Designing Maps for Scientific Publication

10 Simple Rules for Making Better Maps and Figures

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2015 Summer Polar Boot Camp
University of Minnesota
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We'll answer these questions...

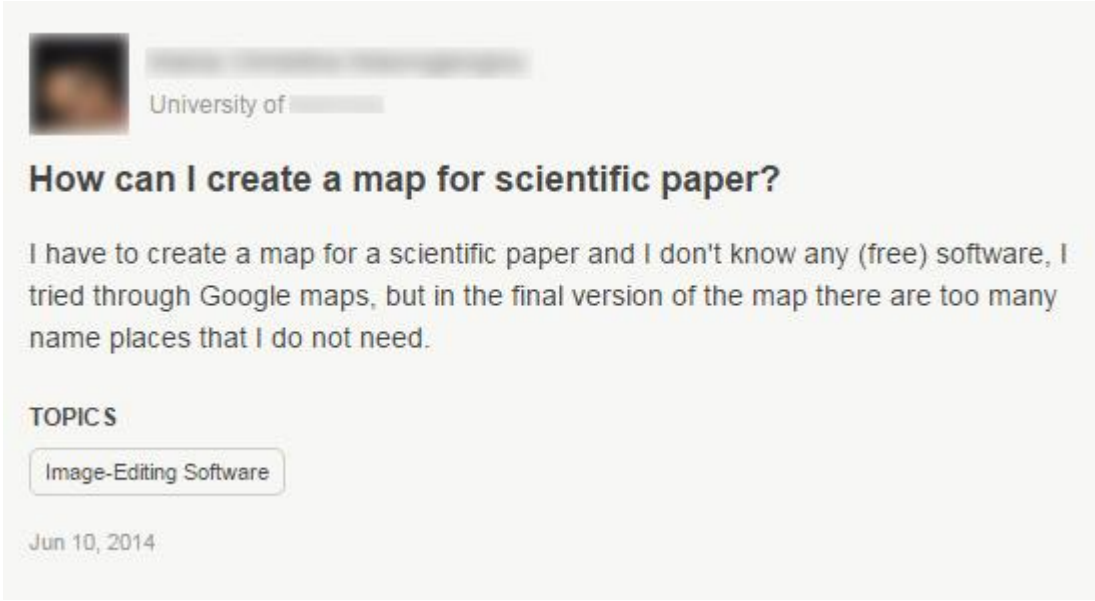
1. What does a good journal map look like? A bad one*?

2. I'm not a cartographer! Where do I begin to start making maps?

3. How can I apply these practices to other parts of a journal submission?

4. What are all these file formats that my journal is asking for?

Background.



University of

How can I create a map for scientific paper?

I have to create a map for a scientific paper and I don't know any (free) software, I tried through Google maps, but in the final version of the map there are too many name places that I do not need.

TOPICS

Image-Editing Software

Jun 10, 2014

Question posted on ResearchGate.net

Background.

There are way too many figures like this.

GIS analysis of landslide prone Hilly-Terrain roads: A case study of Aravalli Mountain, North-West, India

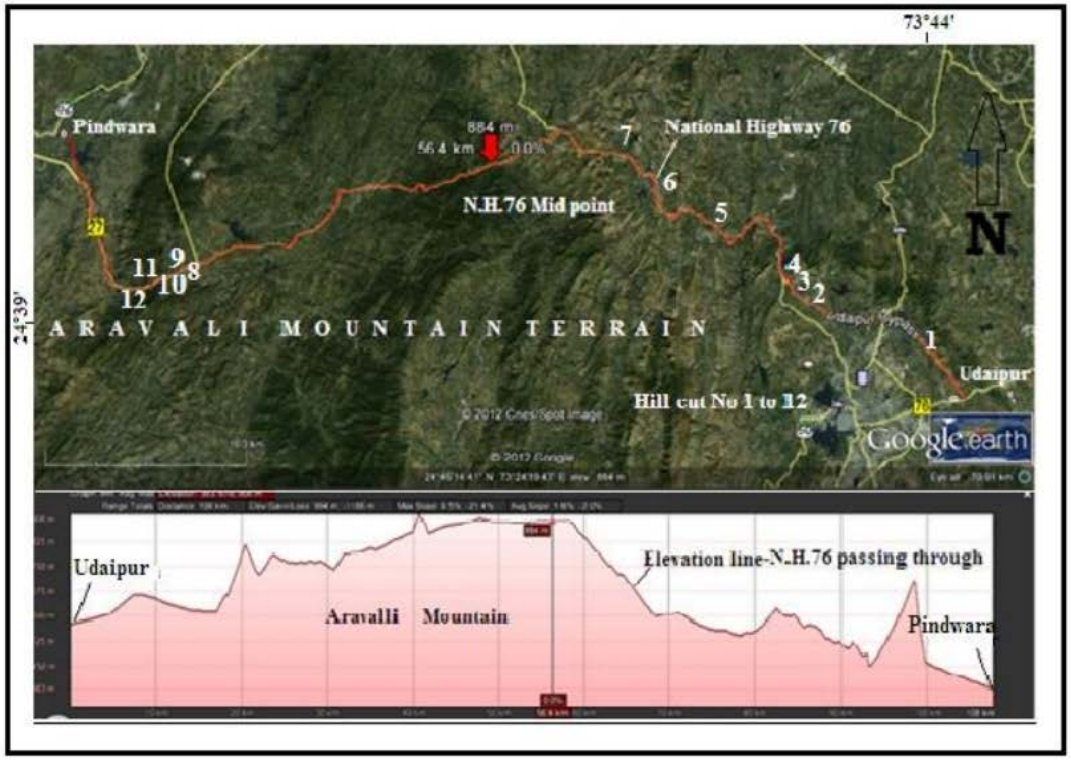


Figure 2: Showing irregular section line in image and profile of the road along Udaipur- Pindwara.

Image: International Journal of Advances in Remote Sensing and GIS (author's name withheld)

Background.

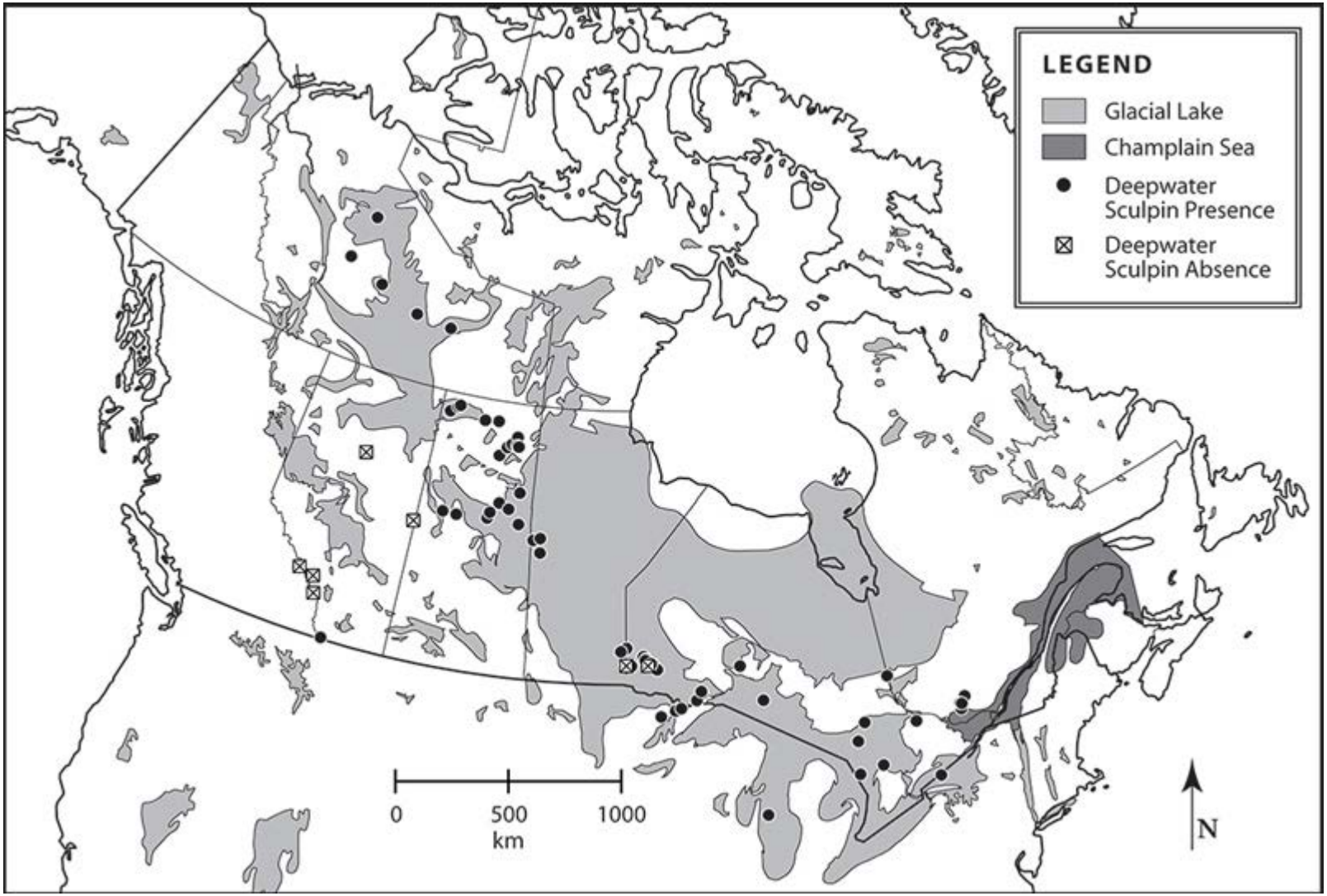


Image: Aqua Terra Maps

Background.

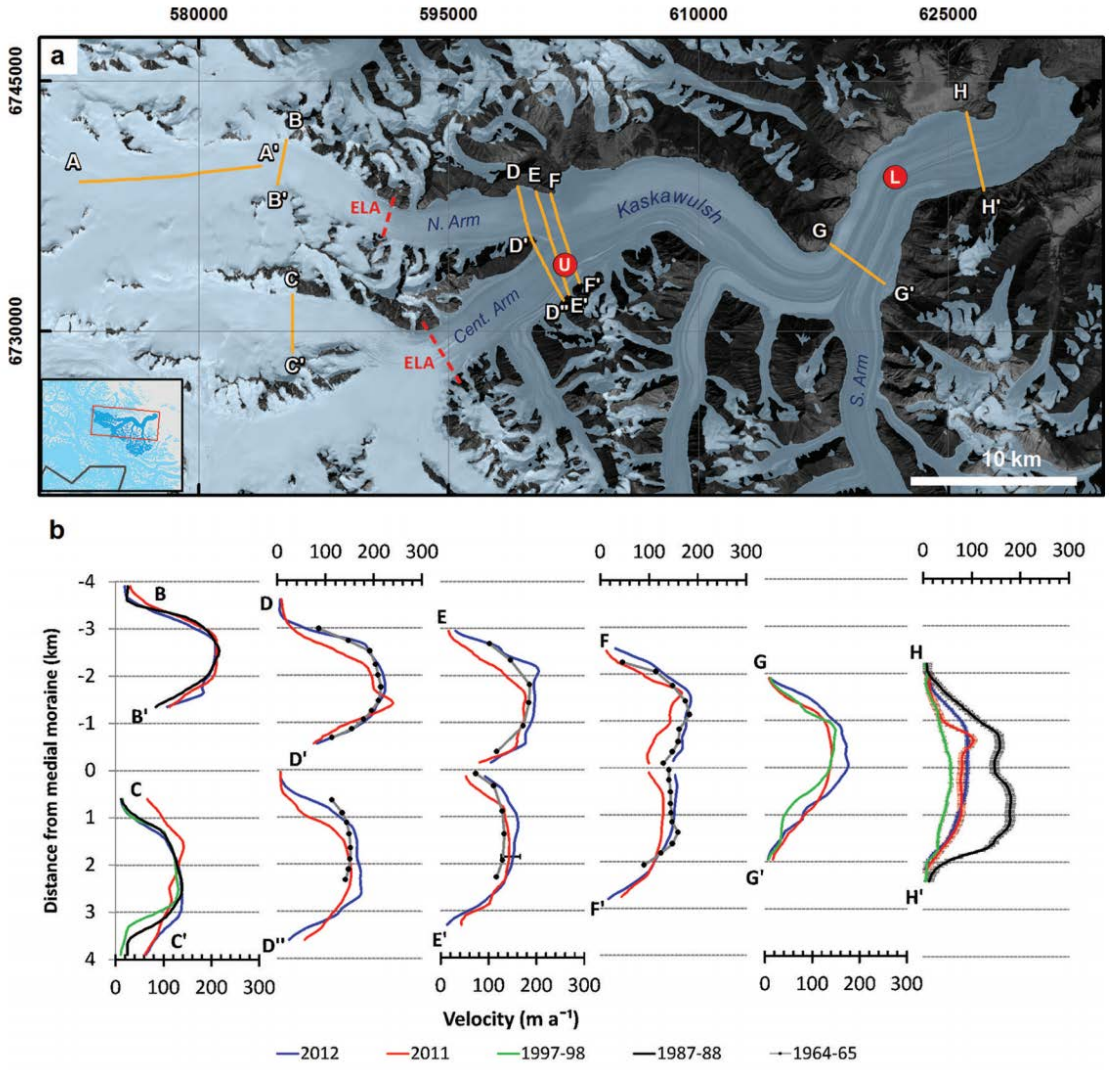


Image: Journal of Glaciology (author's name withheld)

10 Simple Rules for Better Maps & Figures

#1

Know Your Audience.

Adapted from Rougier et al (2014)

#1 Know Your Audience.

What assumptions are allowed?

- Know Your Journal
  - Discipline specific
  - Geography specific
  - Level of expertise
  - These are important
- Know Your Data
  - Location-based (discrete location on the Earth)
  - Sample sites, transects, and/or gridded models
  - Spatial context, scale, and dimensionality
- Know Your Purpose
  - Simple
  - Complex
  - Purpose yields content

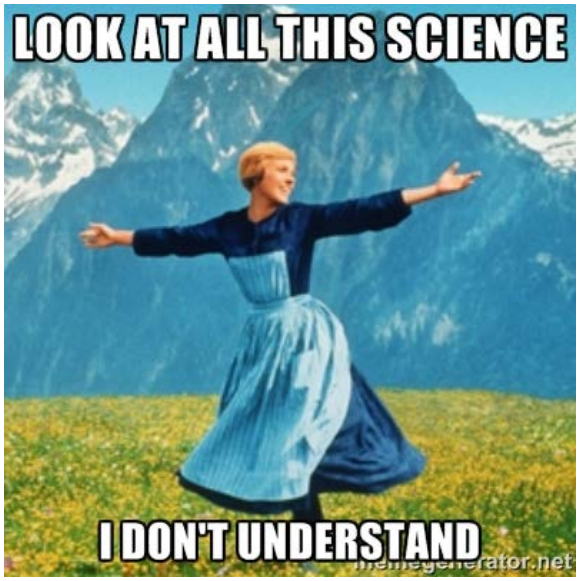


Image: memegenerator.net

#1 Know Your Audience.

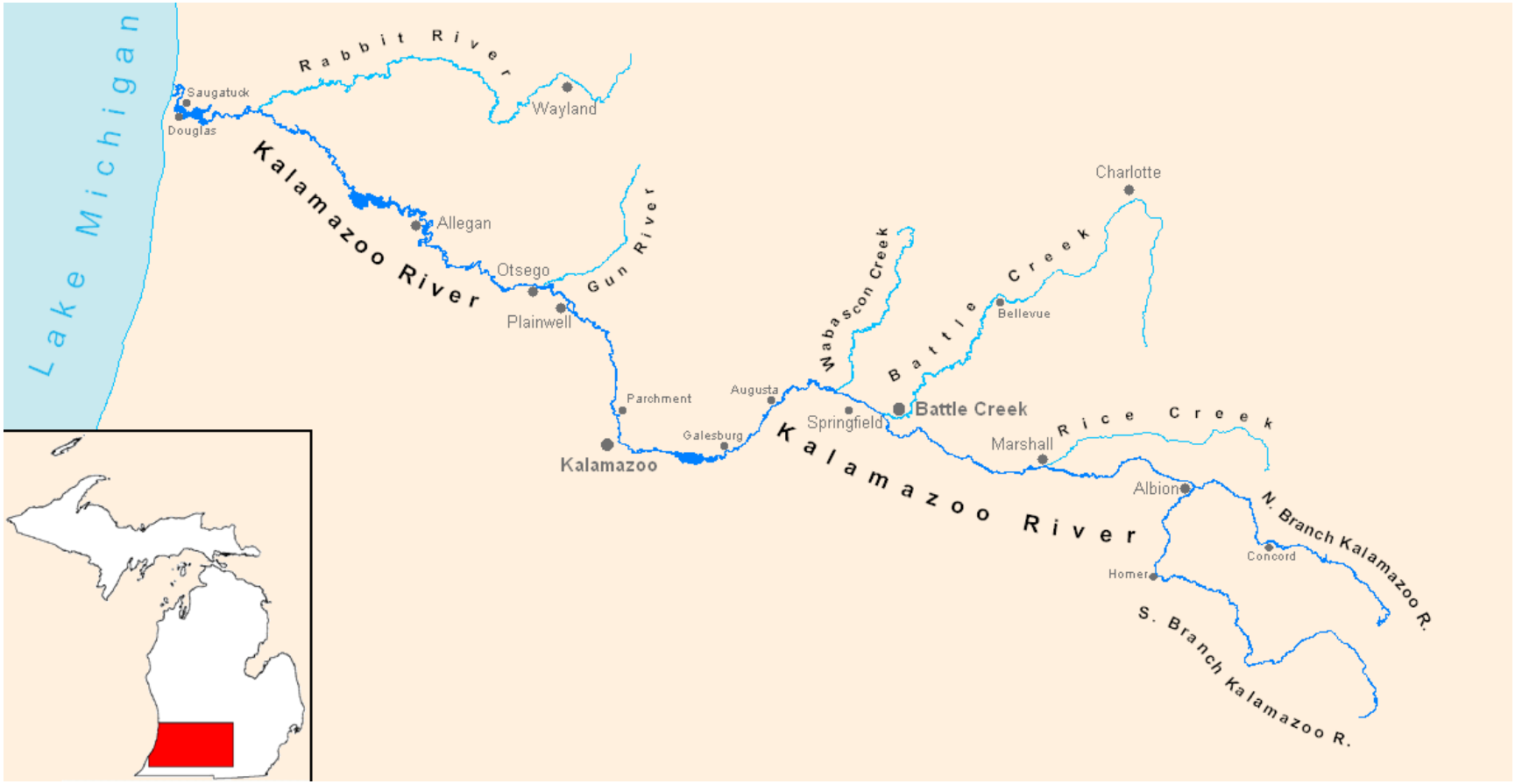


Image: Daniel Huffman, Cartastrophe

#2

Identify Your Message.

Adapted from Rougier et al (2014)

#2 Identify Your Message.

Typical maps to include in publications.

- ### Overview of the geographic area for the study
  - Introduce and familiarize the readers to your location - in context
  - Be simple!

- ### Study site detail
  - Larger-scale map showing discrete locations (e.g. sample sites, transects, etc.)
  - Symbology and labeling are the most important

- ### Data map
  - Depict the results of analysis in a geographic context
  - Can be combined with other data elements (e.g. cross section, images, etc.)

#2 Identify Your Message.

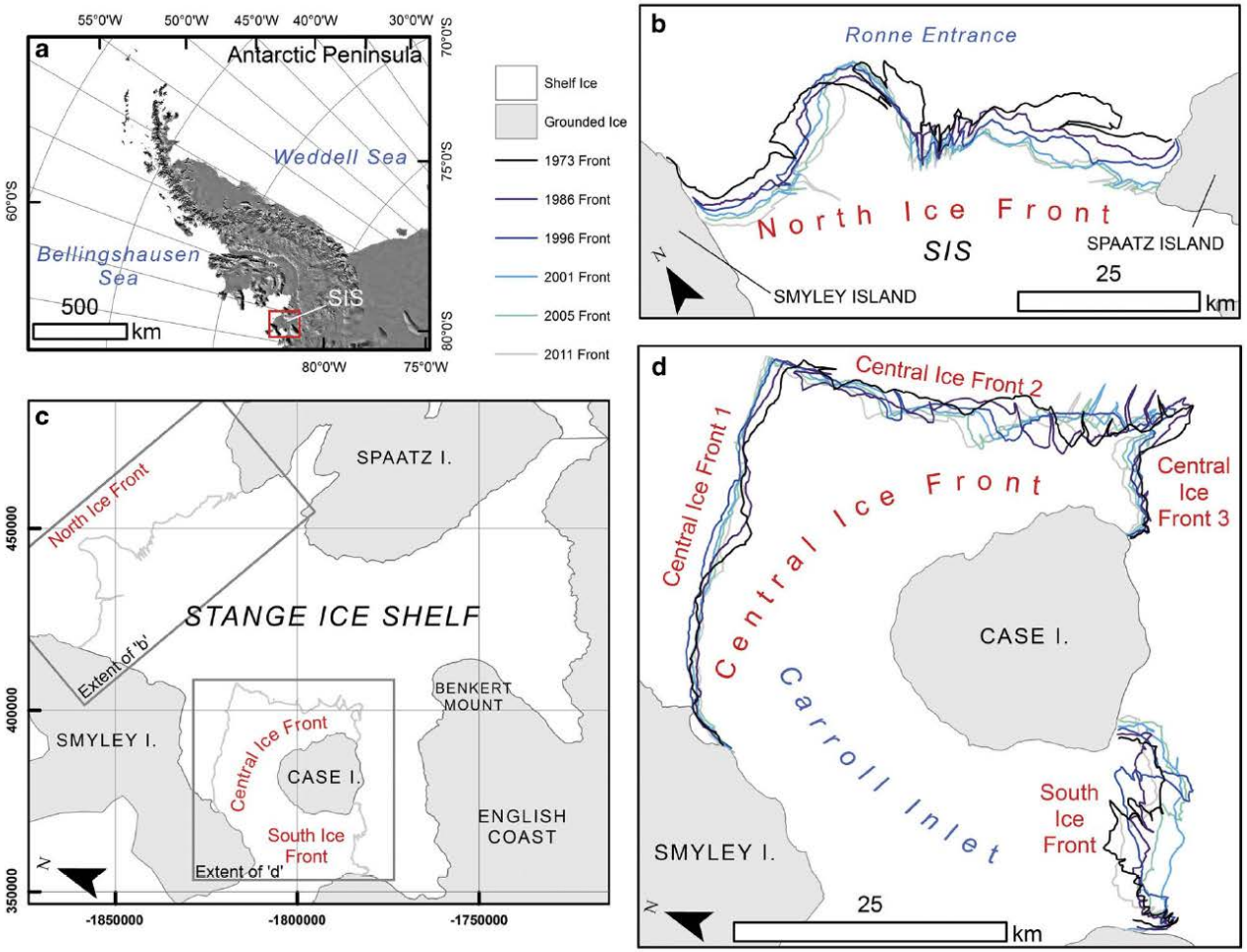


Fig. 1a. Location of Stange Ice Shelf on the Antarctic Peninsula. **c.** Overview of Stange Ice Shelf from 1973–2011. **b.** & **d.** Changes at the north, central and south ice fronts.

Image: Antarctic Science (author's name withheld)

#2 Identify Your Message.

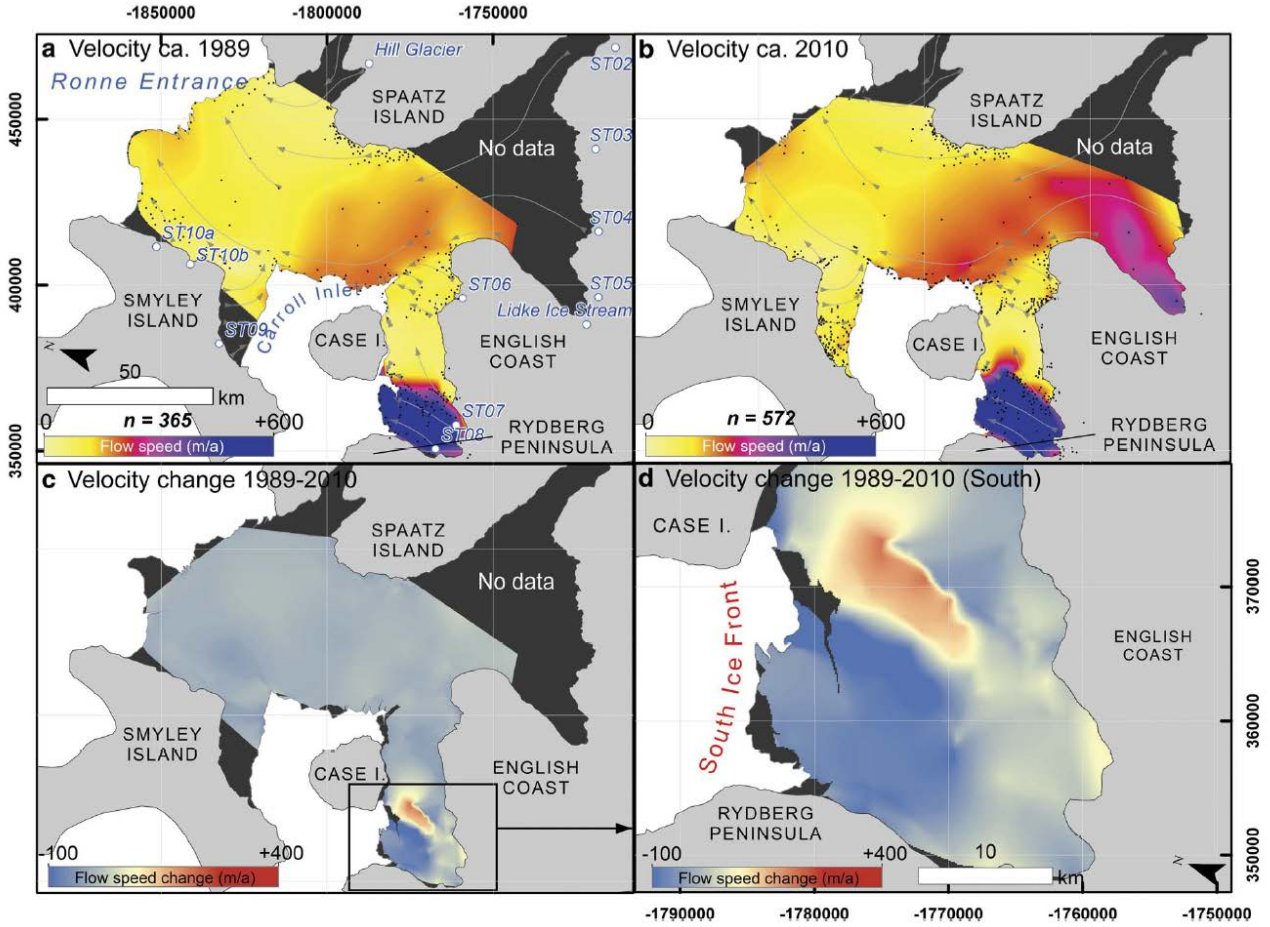


Fig. 3. Stange Ice Shelf flow velocities derived from manual feature tracking for **a.** *c.* 1989 and **b.** *c.* 2010. Grey arrows indicate flow direction, black dots are the points from which velocities have been interpolated (number of points used a. $n = 365$, b. $n = 572$). **c.** Overall velocity change. **d.** Area of the greatest velocity change near the south ice front.

Image: Antarctic Science (author's name withheld)

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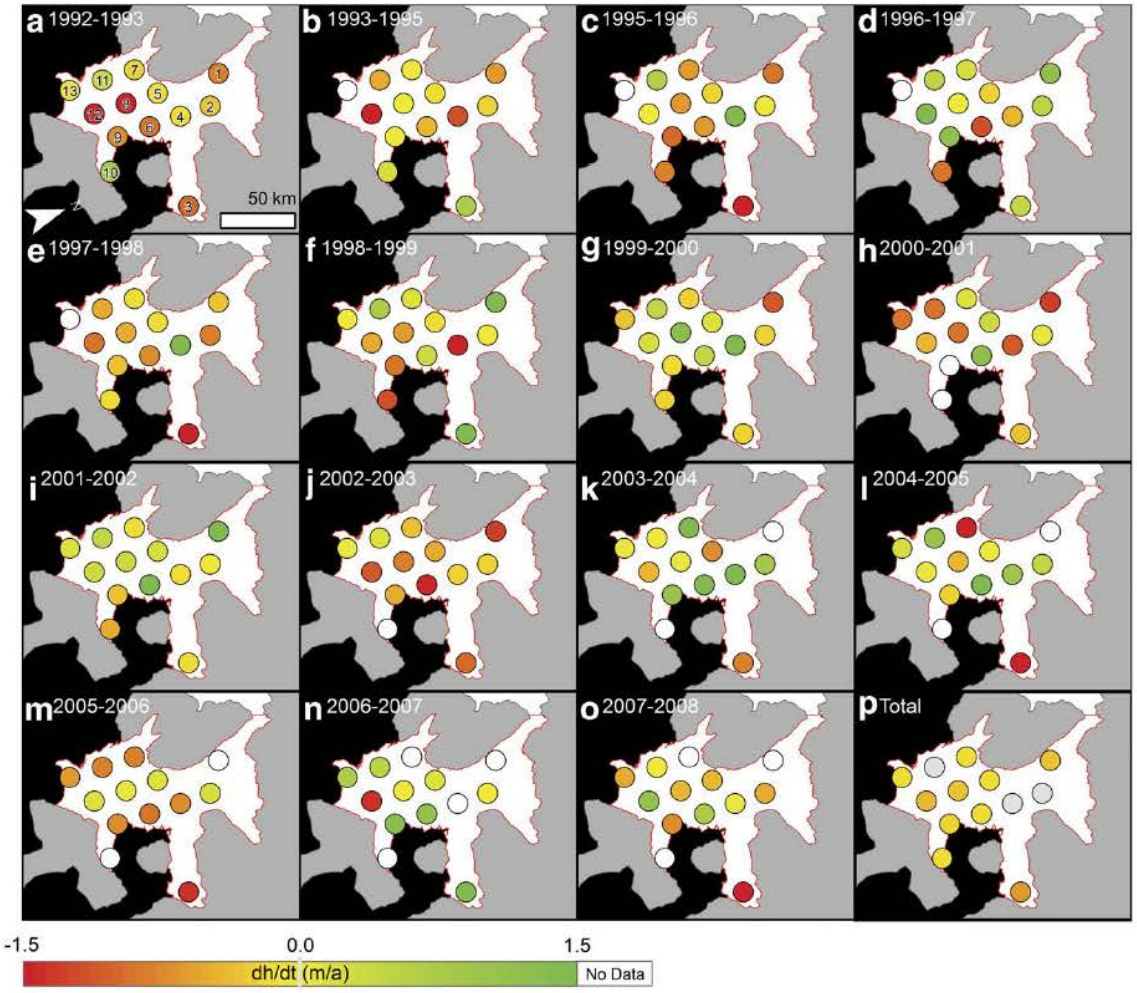


Fig. 5a–o. Annual surface elevation change (dh/dt) measurements for the 13 ERS/Envisat RA crossovers on SIS between 1992 and 2008. Crossover labels are given in a. **p.** Total ice surface elevation change, displayed in metres per annum, for each crossover for the full observation period. See also Fig. 6 and Table III.

Image: Antarctic Science (author's name withheld)

#3

Adapt To The Medium.

Adapted from Rougier et al (2014)

#3 Adapt To The Medium.

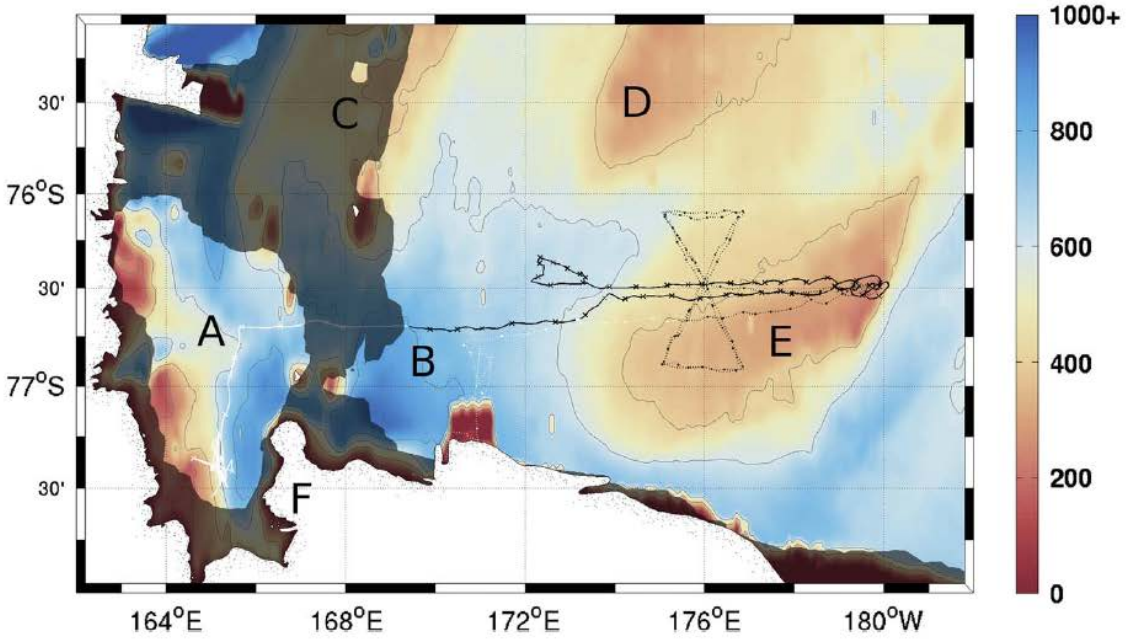


Fig. 1. Seaglider survey locations. Crosses on the solid line show every tenth dive by SG502, circles on the dotted line show every tenth dive by SG503. Dark shading corresponds to the 50% ice cover contour on the day SG502 crossed beneath the ice bridge (14 December 2010) and entered the Ross polynya. Contours correspond to bathymetry in metres (GEBCO 2010). Contours are located at 200 m intervals through 1000 m. **a.** McMurdo Sound, **b.** Central Basin, **c.** Crary Bank, **d.** Pennell Bank, **e.** Ross Bank, **f.** Ross Island.

Image: Antarctic Science (author's name withheld)

#3 Adapt To The Medium.

Most important difference between conventional maps and publication maps.

- You are designing for a very small space
  - Typically ¼ (single-column), ½ (double-column), or full-page
- You are designing for electronic and print
  - Some things “scale,” other things don’t
  - Anticipate the reproducibility for best design
- Your journal has rules to follow
  - Size, colors, fonts, line weights, file formats …

Image: memegenerator.net

#3 Adapt To The Medium.

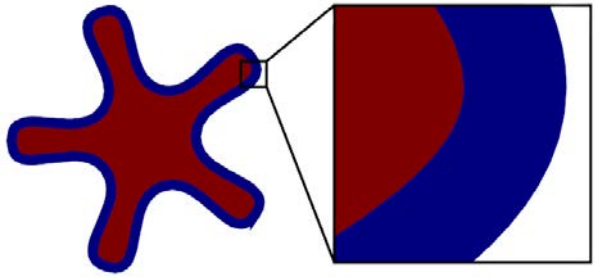
Designing for small spaces.

- Know your size and stick with it
- Preview it (print) at actual size
- Design techniques to achieve this
  - Small Multiples
  - Combination maps and layers
  - Simplify linework
  - Do not be redundant (scale bars, etc.)
  - No extras (see #8)

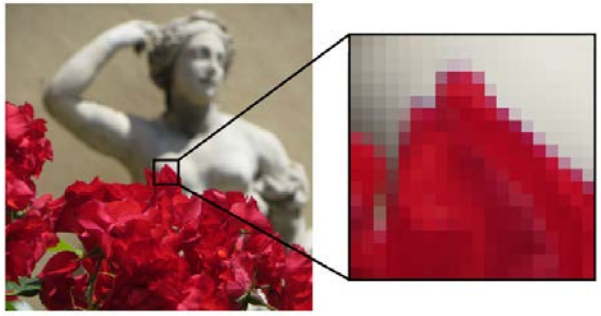
#3 Adapt To The Medium.

Designing for electronic and print.

- ### Vector file formats
  - Scalable and resolution independent
  - Represented by simple geometries: points, lines, polygons, text
  - Line widths & lettering expressed in points (1 pt = 1/72 inch)
  - Example formats:
    - Encapsulated PostScript (EPS)
    - Portable Document Format (PDF)
    - Adobe Illustrator artwork (AI)
    - Scalable Vector Graphics (SVG)



- ### Raster file formats
  - Does not scale
  - Represented by pixels
  - Dots Per Inch (DPI): measure of dot density that can be placed in a row of 1-inch length
  - Example formats:
    - Joint Photographic Experts Group (JPEG)
    - Tagged Image File Format (TIFF)
    - Portable Network Graphics (PNG)
    - Bitmap Image File (BMP)



Images: Benjamin Nanes

#4

Captions Are Not Optional.

Figure 4.1. This is the title slide for the section on captions. Although it may seem obvious to some users, the caption is the source for further explanatory information. The font shown in the title above, Roboto Condensed, was created by the lead visual designer for Android at Google, Inc.

Adapted from Rougier et al (2014)

#4 Captions Are Not Optional.

Map elements to consider for journal maps.

Scale Bar	**Yes**	*Use appropriate units and breaks*
North Arrow	**Yes**	*Small and simple*
Latitude/Longitude (Graticule) Lines	**Yes**	*Small*
Legend	**Yes**	*Small; Title is unnecessary*
Title	No	*Utilize the caption*
Explanatory Text	No	*Utilize the caption*
Inset/Locator Maps	**Yes**	*Two maps for the price of one*
Data Sources	No	*Utilize the caption*
Neatlines	No	*Expensive real estate*

#4 Captions Are Not Optional.

Scale Bar.

Do This…

Not This…

More

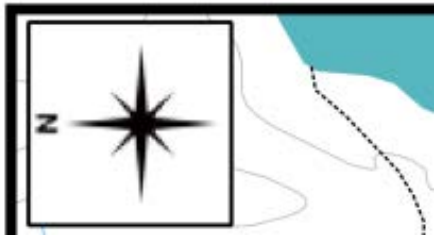
Digital images scale in size, do not use scale text (e.g. 1:100,000)
Use whole, round numbers
Do not dominate the page

#4 Captions Are Not Optional.

North Arrow.

Do This…

Not This…



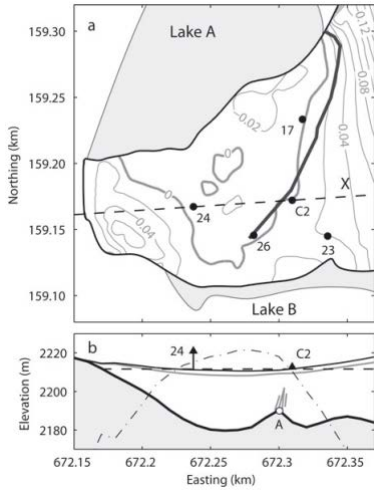
More

Small and subtle
Do not dominate the page
Utilize empty space on the map layout

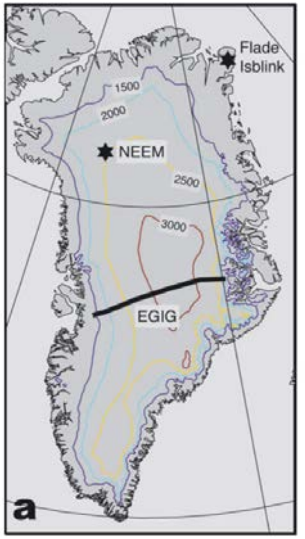
#4 Captions Are Not Optional.

Latitude/Longitude Lines.

Do This…



Not This…



More

Lines on the map are not always required

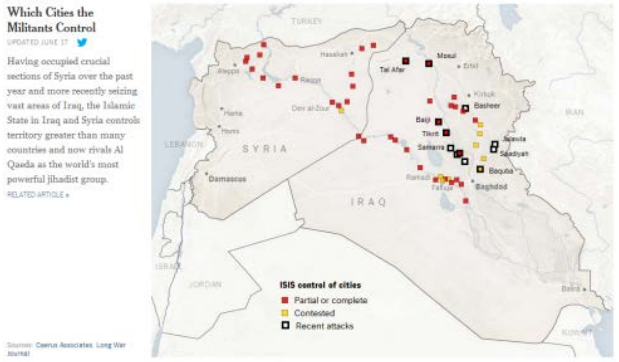
Some journals absolutely require depiction of latitude/longitude

Images: Journal of Glaciology (authors' names withheld)

#4 Captions Are Not Optional.

Map Legend.

Do This…



Not This…

More

Do not use a title, especially one called “Legend”
Layer legend items based on geographic type or logical groupings
Utilize empty space on the map layout

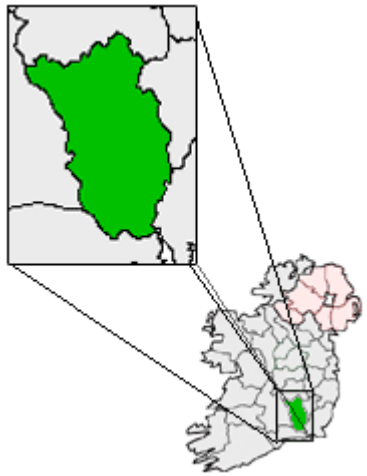
Images: New York Times, Associated Press

#4 Captions Are Not Optional.

Inset/Locator Maps.

Do This…

Not This…



More

Do not be afraid to extend to more than one figure

Geographic context? World, continental, regional, local

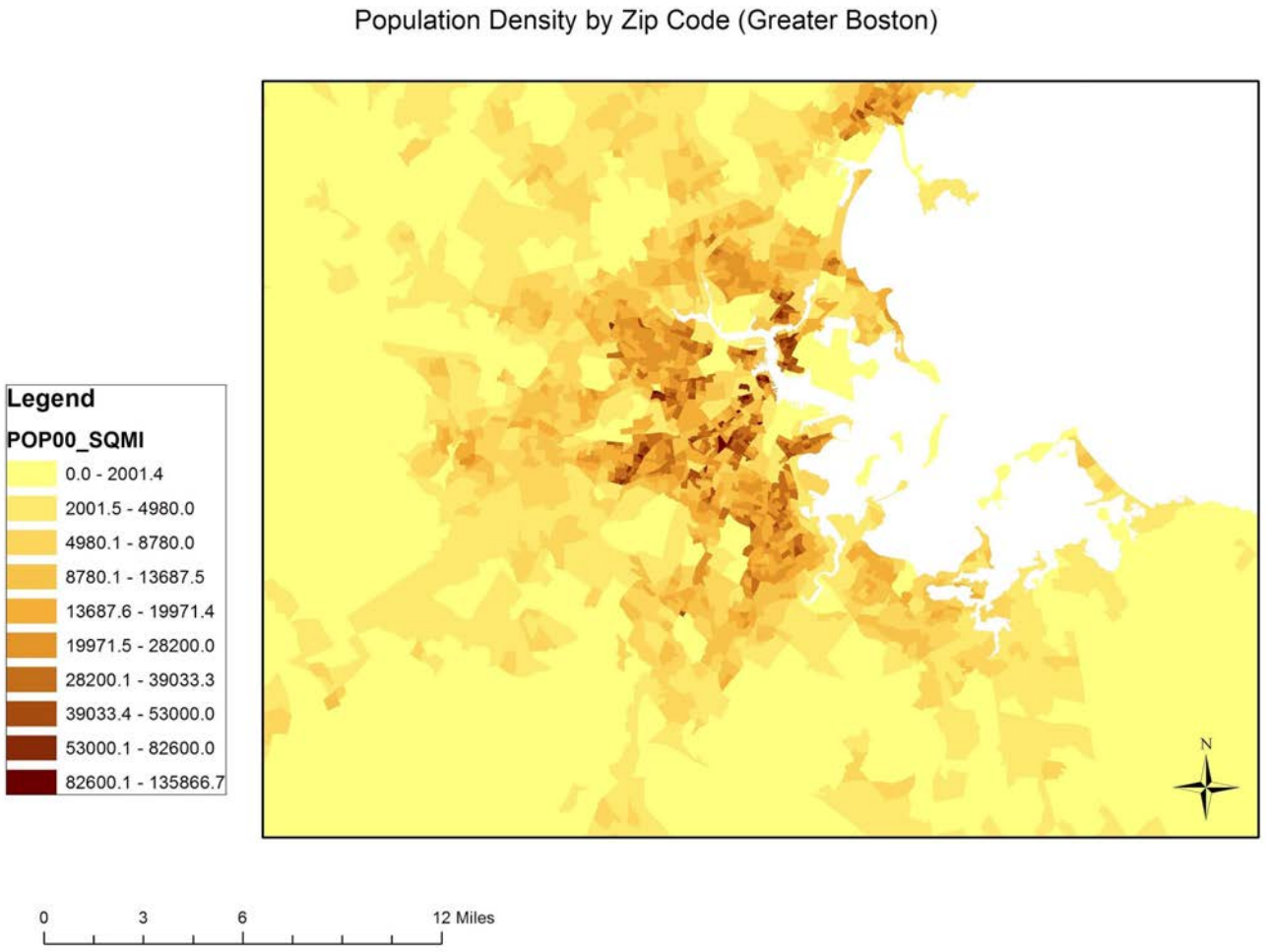
Images: National Geographic; Wikipedia

#5

Do Not Trust The Defaults.

Adapted from Rougier et al (2014)

#5 Do Not Trust The Defaults.



Data: Esri

#5 Do Not Trust The Defaults.

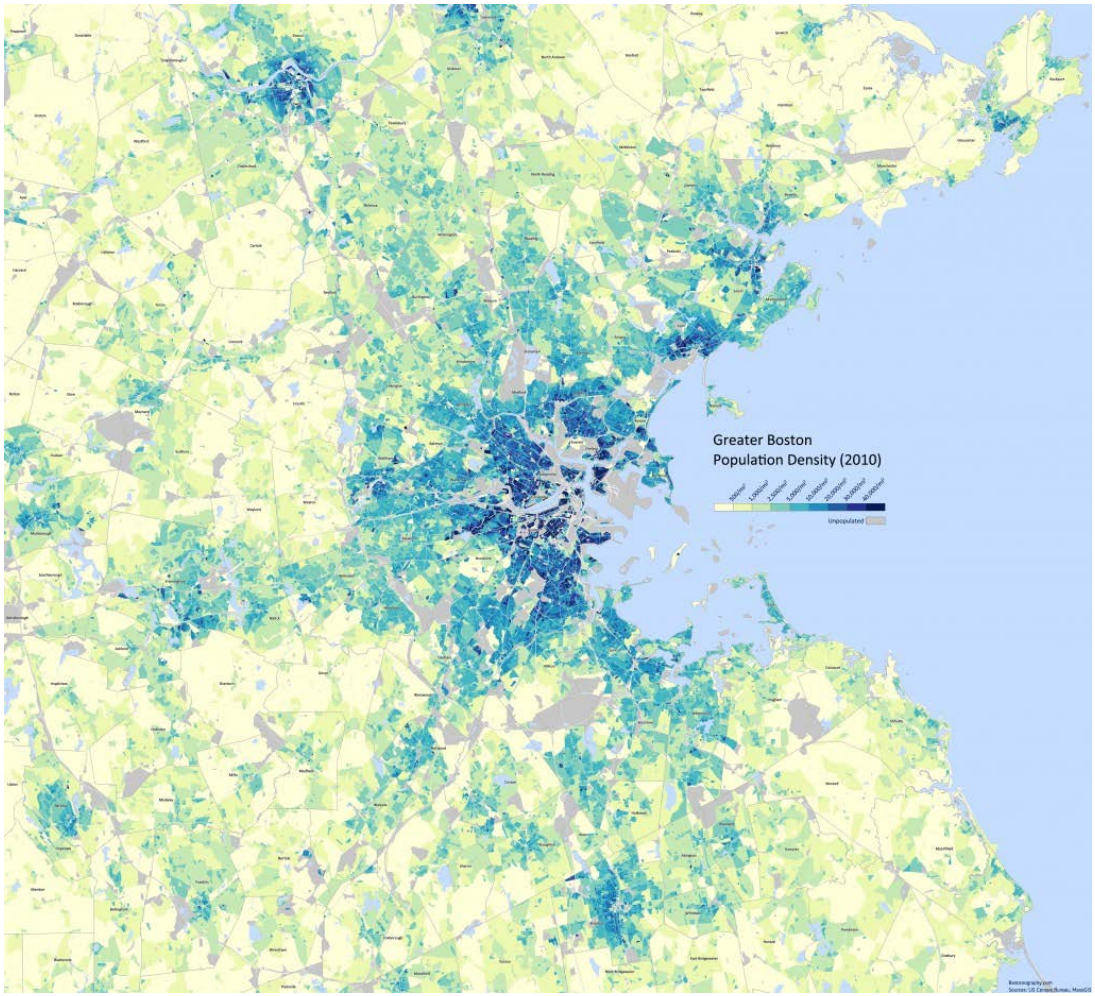


Image: Andy Woodruff, Bostonography

#5 Do Not Trust The Defaults.

Yes, this requires additional effort.

No, you do not need to be a graphic designer.

- At a minimum:
  - Select an appropriate font that your journal accepts and use it as a design element
  - Sketch your design ahead of time, then mimic it (I bet you didn't draw a 3 pt dashed border!)
  - Make a conscious choice
  - Think about how readers will interpret those choices
  - Be consistent
  -

#6

Use Color Effectively.

Adapted from Rougier et al (2014)

#6 Use Color Effectively.

A quick introduction to color theory & color spaces.

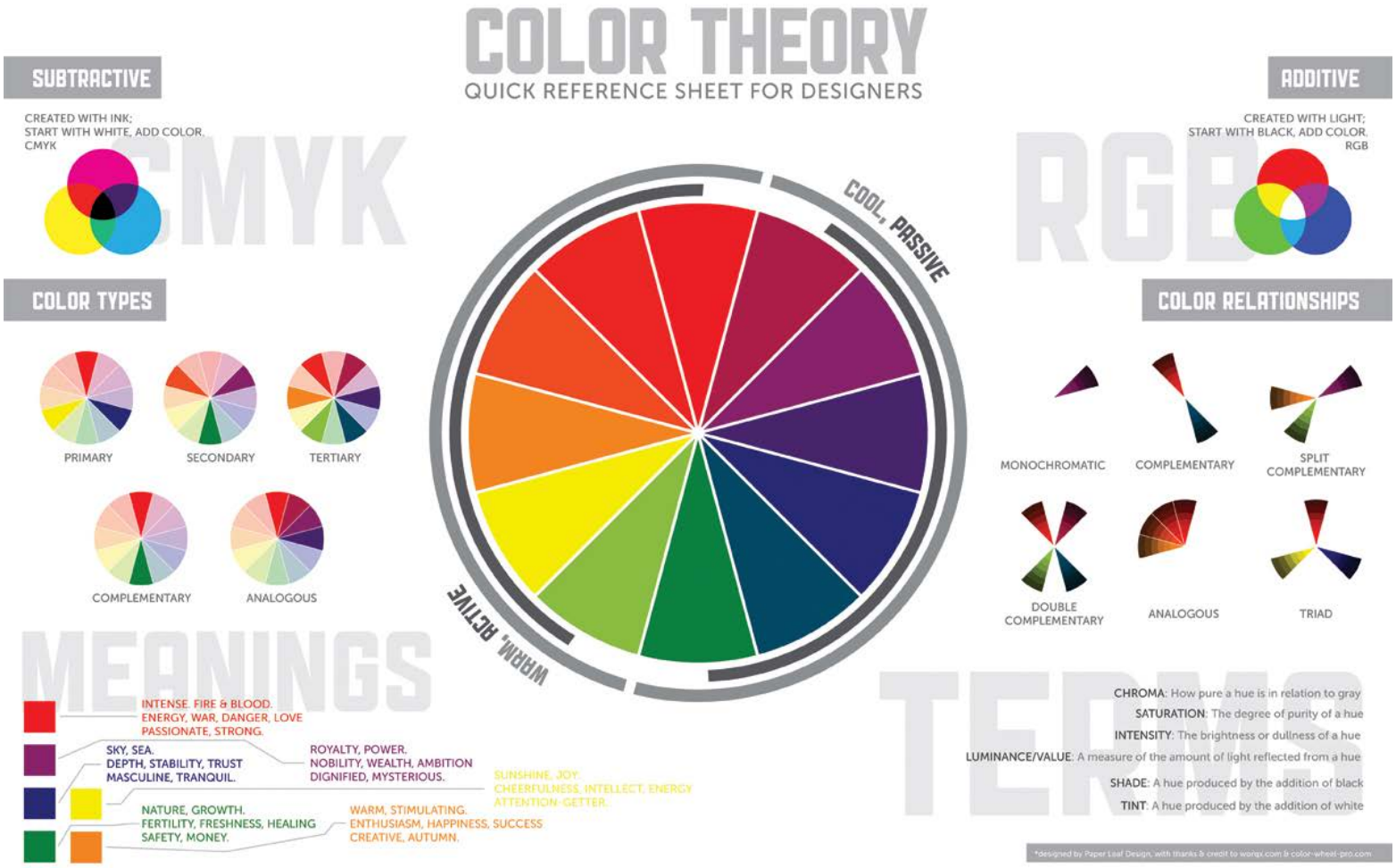


Image: Proper Leaf Design

#6 Use Color Effectively.

Basic Terminology.

Hue
Attribute of a color by its definition dependent on the dominant wavelength (e.g. red, green, orange)

Saturation/Intensity
Degree of purity/intensity of a specific color relative to neutral gray

Lightness/Brightness/Value
Value along the white/black (light/dark) scale

Tint
Add white to a pure hue

Tone
Add gray to a pure hue

Shade
Add black to a pure hue

Complementary Colors
Pairs of colors that when combined cancel each other out (produce a grayscale color) and when placed next to each other create the strongest contrast

Primary Colors
Sets of colors that can be combined (additive or subtractive) to create more colors
Additive primaries: Red, Green, Blue
Subtractive primaries: Cyan, Magenta, Yellow

Gamut
The complete subset of representable colors by a color space (or device)

#6 Use Color Effectively.

Red Green Blue

Usage
Screen

Type
Additive

Numerical Representation
Each primary color represented from 0-255

Color Possibilities
16,777,216

Royal Purple
R: 120
G: 81
B: 169

Cyan Magenta Yellow Key

Usage
Print

Type
Subtractive

Numerical Representation
Percentage from 0-100%

Color Possibilities
1,000,000

Royal Purple
C: 62
M: 79
Y: 0
K: 0

#6 Use Color Effectively.

Color has meaning.

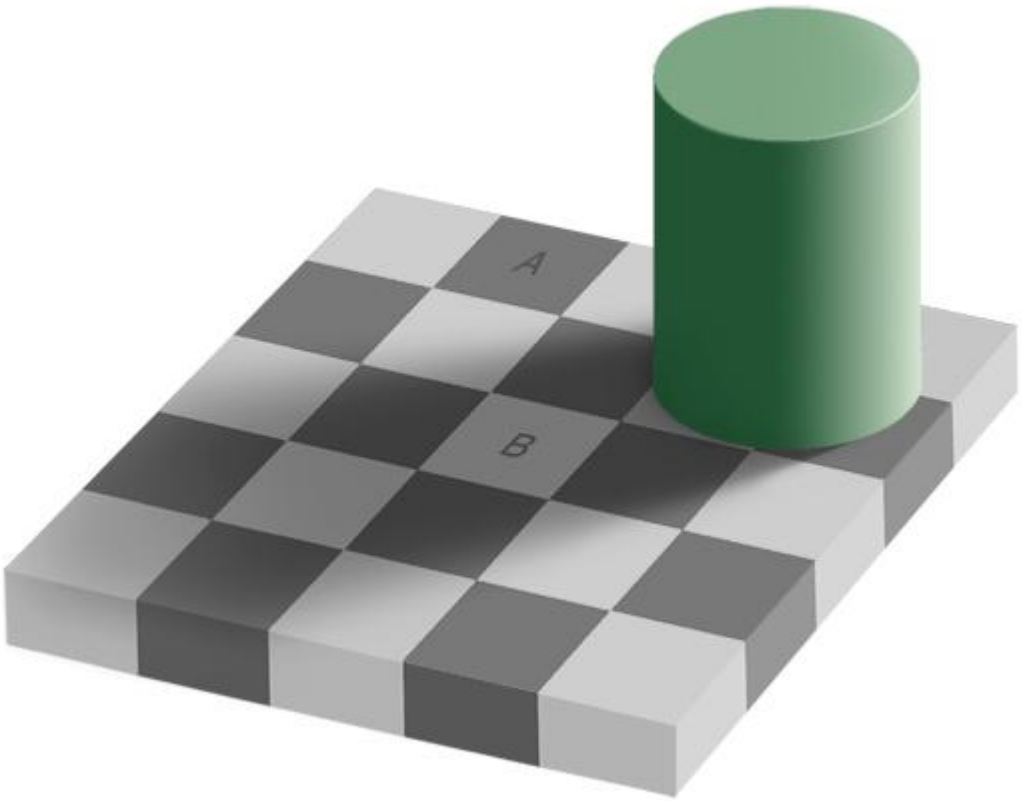


Image: Adelson (1995)

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Color has meaning.

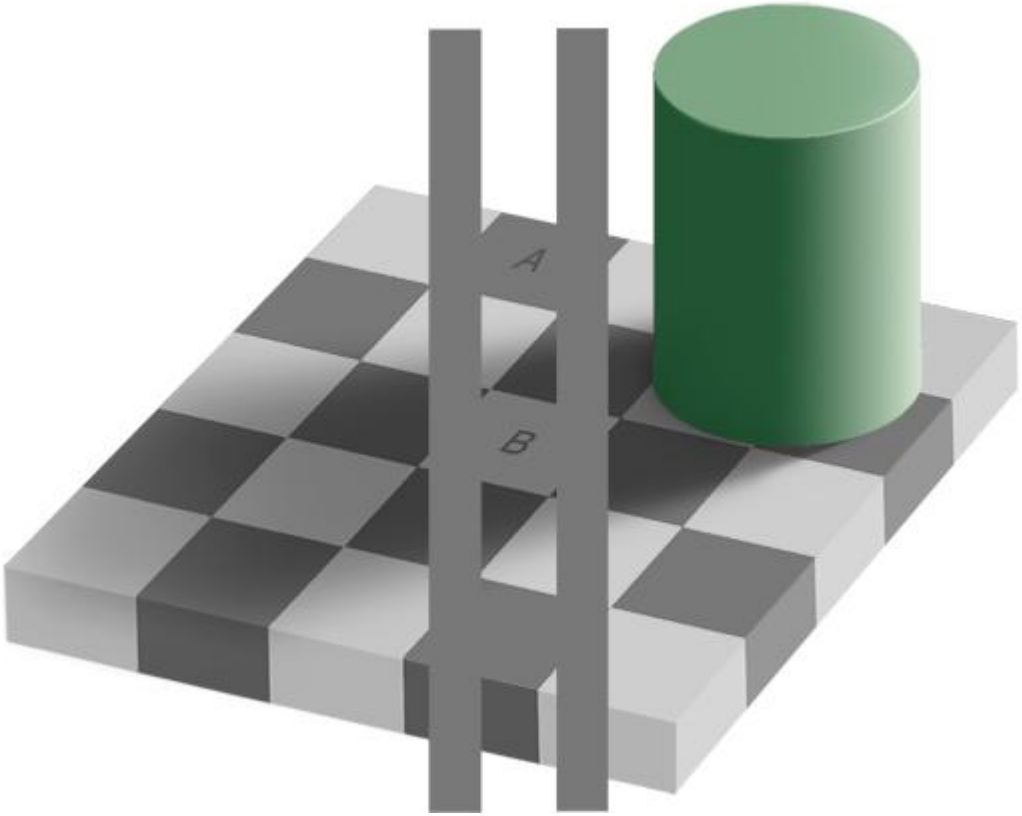

Image: Adelson (1995)

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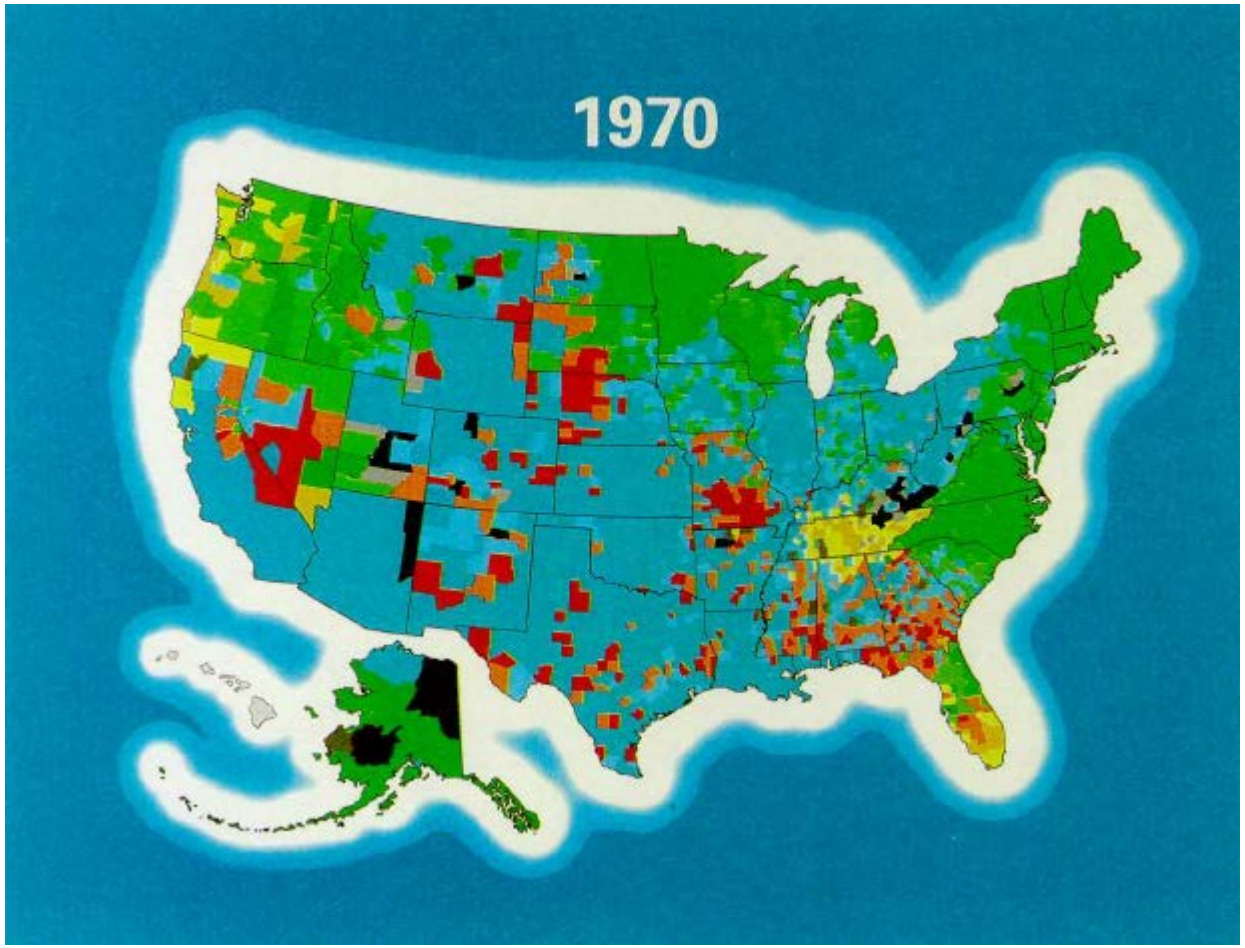
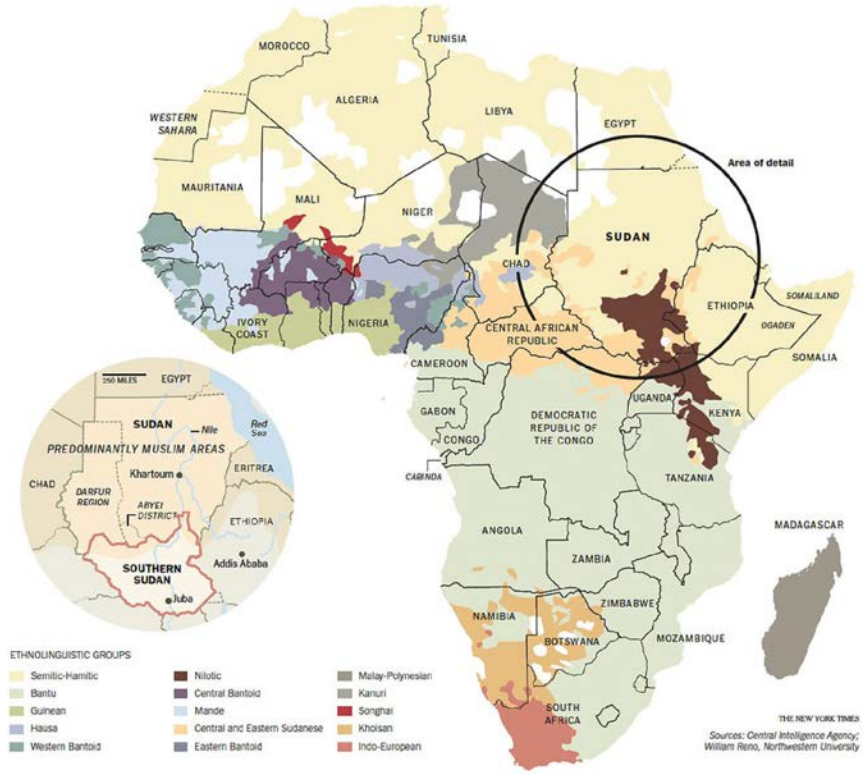


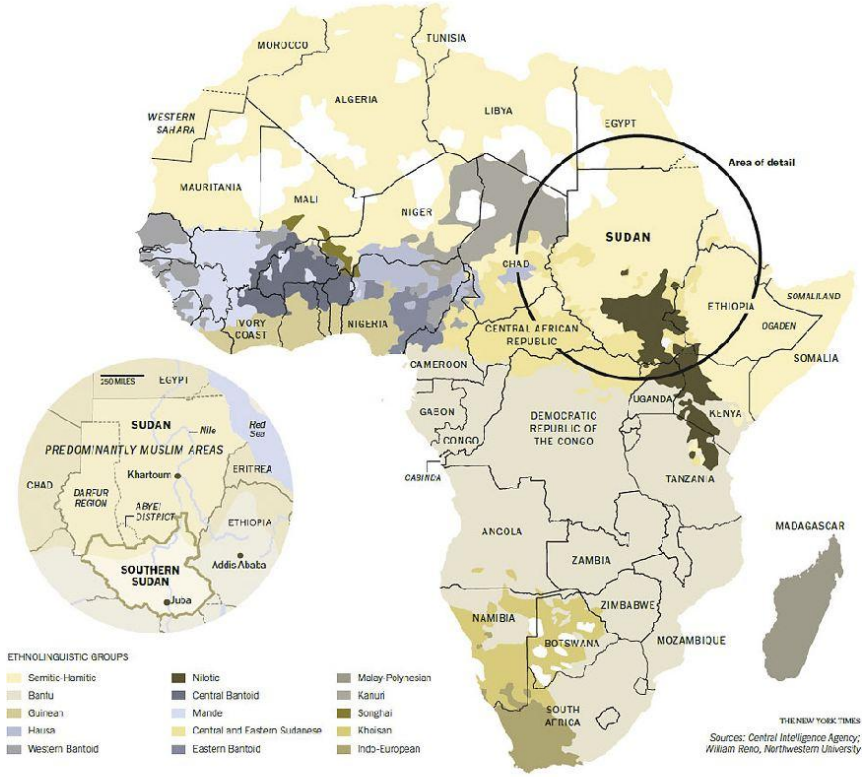
Image: Tufte (1990) Envisioning Information

#6 Use Color Effectively.

Color for all users.



Original Image



Red-Green (Deuteranopia) Color Blindness

Image: New York Times

#7

Do Not Mislead The Reader.

Adapted from Rougier et al (2014)

#7 Do Not Mislead The Reader.

Represent your data appropriately.

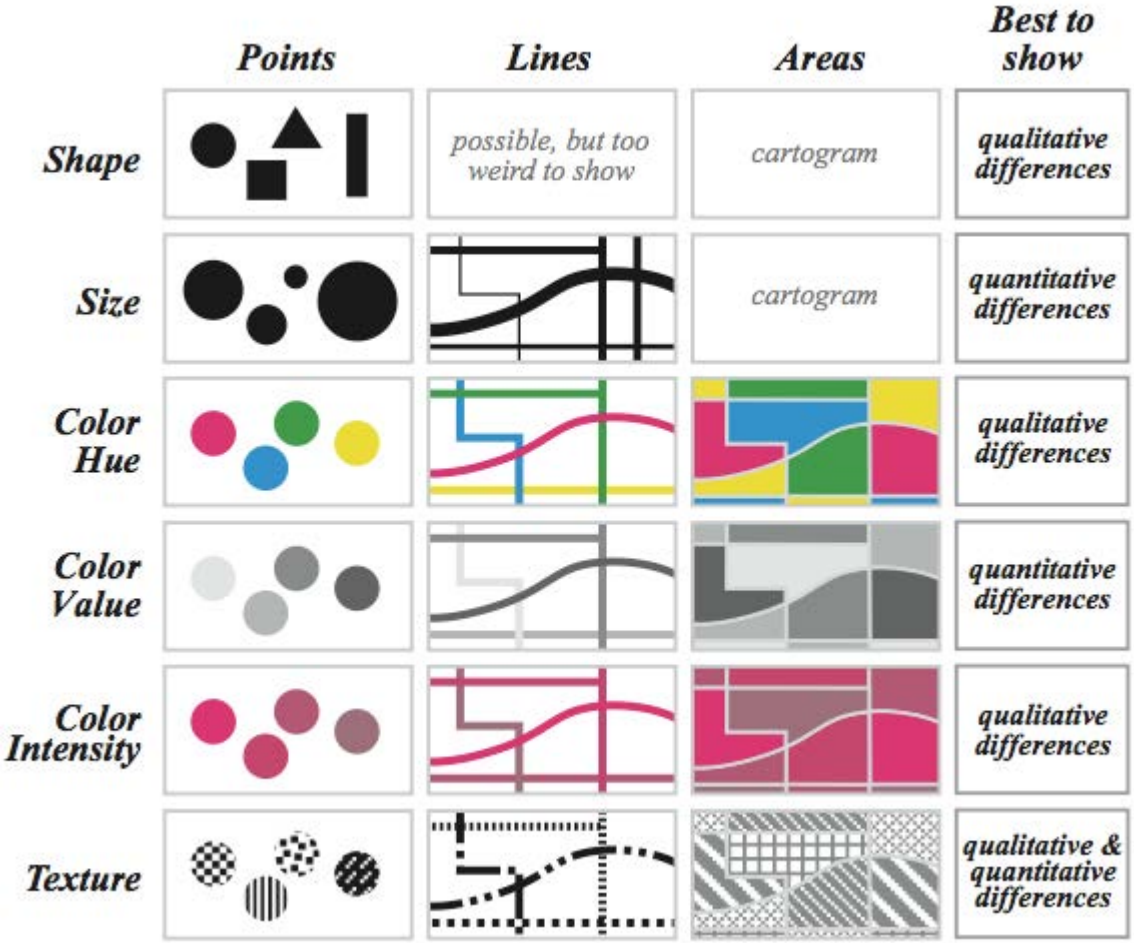
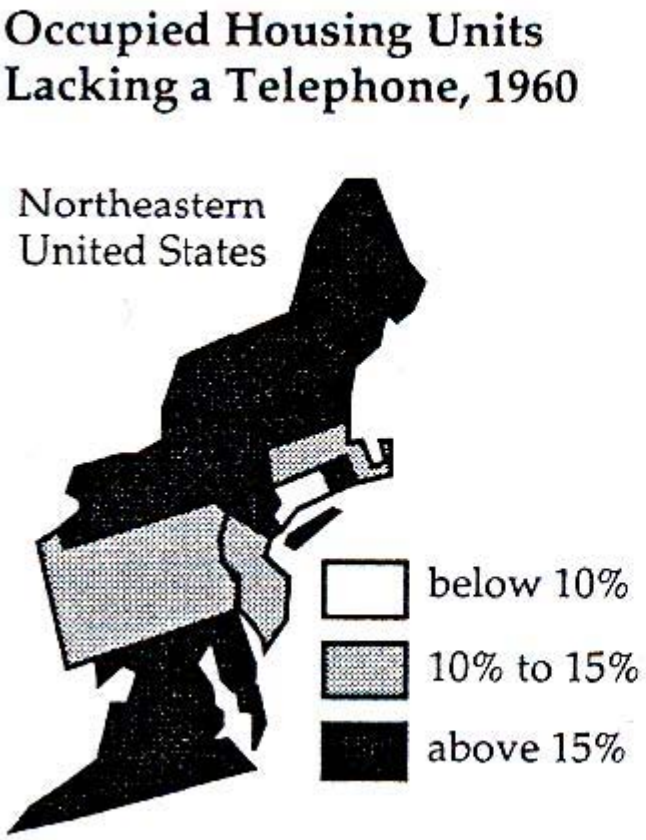


Image: Krygier and Wood (2005) Making Maps

#7 Do Not Mislead The Reader.

How to lie with maps.



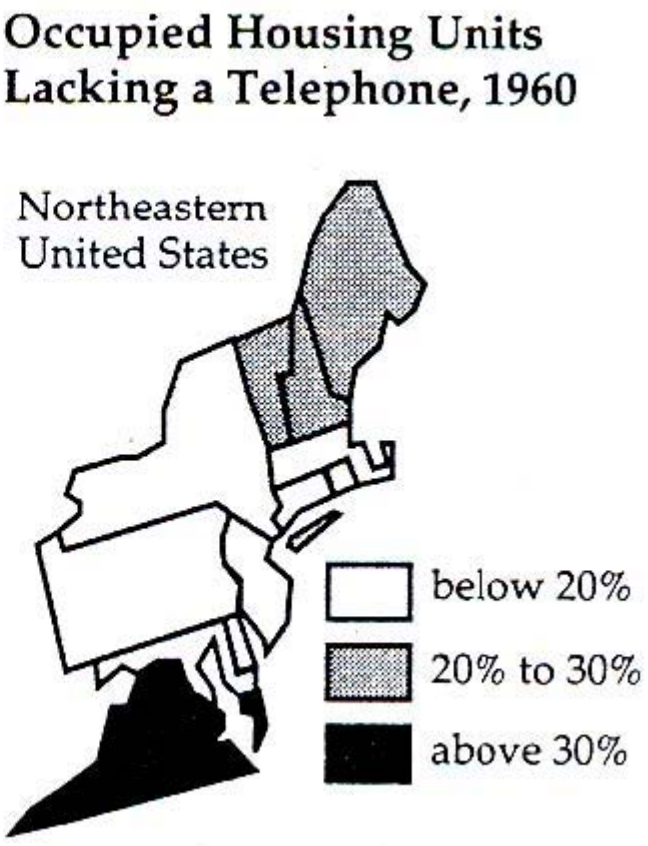


Image: Monmonier / University of Chicago Press

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How to lie with maps.

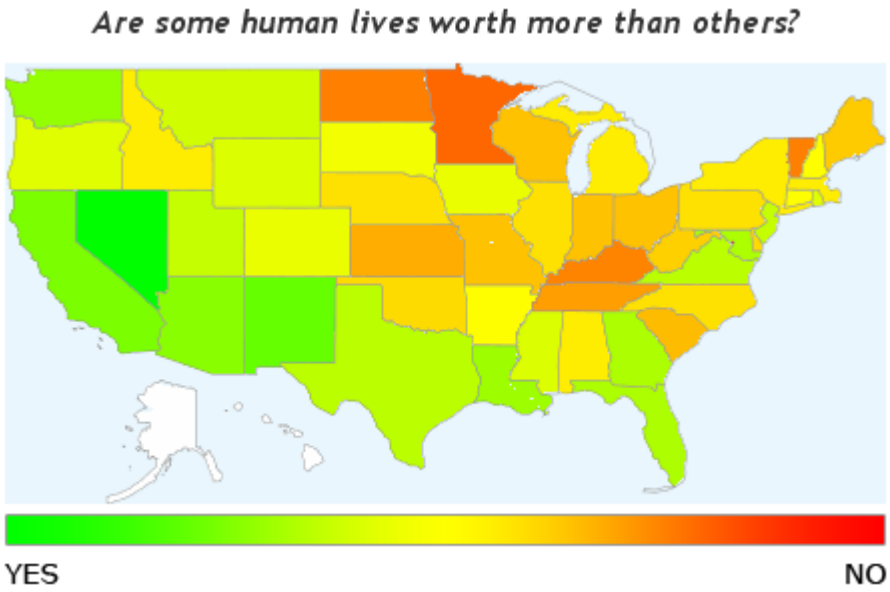


Image: Daniel Huffman, Cartastophe

#7 Do Not Mislead the Reader.

How to lie with maps.

Image: Misguided Maps

#7 Do Not Mislead The Reader.

How to lie with maps.

Image: Daniel Huffman, Cartastophe

#8

Avoid “Chartjunk” ...and “mapjunk.”

Adapted from Rougier et al (2014)

10 Simple Rules for Better Maps & Figures.

"The interior decoration of graphics generates a lot of ink that does not tell the viewer anything **new**. The purpose of decoration varies — to make the graphic appear more scientific and precise, to enliven the display, to give the designer an opportunity to exercise artistic skills. Regardless of its cause, it is all **non-data-ink or redundant data-ink**, and it is often chartjunk."

- *Edward Tufte*

Tufte (1983). The Visual Display of Quantitative Information

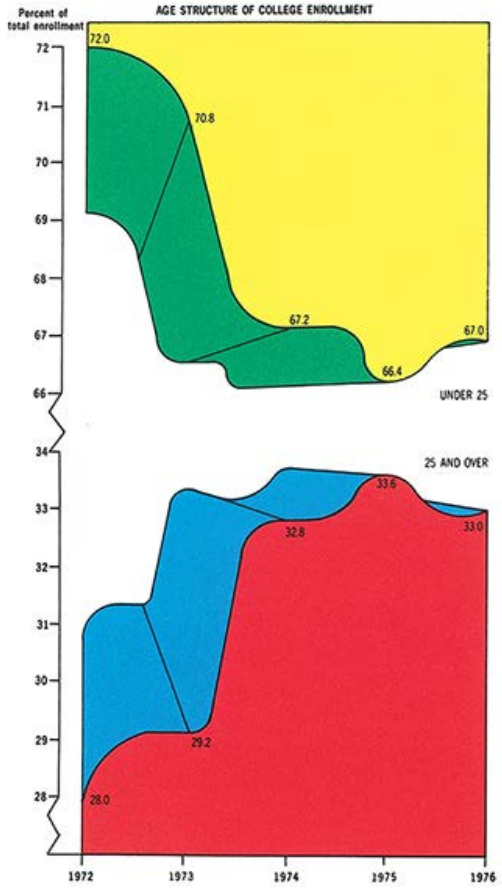
#8 Avoid Chartjunk.

The Beautiful Disasters.

Image: Wikipedia

#8 Avoid Chartjunk.

The Beautiful Disasters.



"This may well be the worst graphic ever to find its way into print."

-Edward Tufte

Image: Tufte, The Visual Display of Quantitative Information (1983, 2001)

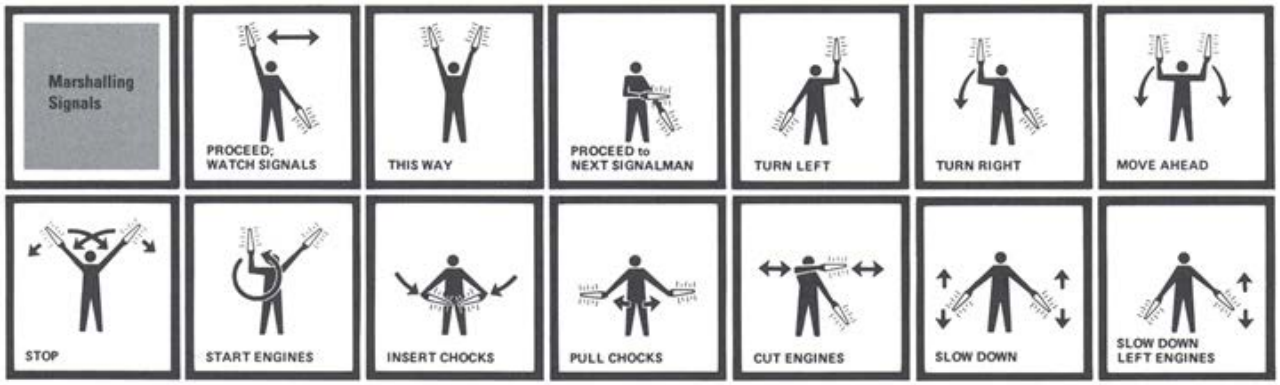
#8 Avoid Chartjunk.

The Beautiful Disasters.

Image: Jalopnik

#8 Avoid Chartjunk.

Removing Chartjunk.



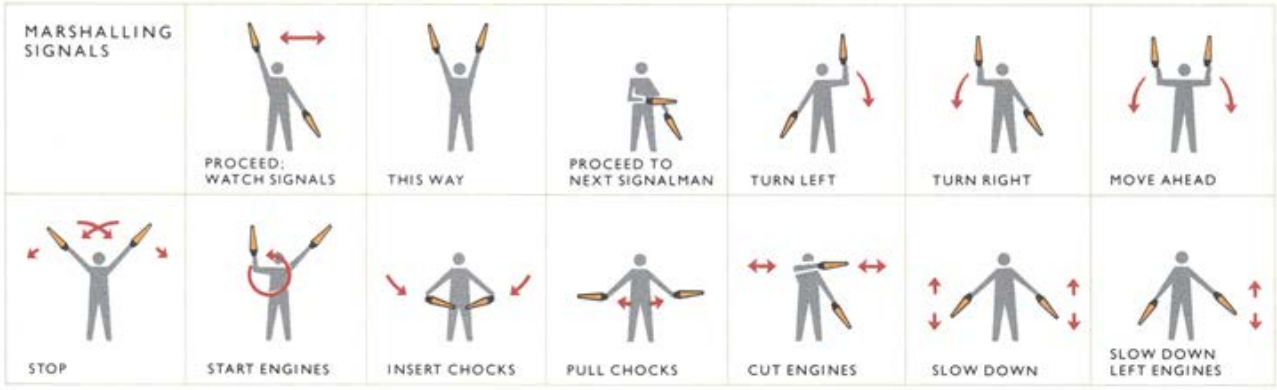


Image: Tufte (1983). The Visual Display of Quantitative Information

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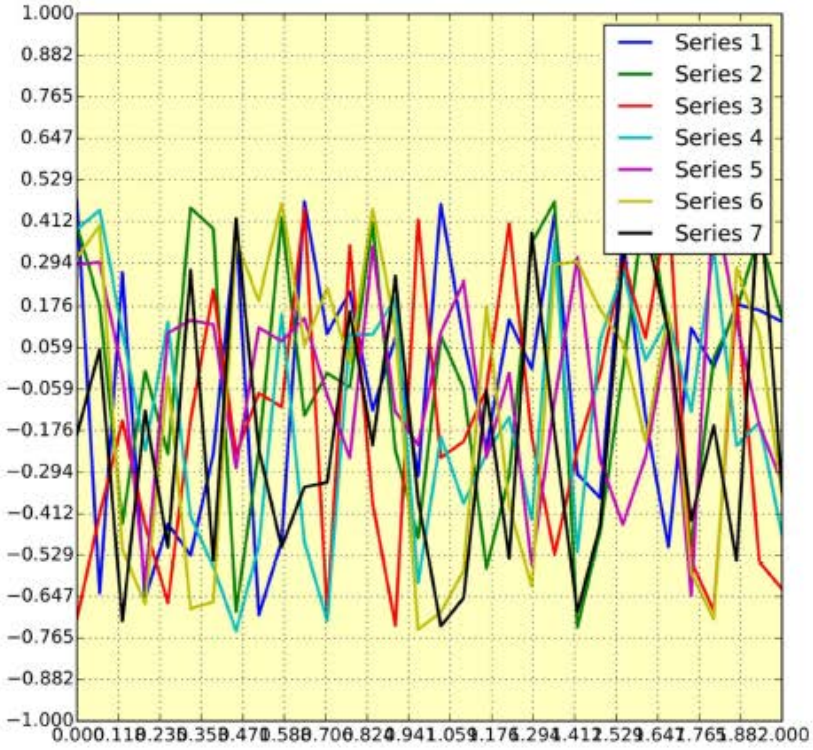
Removing Chartjunk.



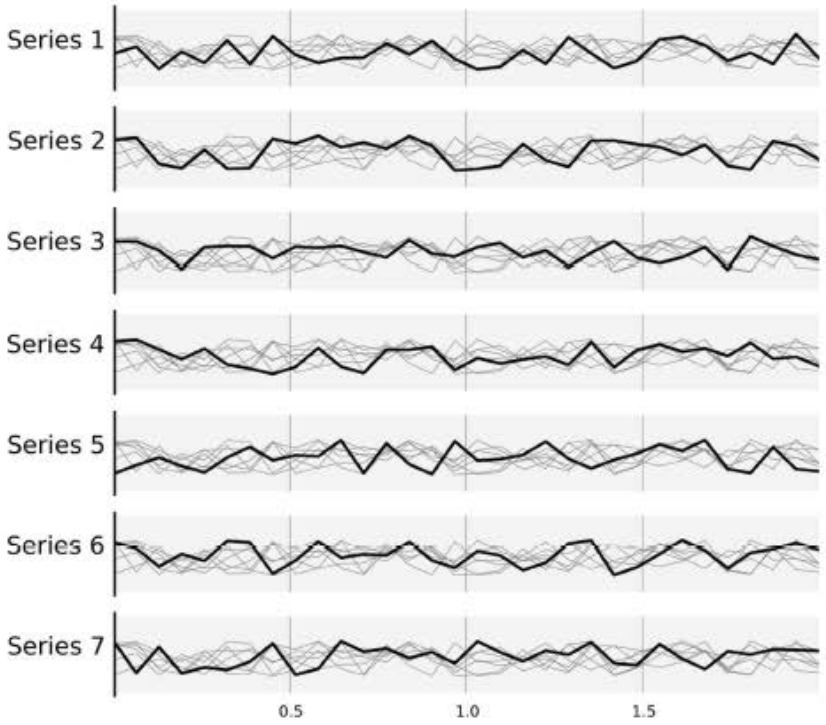


Image: Rougier et al (2014)

#8 Avoid Chartjunk.

1 + 1 = 3 (yes, really!)

1 + 1 = 2

1 + 1 = 3

Adapted from Albers (1969). One Plus One Equals Three or More: Factual Facts and Actual Facts

#8 Avoid Chartjunk.

1 + 1 = 3 (yes, really!)

1 + 1 = 2

1 + 1 = 3

How many pieces of information could be conveyed here?

Adapted from Albers (1969). One Plus One Equals Three or More: Factual Facts and Actual Facts

#8 Avoid Chartjunk.

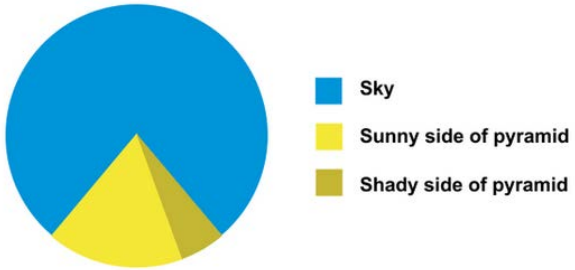
1 + 1 = 3 (yes, really!)

1 + 1 = 2

1 + 1 = 3

How many pieces of information could be conveyed here?

Or here?



Adapted from Albers (1969). One Plus One Equals Three or More: Factual Facts and Actual Facts

#8 Avoid Chartjunk.

To Summarize.

- Avoid unnecessary ornamentation
- Make each “ink mark” a “data mark”
- Sometimes more *is* less
- Just because the software lets you does not mean you should
- Chartjunk and mapjunk are distracting
- Chartjunk and mapjunk can mislead the reader

#9

Message Trumps Beauty.

Adapted from Rougier et al (2014)

#9 Message Trumps Beauty.

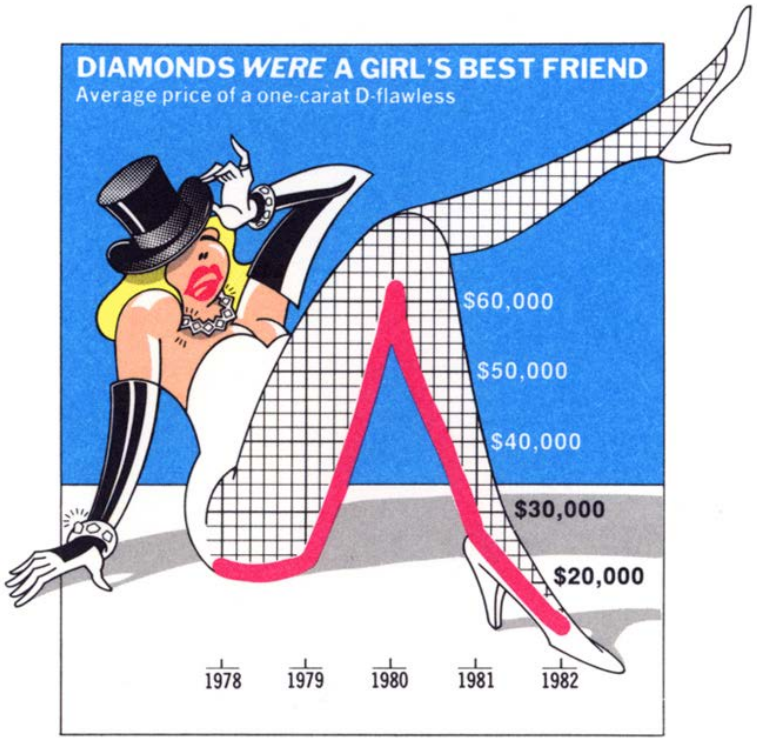
This is absolutely true.

But… simple can be beautiful.

But… ugly can clout the message.

So…

Design for the message.



My version:

Do not mask your message by making an "award-winning" design; rather, let the data drive the design, then execute design appropriately using visual conventions and techniques.

Image: Time, Inc. (1982)

#9 Message Trumps Beauty.

	Relative survival rate, % (SE)			
	5 years	10 years	15 years	20 years
Cancer site				
Oral cavity and pharynx	56·7 (1·3)	44·2 (1·4)	37·5 (1·6)	33·0 (1·8)
Oesophagus	14·2 (1·4)	7·9 (1·3)	7·7 (1·6)	5·4 (2·0)
Stomach	23·8 (1·3)	19·4 (1·4)	19·0 (1·7)	14·9 (1·9)
Colon	61·7 (0·8)	55·4 (1·0)	53·9 (1·2)	52·3 (1·6)
Rectum	62·6 (1·2)	55·2 (1·4)	51·8 (1·8)	49·2 (2·3)
Liver and intrahepatic bile duct	7·5 (1·1)	5·8 (1·2)	6·3 (1·5)	7·6 (2·0)
Pancreas	4·0 (0·5)	3·0 (0·5)	2·7 (0·6)	2·7 (0·8)
Larynx	68·8 (2·1)	56·7 (2·5)	45·8 (2·8)	37·8 (3·1)
Lung and bronchus	15·0 (0·4)	10·6 (0·4)	8·1 (0·4)	6·5 (0·4)
Melanomas	89·0 (0·8)	86·7 (1·1)	83·5 (1·5)	82·8 (1·9)
Breast	86·4 (0·4)	78·3 (0·6)	71·3 (0·7)	65·0 (1·0)
Cervix uteri	70·5 (1·6)	64·1 (1·8)	62·8 (2·1)	60·0 (2·4)
Corpus uteri and uterus, NOS	84·3 (1·0)	83·2 (1·3)	80·8 (1·7)	79·2 (2·0)
Ovary	55·0 (1·3)	49·3 (1·6)	49·9 (1·9)	49·6 (2·4)
Prostate	98·8 (0·4)	95·2 (0·9)	87·1 (1·7)	81·1 (3·0)
Testis	94·7 (1·1)	94·0 (1·3)	91·1 (1·8)	88·2 (2·3)
Urinary bladder	82·1 (1·0)	76·2 (1·4)	70·3 (1·9)	67·9 (2·4)
Kidney and renal pelvis	61·8 (1·3)	54·4 (1·6)	49·8 (2·0)	47·3 (2·6)
Brain and other nervous system	32·0 (1·4)	29·2 (1·5)	27·6 (1·6)	26·1 (1·9)
Thyroid	96·0 (0·8)	95·8 (1·2)	94·0 (1·6)	95·4 (2·1)
Hodgkin's disease	85·1 (1·7)	79·8 (2·0)	73·8 (2·4)	67·1 (2·8)
Non-Hodgkin lymphomas	57·8 (1·0)	46·3 (1·2)	38·3 (1·4)	34·3 (1·7)
Multiple myeloma	29·5 (1·6)	12·7 (1·5)	7·0 (1·3)	4·8 (1·5)
Leukaemias	42·5 (1·2)	32·4 (1·3)	29·7 (1·5)	26·2 (1·7)

Rates derived from SEER 1973–98 database (both sexes, all ethnic groups).[12]
NOS=not otherwise specified.

Table 4: **Most recent period estimates of relative survival rates, by cancer site**

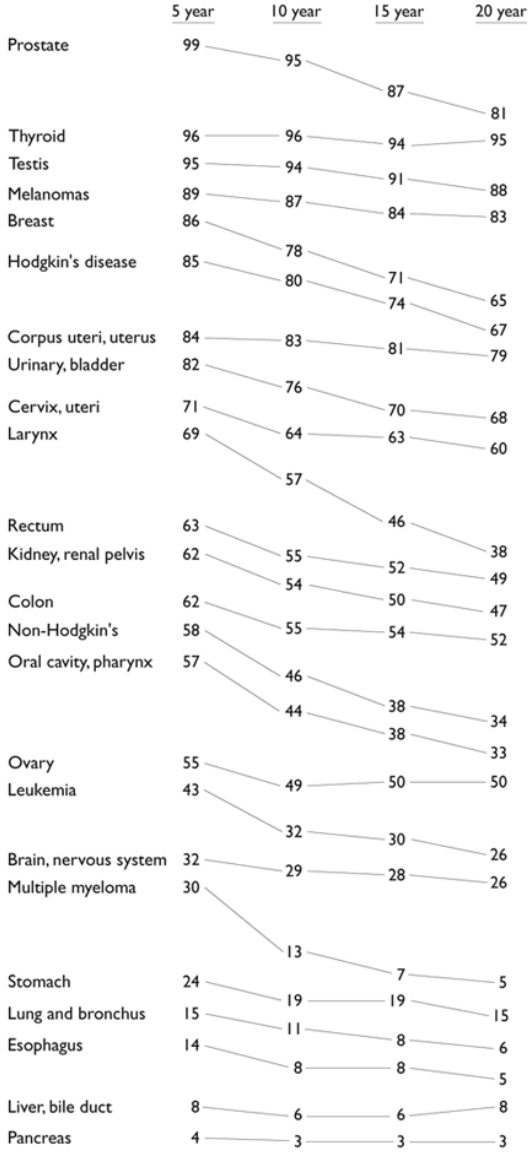


Image: Edward Tufte (www.edwardtufte.com)

#10

Get The Right Tool.

Adapted from Rougier et al (2014)

#10 Get The Right Tool.

Some of these will get you started.

Manage Your (Geo)Data

ArcGIS
QGIS
GMT (Generic Mapping Tools)
Excel
Matlab
R

Refine Your Design

Adobe Illustrator
Adobe Photoshop
Adobe Acrobat
GIMP
ImageJ
Inkscape
D3.js
~~Powerpoint~~
~~MS Paint~~

Along The Way

ColorBrewer
TypeBrewer

#11

WWTD?

(What Would Tufte Do?)

Brad's custom rule

Questions?