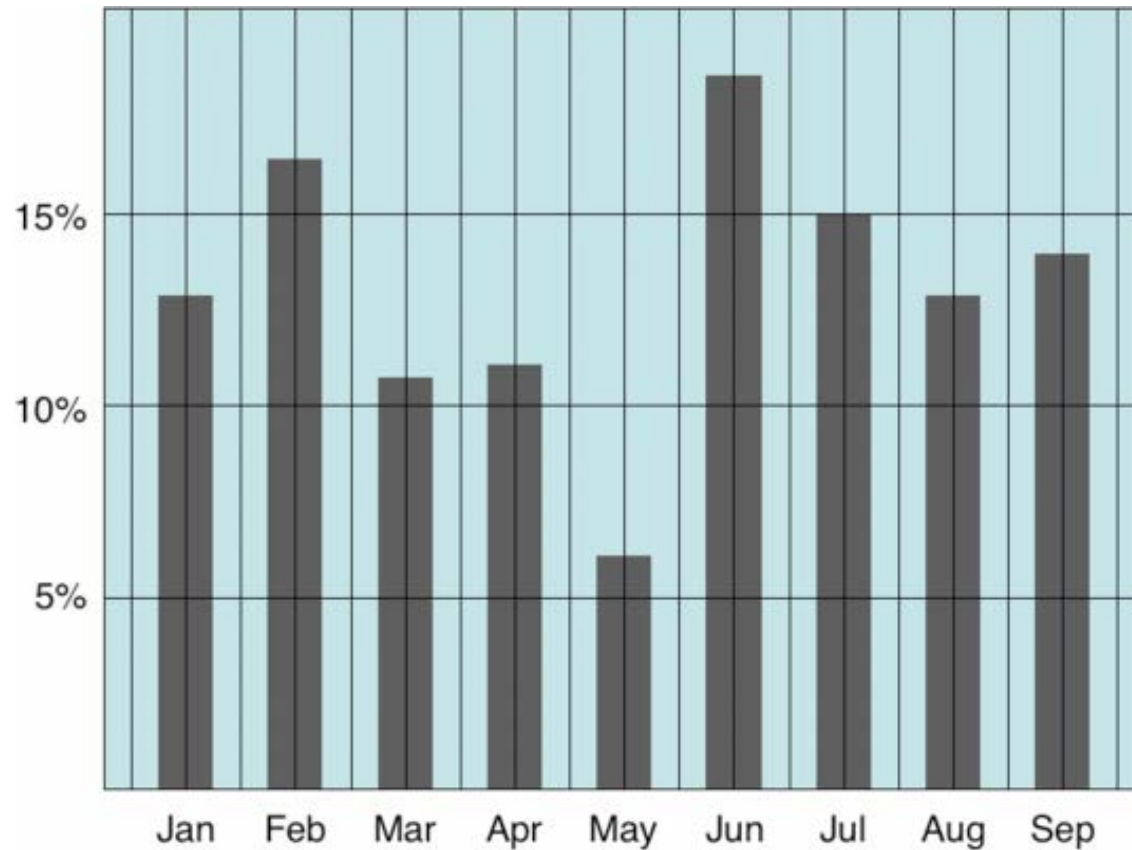


Sparklines

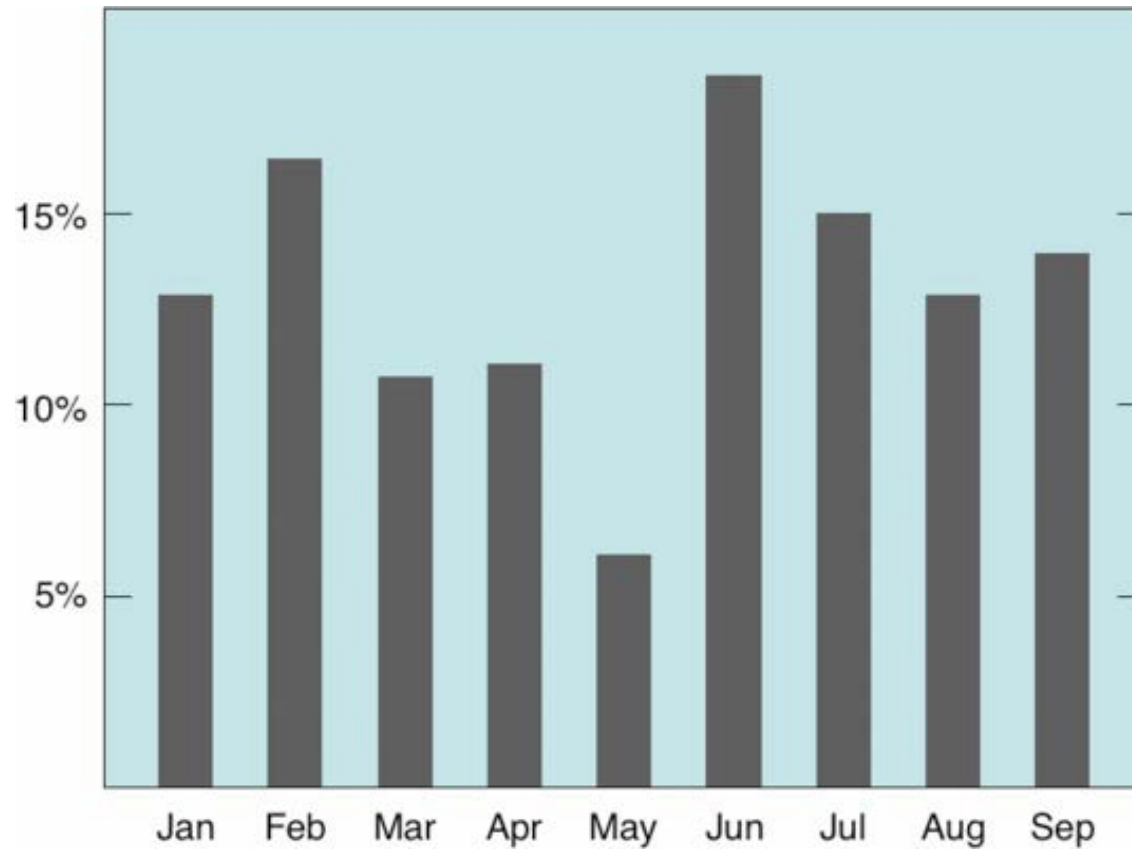


Avoid Chartjunk

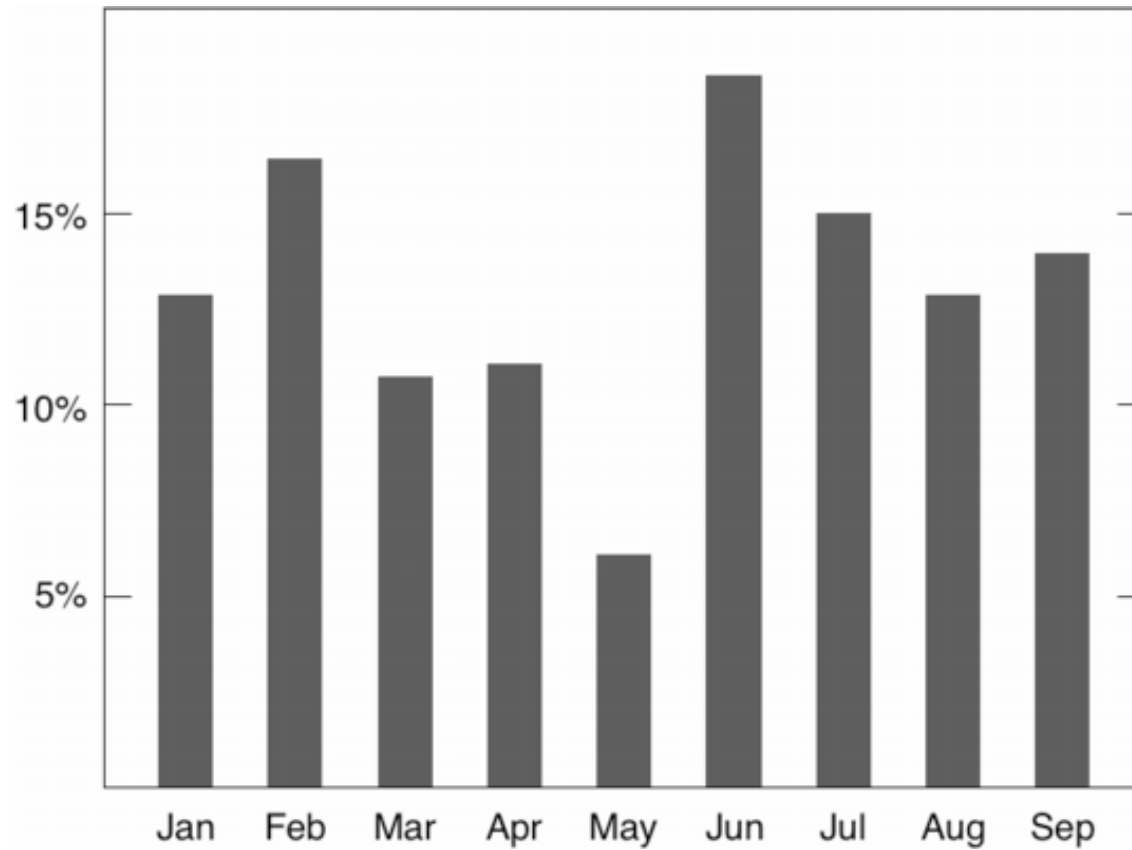
Extraneous visual elements that distract from the message



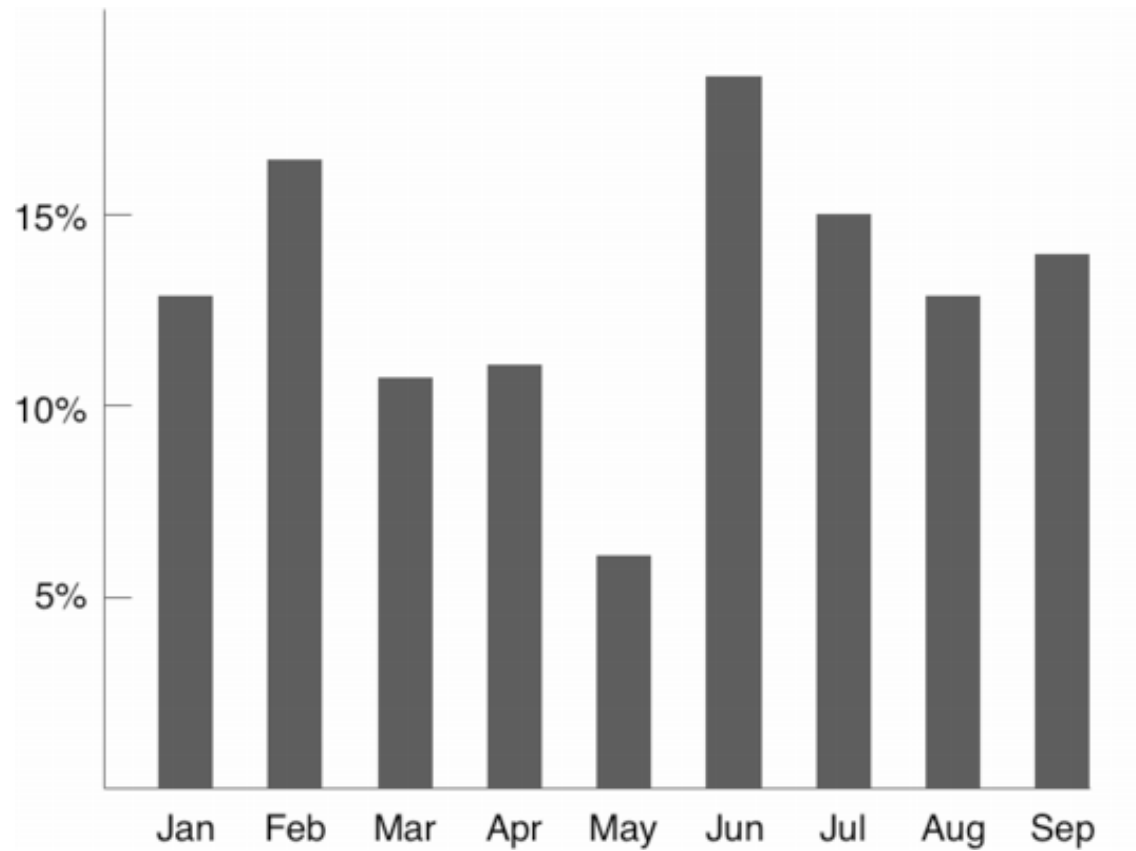
Avoid Chartjunk



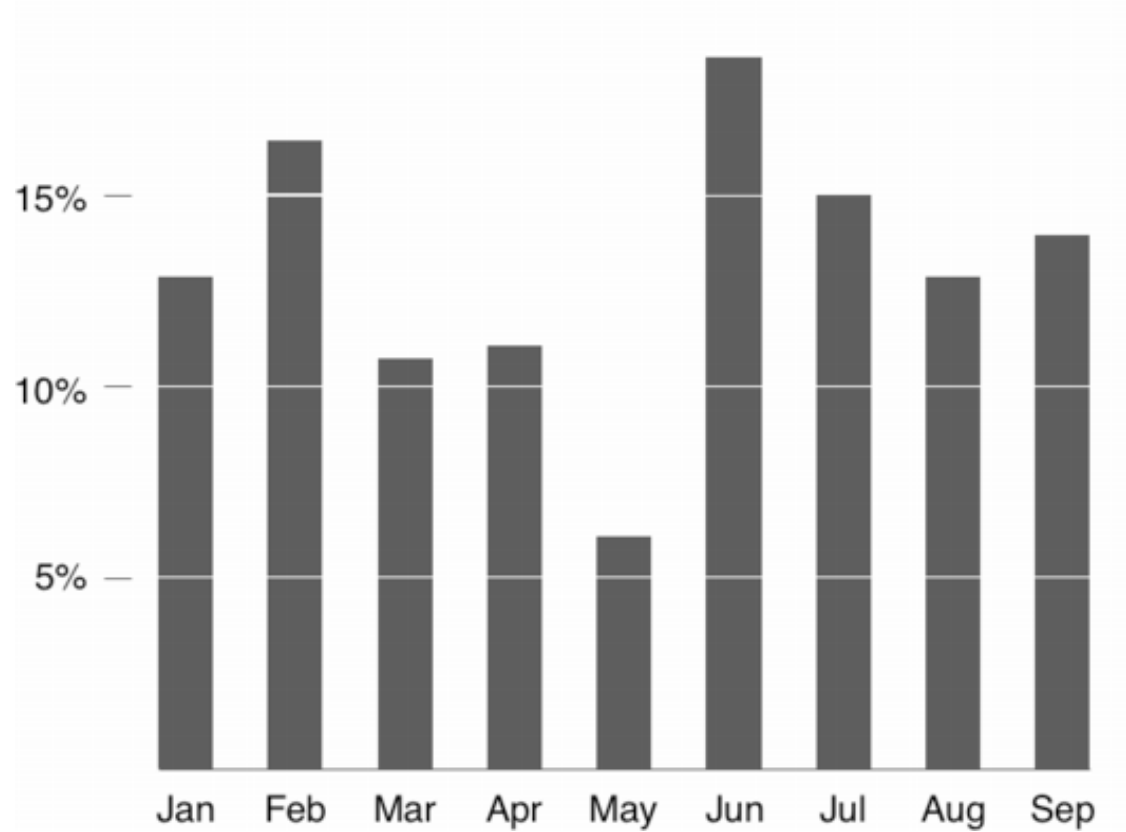
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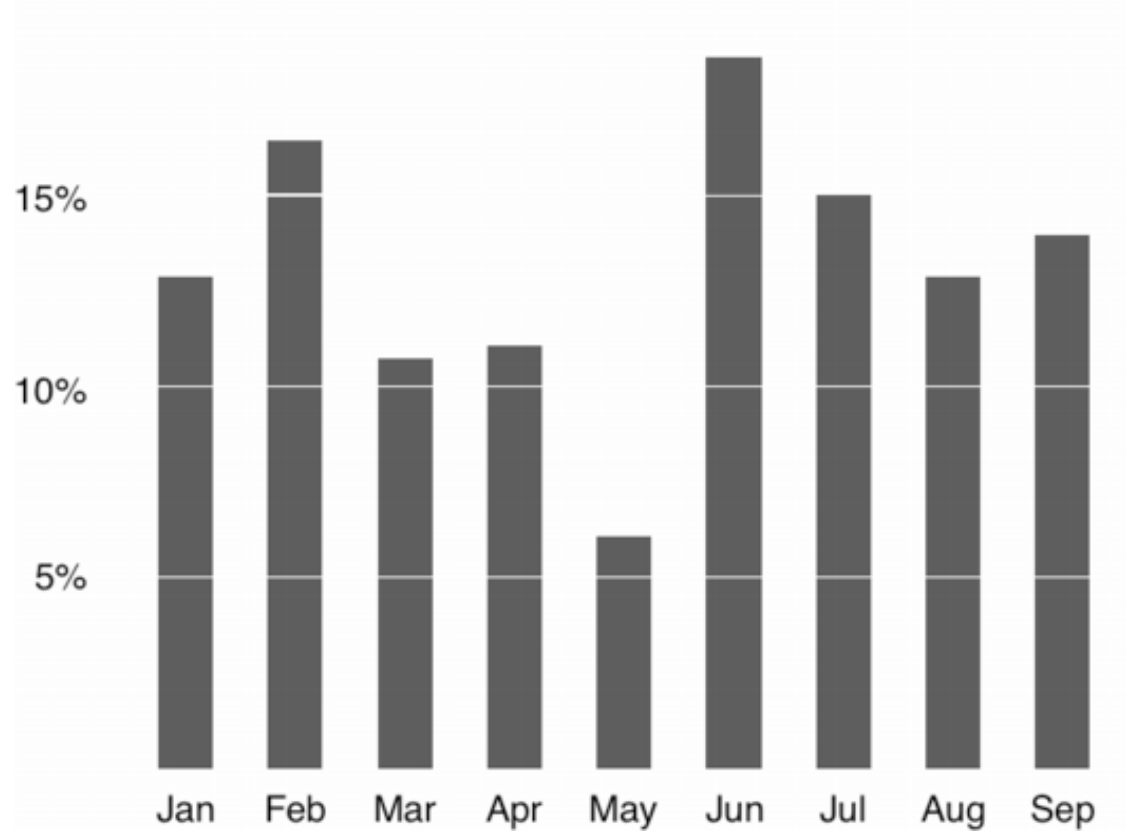
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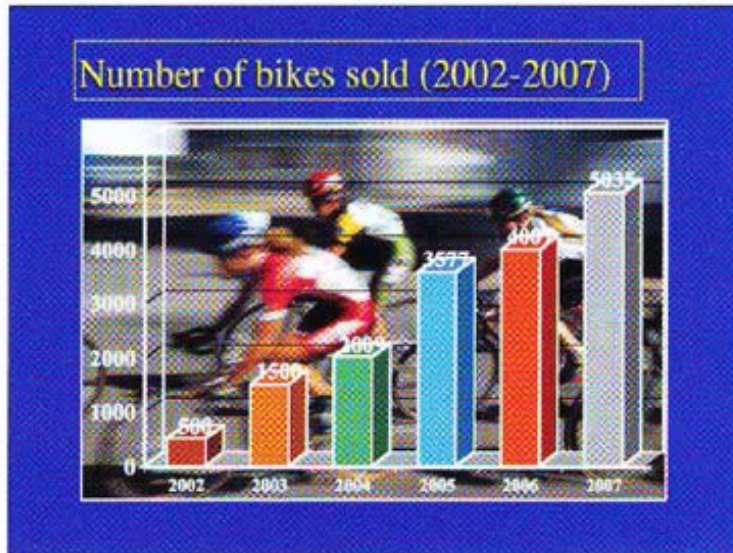
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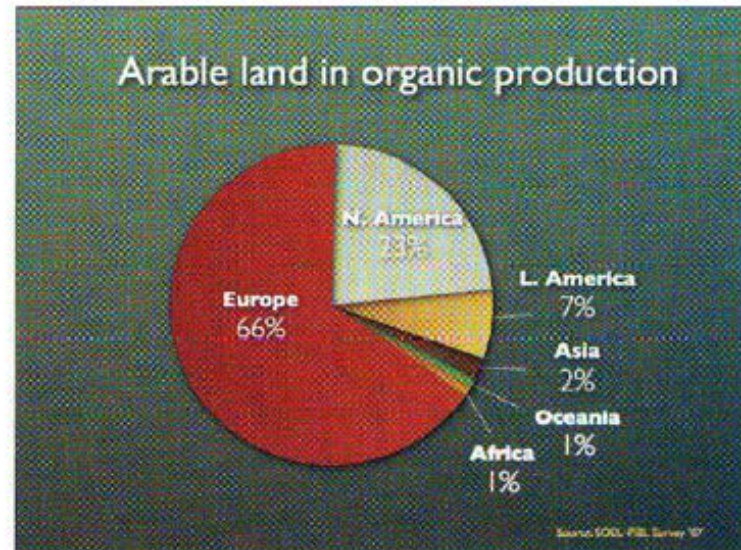
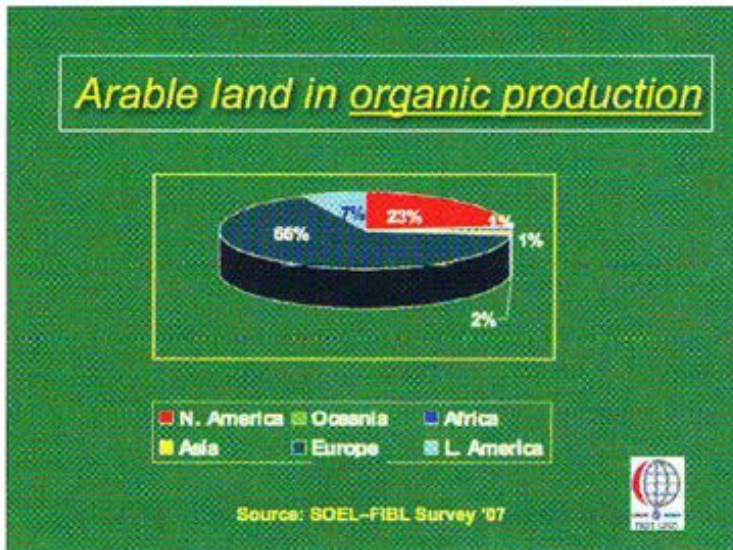
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Before

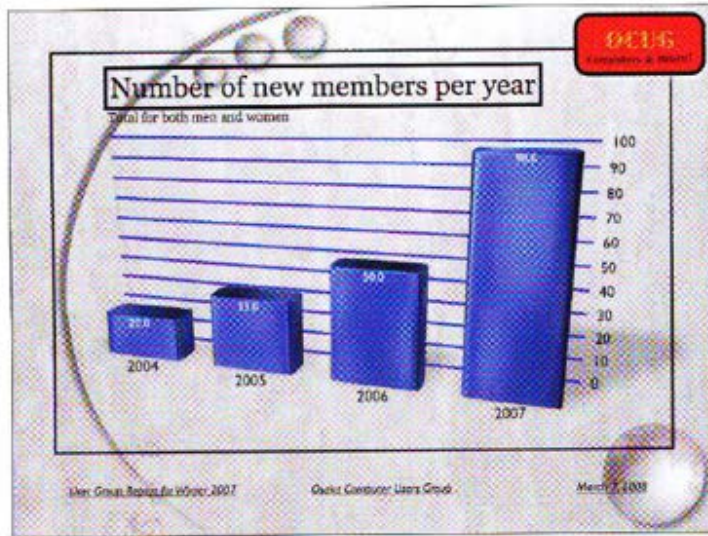


After

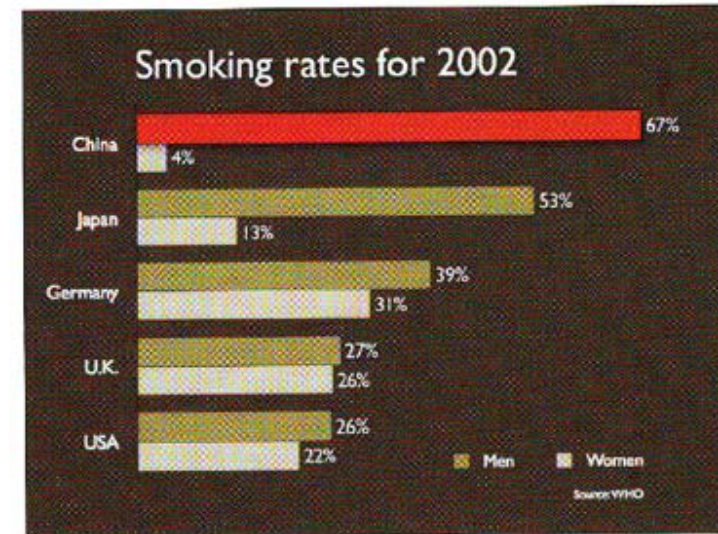
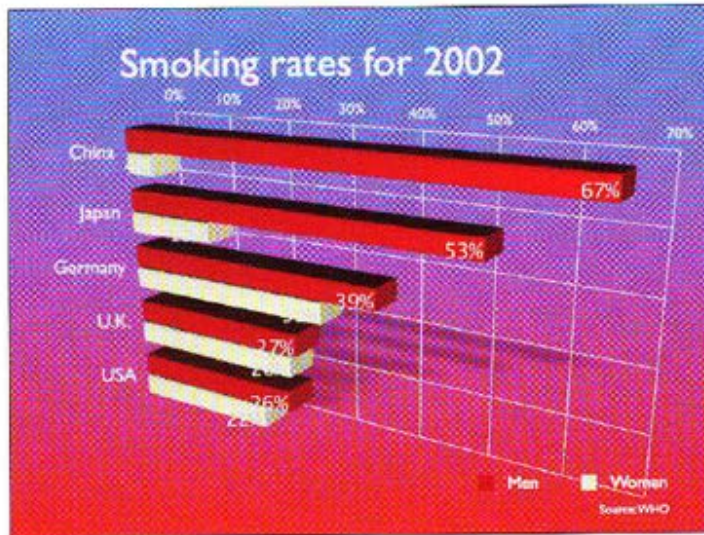
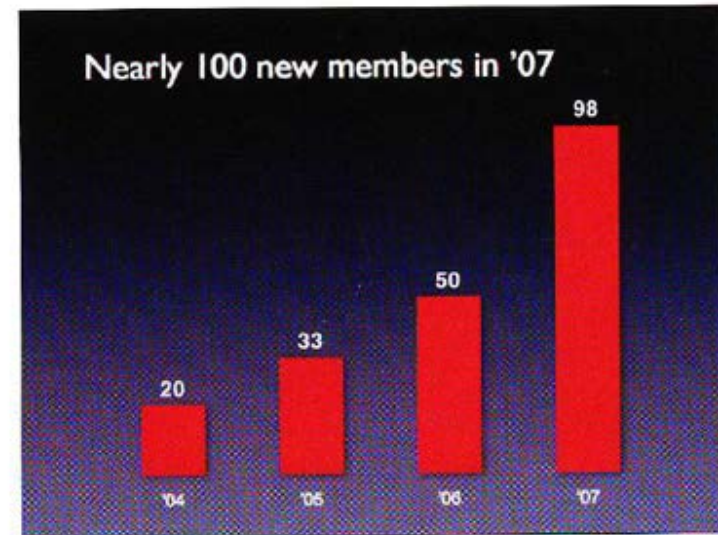


G. Reynolds, Presentation Zen

Before

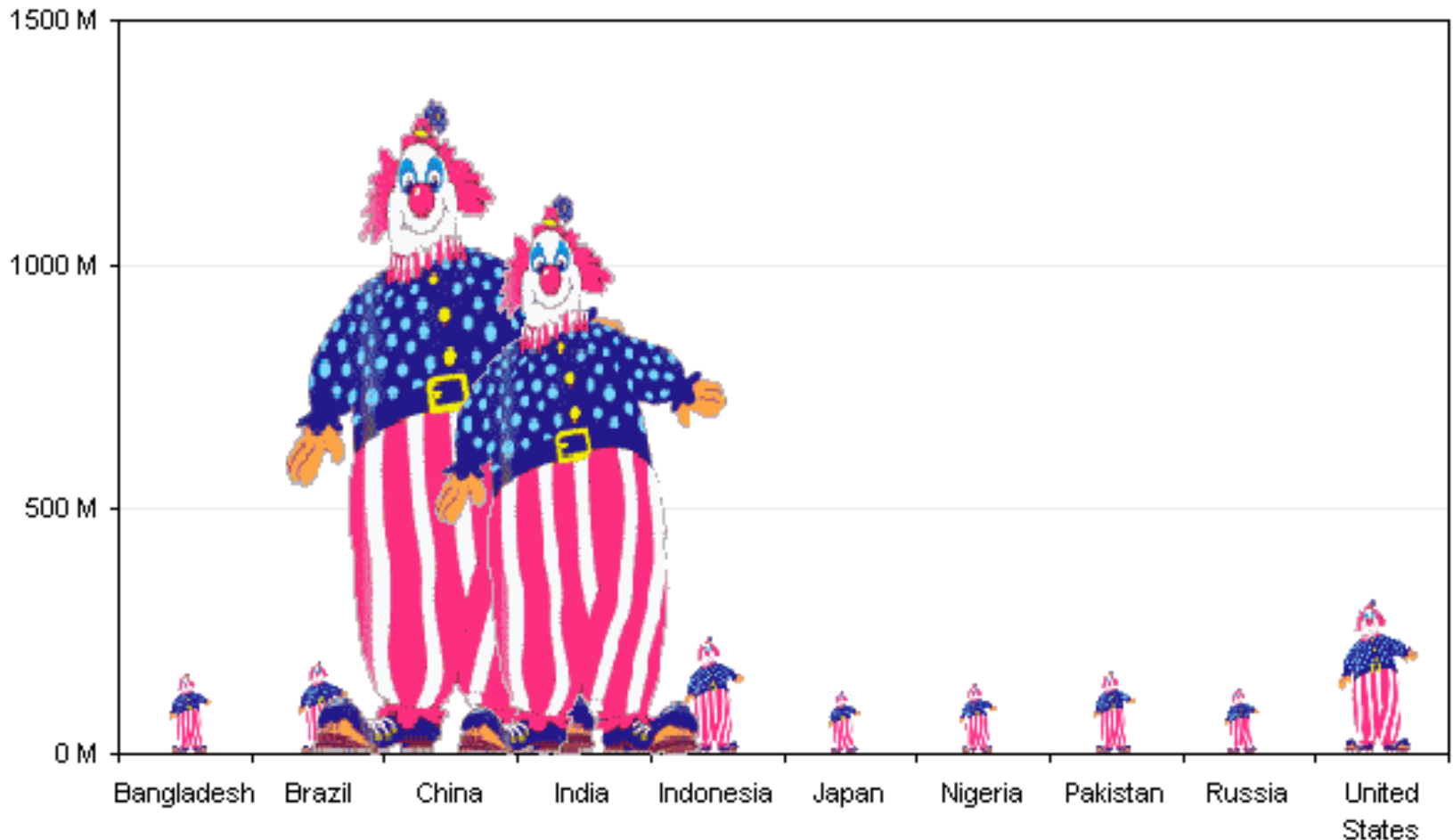


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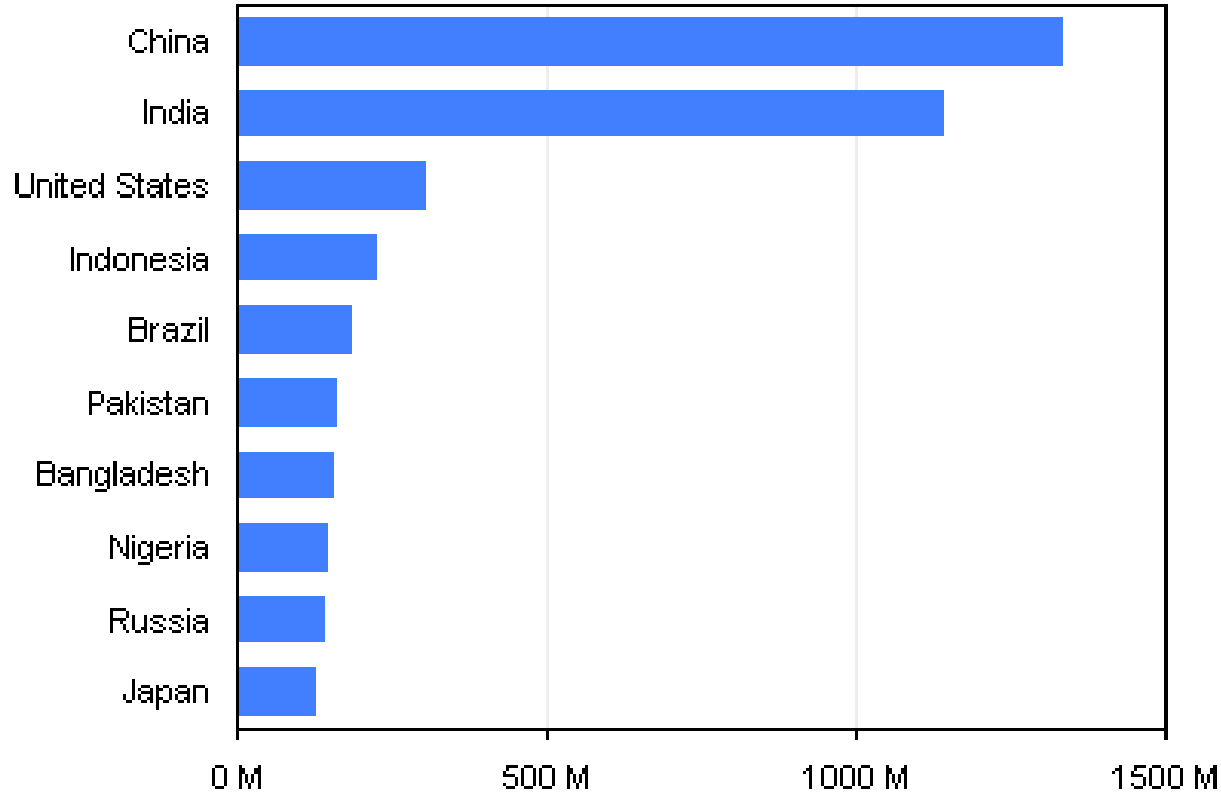
G. Reynolds, Presentation Zen

Bring in the Clowns...



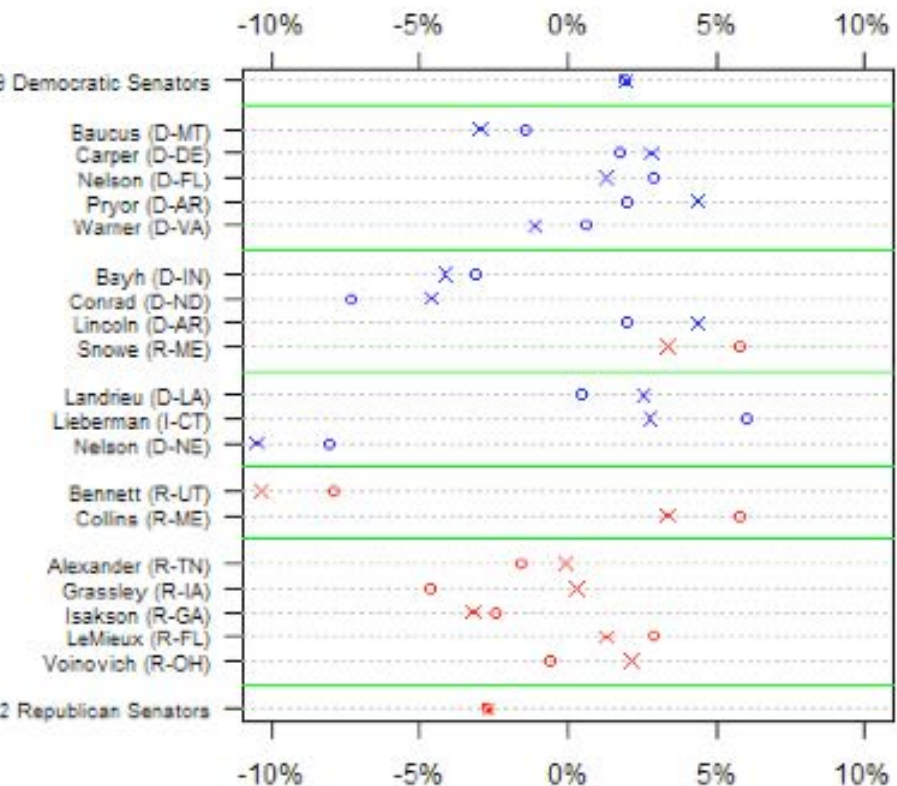
World Population in 2008

A better version...



World Population in 2008

Senators and State support for health care



o: 2000 avg. is 67%
 x: 2004 avg. is 73%

SENATORS AND STATE SUPPORT FOR HEALTH CARE



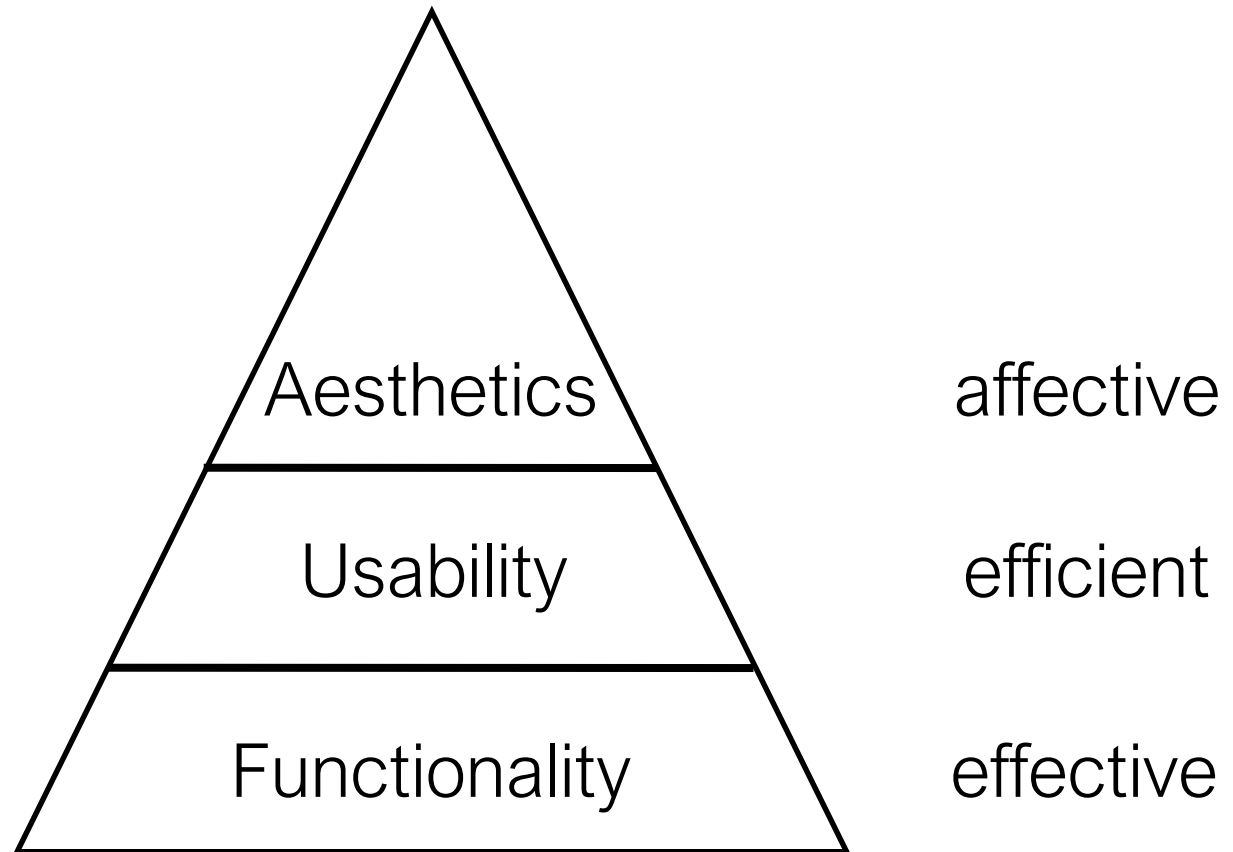
X = percentage of state voters who supported increased federal spending on health care in the 2004 Annenberg survey; percentages are relative to the national average.

Andrew Gelman, Nov. 2009

Tufte's Design Principles

- Above all else show the data
- Maximize data-ink ratio
- Erase non-data ink
- Erase redundant data ink
- Revise and edit

Design Pyramid



Subjective Dimensions

- Aesthetics: Attractive things are perceived as more useful than unattractive ones
- Style: Communicates brand, process, who the designer is
- Playfulness: Encourages experimentation and exploration
- Vividness: Can make a visualization more memorable

Design Elements

CRAP

Contrast
Repetition
Alignment
Proximity

Contrast

Peter's cake metaphor ties in nicely with Galls Law

A complex system that works is invariably found to have evolved from a simple system that worked. The inverse proposition also appears to be true: A complex system designed from scratch never works and cannot be made to work. You have to start over, beginning with a working simple system.

Before

After

Obesity among OECD nations

Percentage of population aged 15 and above with a BMI greater than 30 (2004)



Japan	3.2
Korea	3.2
Switzerland	7.7
Norway	8.3
Italy	9
Austria	9.1
Denmark	9.5
France	9.5
Sweden	9.8
Netherlands	10.9
Turkey	12
Iceland	12.4
Poland	12.5
Belgium	12.7
Portugal	12.8
Germany	12.9
Ireland	13
Spain	13.1
Finland	14
Czech Republic	14.8
Slovak Republic	15.4
Luxembourg	16.2
Hungary	16.8
New Zealand	20.9
Australia	21.7
Greece	21.9
Canada	22.4
United Kingdom	22
Mexico	24.2
United States	32.2



OECD Fatbook 2007

Obesity among OECD nations

Percentage of population aged 15 and above with a BMI greater than 30 (2004)

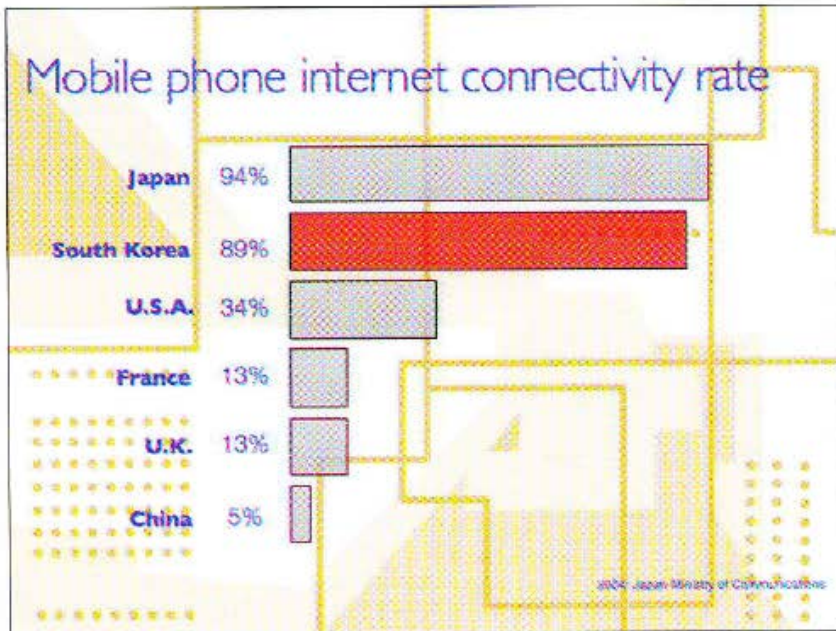
Japan	3.2
France	9.5
Sweden	9.8
Belgium	12.7
New Zealand	20.9
Australia	21.7
Greece	21.9
Canada	22.4
United Kingdom	23
Mexico	24.2
United States	32.2

10x

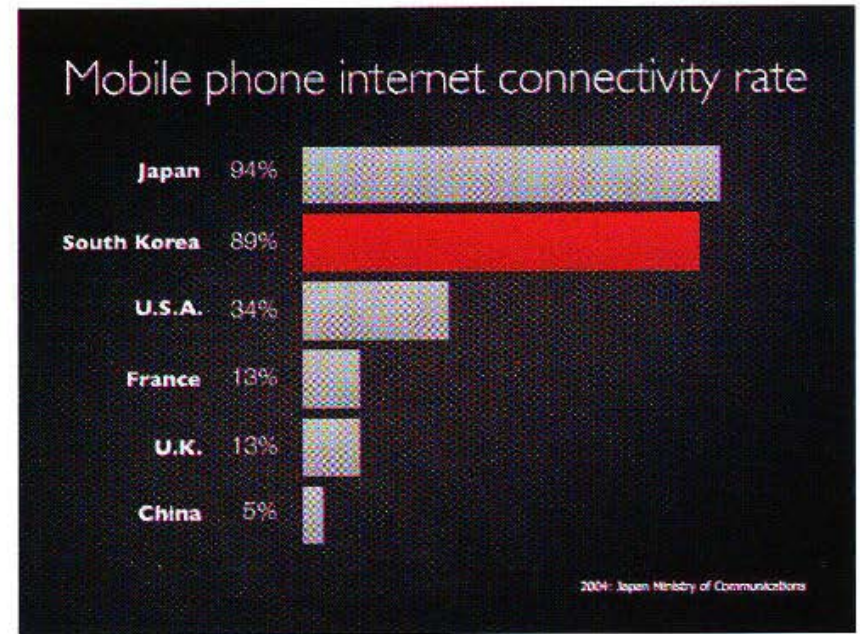
OECD Fatbook 2007

G. Reynolds, Presentation Zen

Before



After



G. Reynolds, Presentation Zen

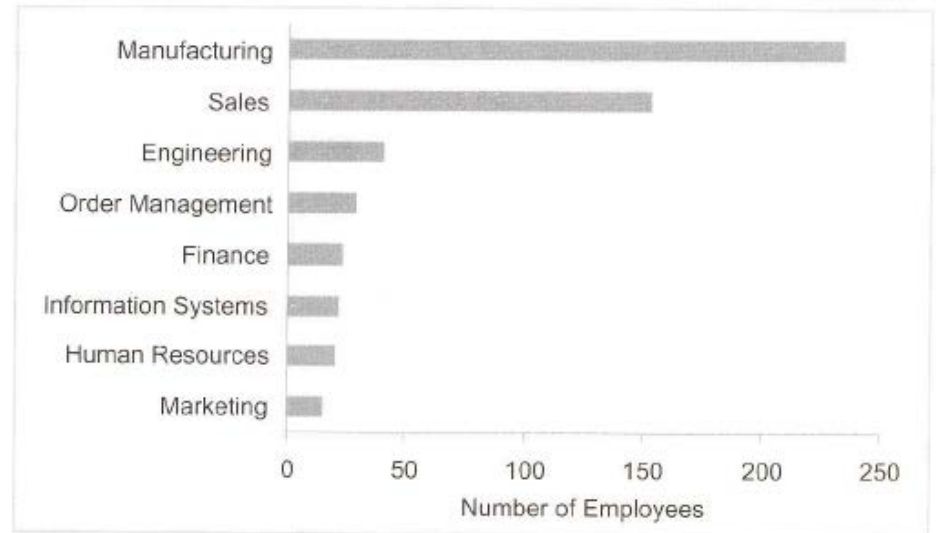
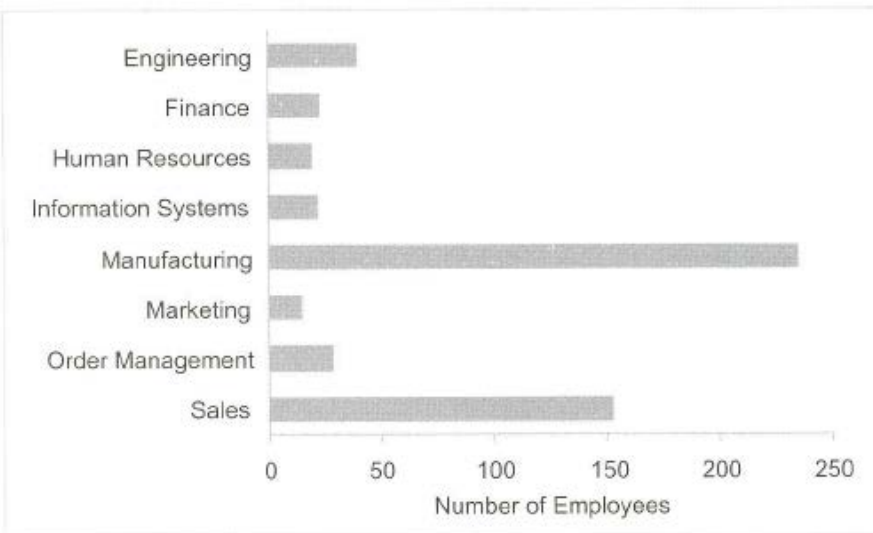
Repetition



Alignment

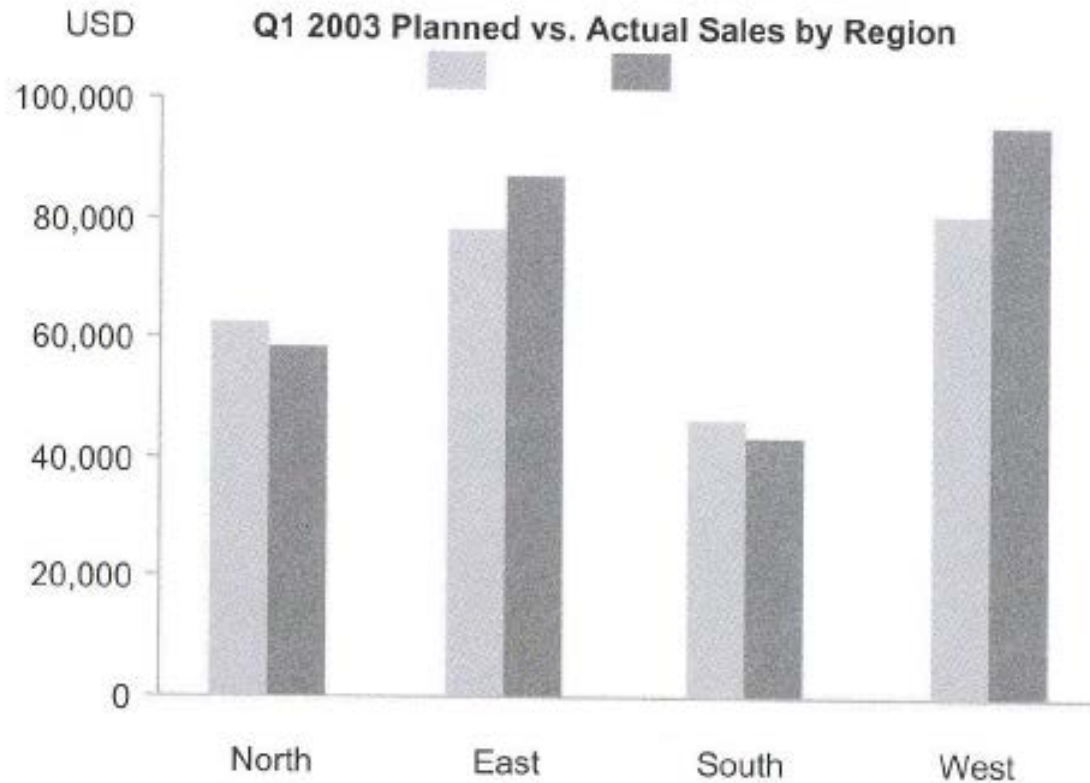
Before

After



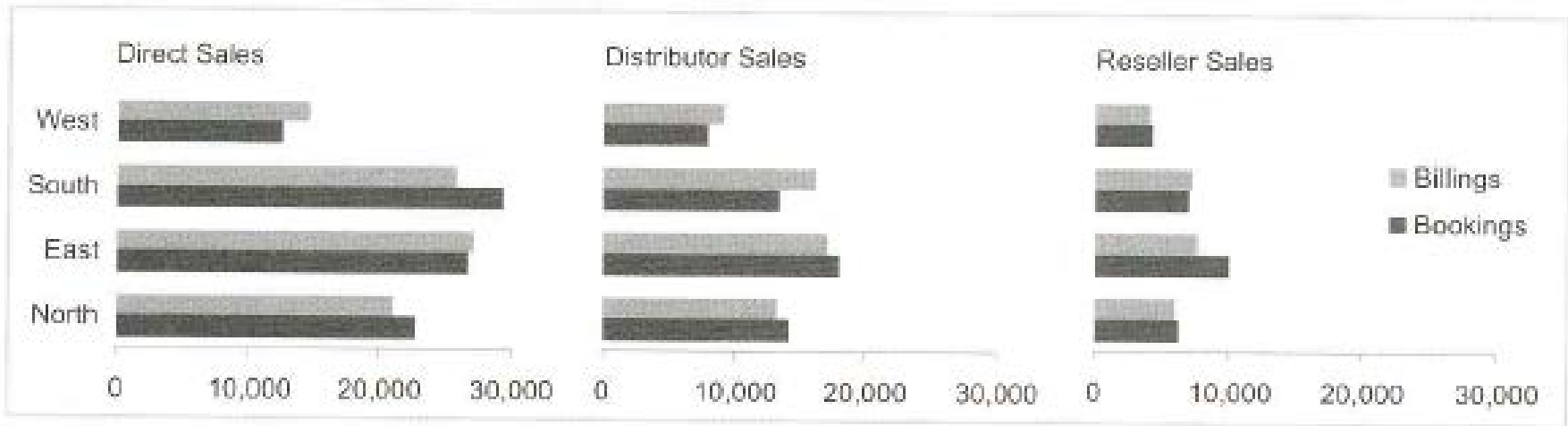
S. Few, Show me the numbers

Proximity



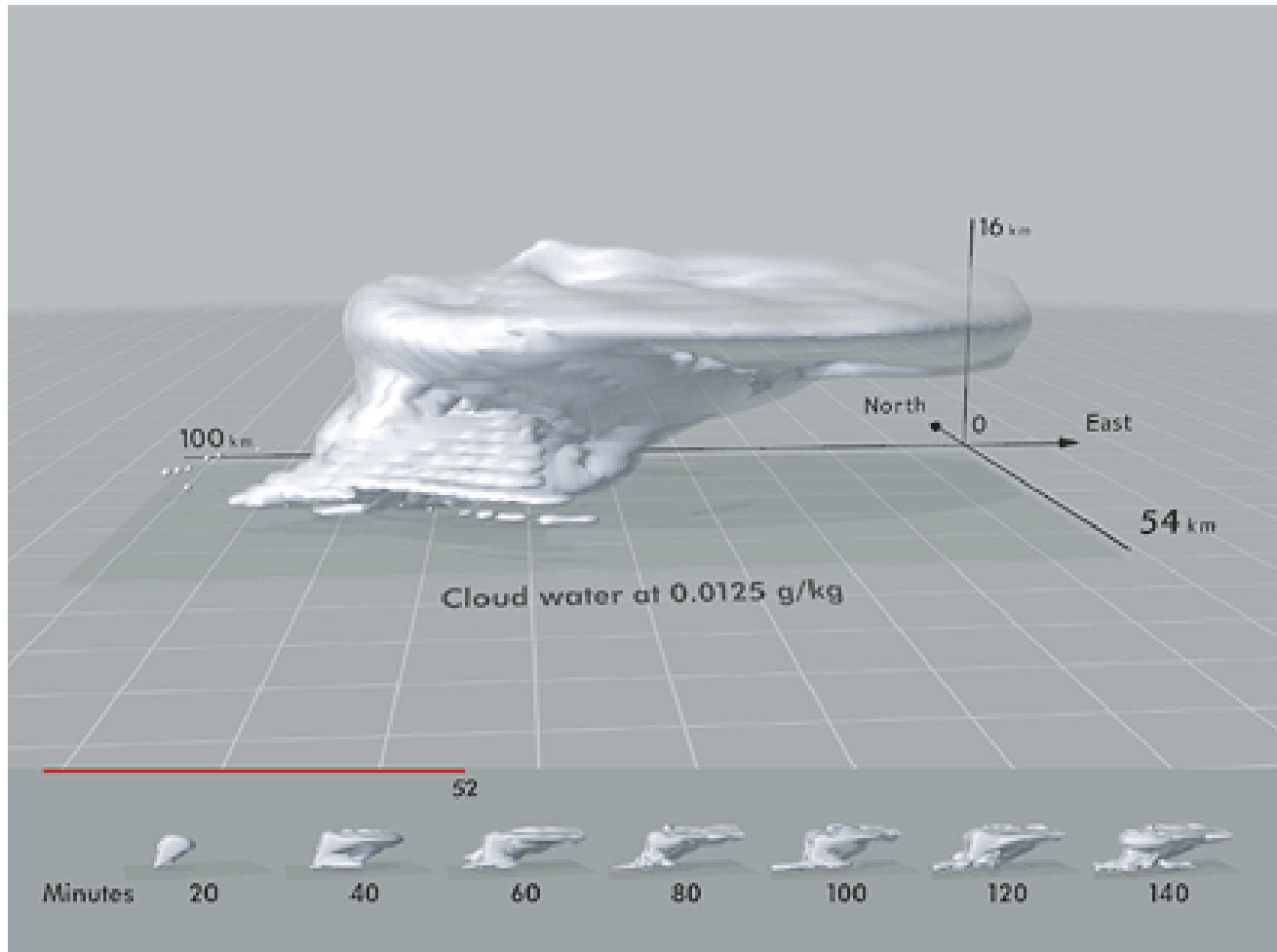
S. Few, Show me the numbers

Small Multiples

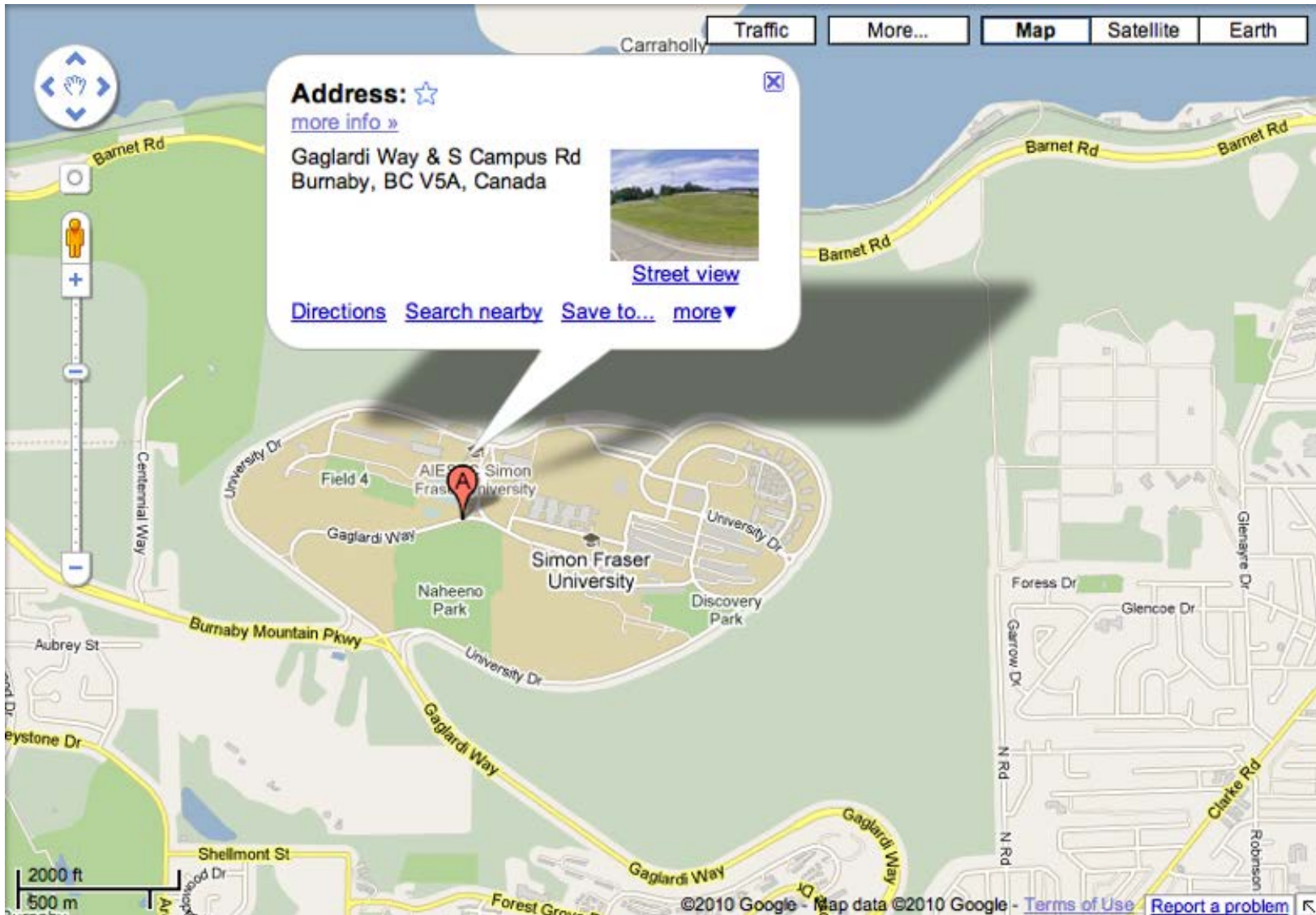


S. Few, Show me the numbers

Small Multiples



Layering and Separation



Layering and Separation

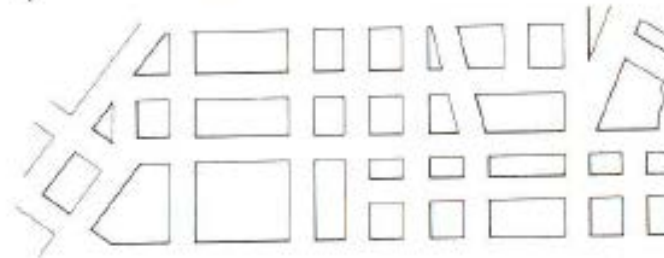
Train No.	3701	3301	3801	3542	3765
New York	12:10	1:30	3:45	7:30	4:33
Newark, N. J.	1:43	10:30	5:21	8:50	11:45
North Elizabeth	....	.....	.....	.....	6:45
Elizabeth	3:33	2:05	.....	.....	7:05
Peekskill	5:34	6:40	.....	7:20	8:50
Edlison, N. J.	4:45	5:20	4:40	2:10	11:05
Princeton, N. J.	1:30	....	.....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

Layering and Separation

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	.....	.....	.....	.....	6:45
Elizabeth	3:33	2:05	.....	.....	7:05
Peekskill	5:34	6:40	.....	7:20	8:50
Edlison, N. J.	4:45	5:20	4:40	2:10	11:05
Princeton, N. J.	1:30	.....	.....	3:30	7:30
Train No.	3701	3901	3801	3542	3765

Negative Space

CROSSWIND TAKEOFF
THE SLIP
CROSSWIND LANDINGS
SHORT FIELD TAKE OFF & LANDING
SOFT FIELD TAKE OFF & LANDING
FORCED LANDING
720 POWER TURNS

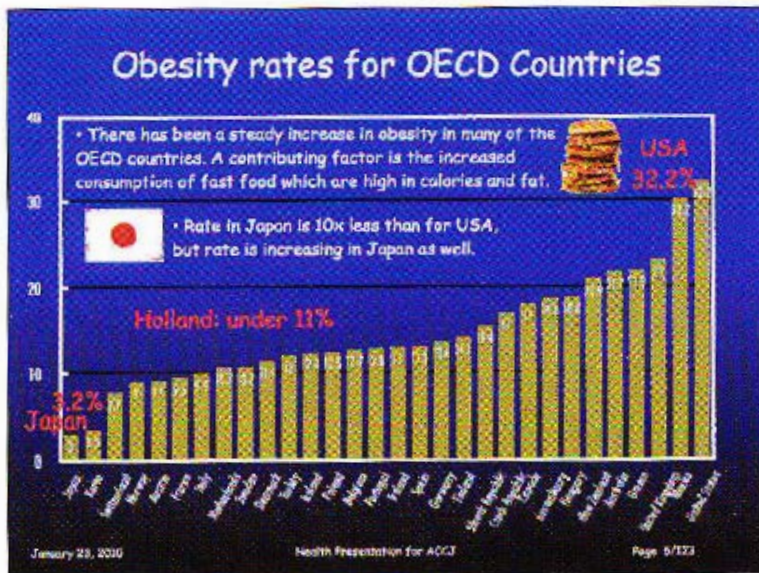


Negative Space

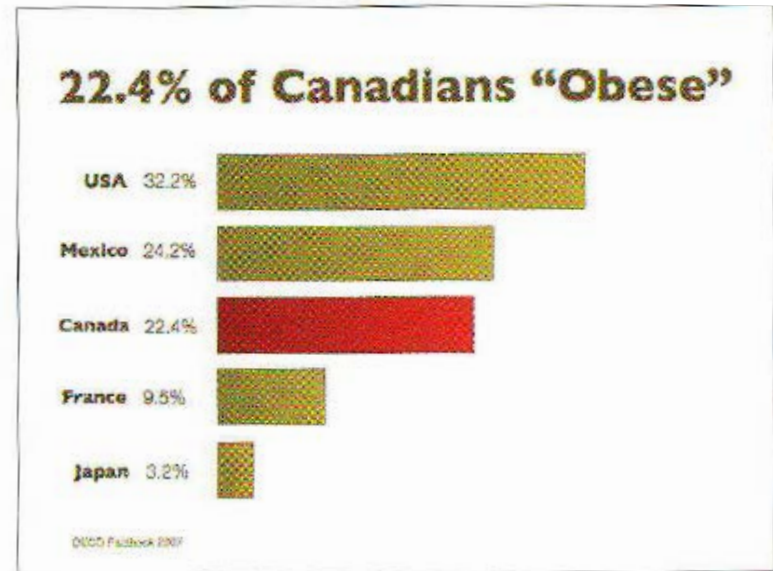


Negative Space Logos

Before



After



G. Reynolds, Presentation Zen

Tufte's Graphical Excellence

- Interesting data
 - Complex ideas, multivariate data
- Clear, precise, concise presentation
 - Data-ink ratio
- Accurate communication
 - Lie factor

Few is Applied Tufte

<i>Relationship</i>	<i>Value-Encoding Object</i>			
	<i>Points</i>	<i>Lines</i>	<i>Points & Lines</i>	<i>Bars</i>
<i>Nominal Comparison</i>	When there is a need to narrow the quantitative scale, and in so doing, remove zero from its base	Avoid	Avoid	Either horizontal or vertical bars
<i>Time Series</i>	Avoid	Categorical subdivisions on X axis, quantitative values on Y axis; emphasis on overall pattern	Categorical subdivisions on X axis, quantitative values on Y axis; mutual emphasis on overall pattern and individual values	Categorical subdivisions on X axis, quantitative values on Y axis; emphasis on individual values
<i>Ranking</i>	When there is a need to narrow the quantitative scale, and in so doing, remove zero from its base	Avoid	Avoid	Horizontal bars are preferable, with values sorted in descending order.
<i>Part-to-Whole</i>	Avoid	Avoid	Avoid	Either horizontal or vertical bars
<i>Deviation</i>	Avoid	Especially useful when combined with time series	Useful when combined with time series and when a slight emphasis on individual values is desired	Either horizontal or vertical bars, except when combined with time series, which requires vertical bars
<i>Distribution Single</i>	Avoid	Known as a <i>frequency polygon</i> ; emphasis on overall pattern	Avoid	Known as a <i>histogram</i> ; emphasis primarily on individual values
<i>Multiple</i>	Use to mark the median in a box plot	Avoid	Avoid	Use in the form of range bars in box plots
<i>Correlation</i>	Known as a <i>scatter plot</i>	Avoid	In this case the line is a trend line, not a line that connects the points.	Either horizontal or vertical bars; can be structured either as a <i>correlation bar graph</i> or a <i>paired bar graph</i>

Analysis Questions

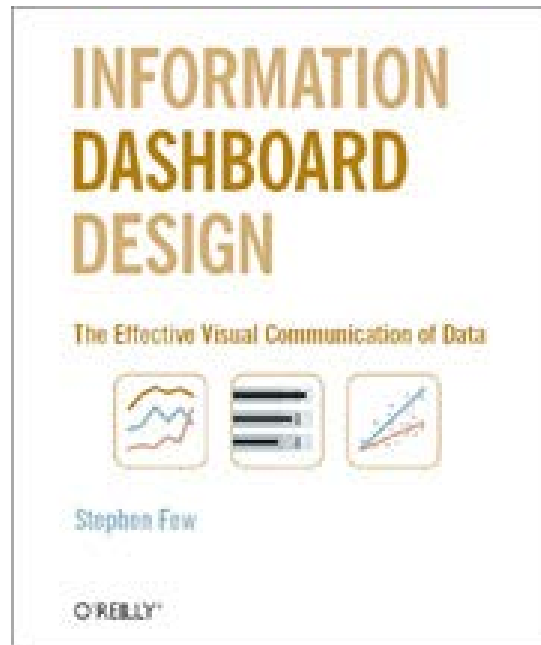
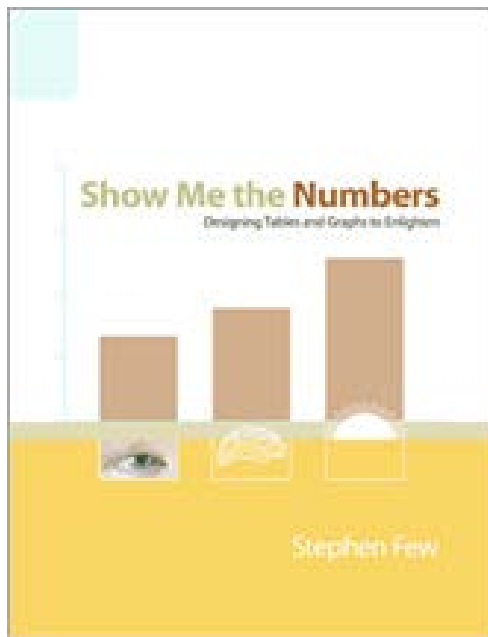
- Who is the intended audience?
- What information does this visualization represent?
- How many data dimensions does it encode?
- List several tasks, comparisons or evaluations it enables
- What principles of excellence best describe why it is good / bad?
- Can you suggest any improvements?
- Why do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

Graphical displays should...

- Show the data
- Induce the viewer to think about the substance, rather than about methodology, graphic design, [or] the technology of graphic productions...
- Avoid distorting what the data have to say
- Present many numbers in a small space
- Make large data sets coherent
- Encourage the eye to compare different pieces of data
- Reveal the data at several levels of detail
- Serve a reasonably clear purpose
- Be closely integrated with the statistical and verbal descriptions

Further Reading

Stephen Few



Robin Williams

