

How maps work

Pamela Kersh

2019 Esri Gulf Coast User Conference



"Cartography is the discipline dealing with the art, science and technology of making and using maps."



Menno-Jan Kraak

President of the International Cartographic Association

"Cartography, to me, is the art and science of simplifying the real world around us to tell a story using pictures."



Ed Parsons

Geospatial Technologist of Google

"Traditionally, map making is graphic rendering of phenomena or relations on the earth. Now the term is expanded to general biobjective representations of spatially distributed relations. For example genetic maps."



Waldo Tobler, deceased

Professor Emeritus at the University of California,
Santa Barbara

"Cartography is the thinking that leads to smarter mapmaking."



Kenneth Field

Professional cartonerd



Cartography is a language



C ompromise

A

R

T

O pportunity

G

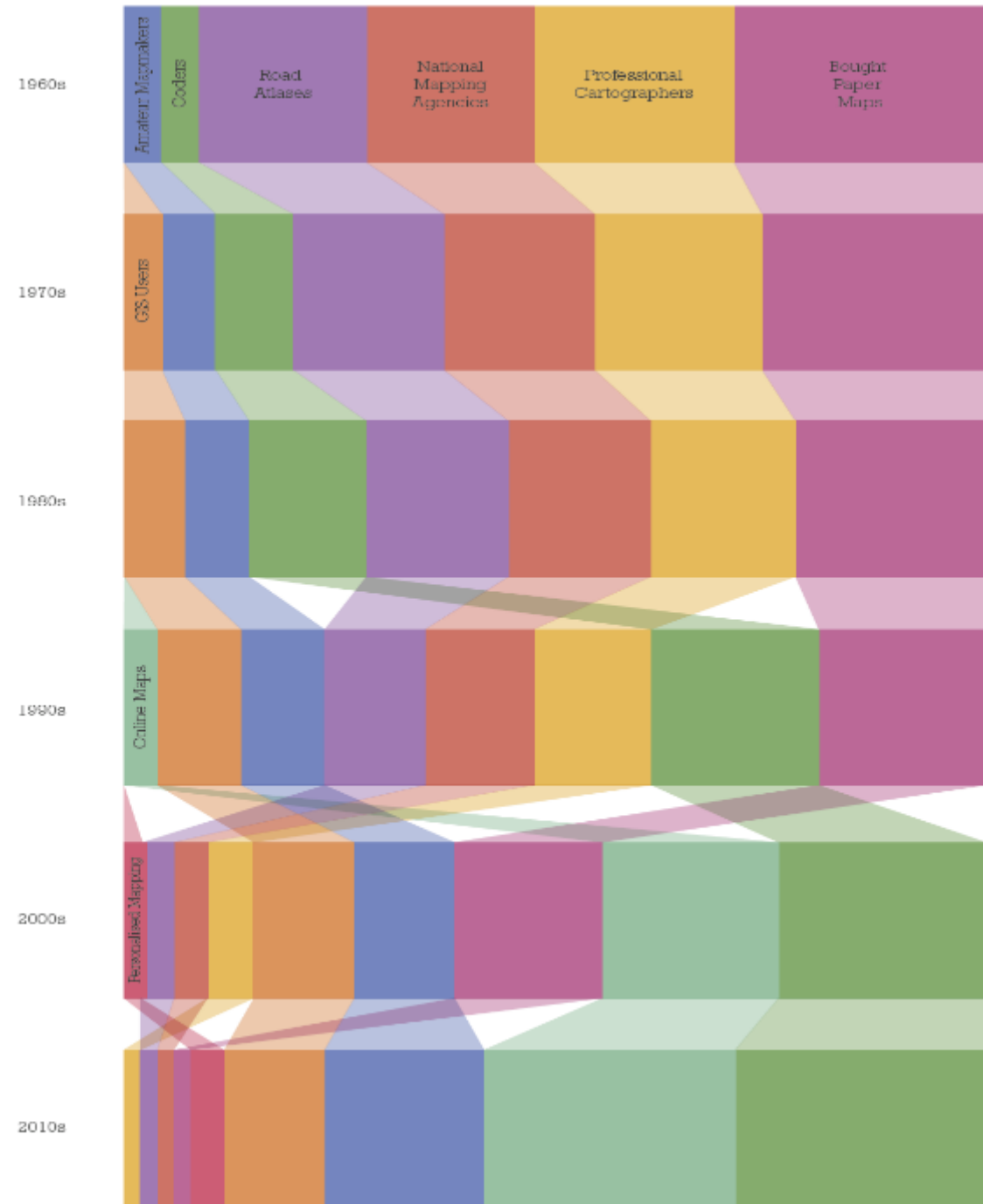
R

A

P

H

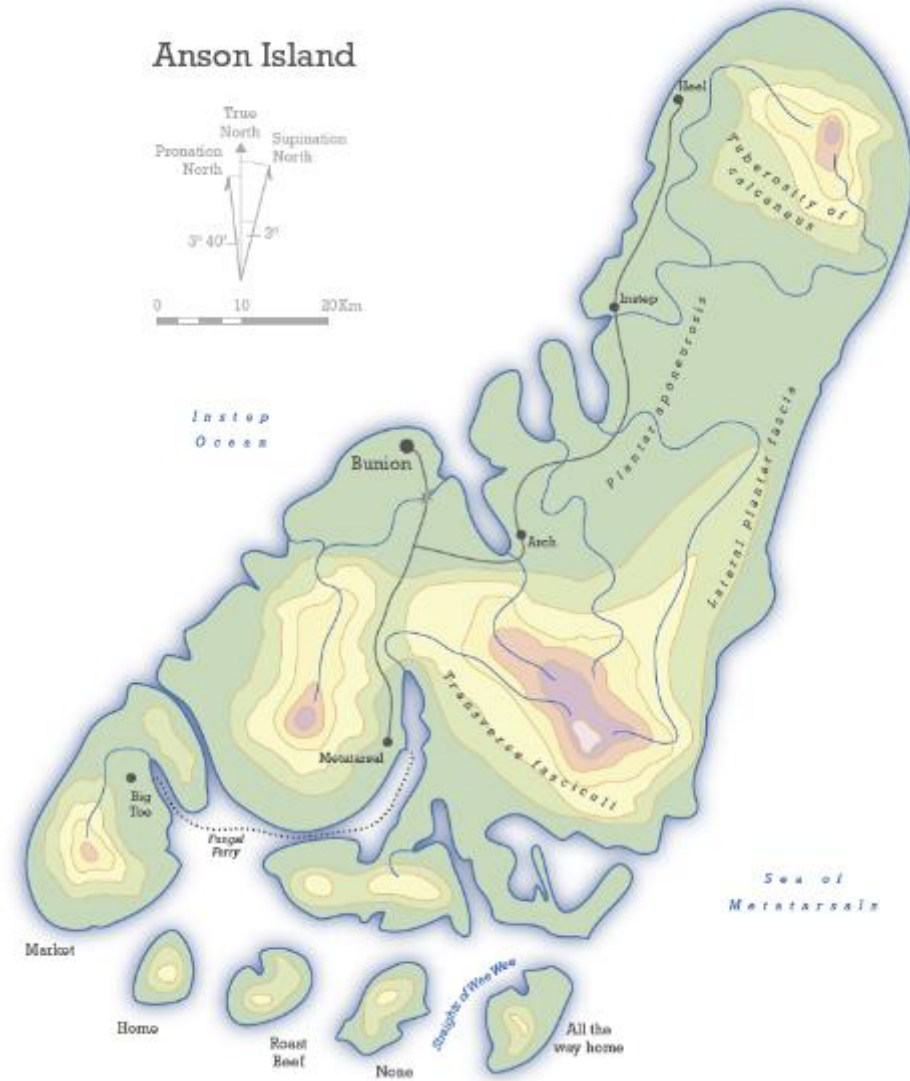
Y why?

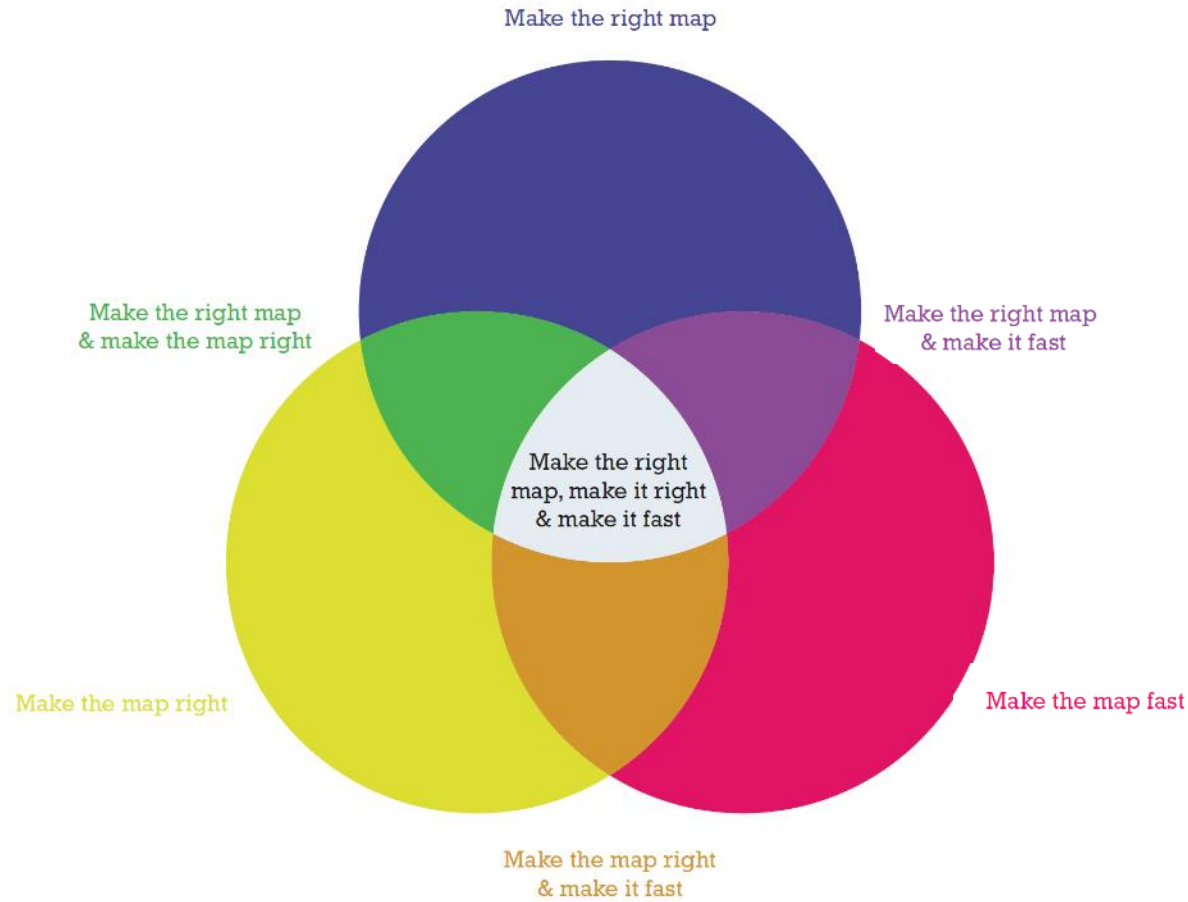


Serial, linear

Draw, stating your scale, a contoured map to show an island 65 km long from SW to NE which varies in width from 48 km in the SW to 16 km in the NE. The SW coast is much dissected by long, narrow fjord-like inlets, and is fringed by 5 small rocky islands of varying sizes. From this coast the land rises sharply to a plateau some 600 m above sea level and extending through about one-third of the island. The plateau descends to a low undulating plain about 25 km long and 20 km wide. From the plain a range of hills rises to the NE, flanked by a coastal plain about 8 km wide. From these hills, rivers flow to both plains and also from the plateau to the larger plain. The plateau is gritstone. The hills which run down to the coast in the NE, to form cliffs, are chalk. Much of the smaller coastal plain is marsh, but the larger plain, from which two estuaries open, is of well drained alluvial land. In addition to relief and topography, show drainage, possible sites of settlement and lines of communication. Name your island appropriately!

Parallel, non-linear

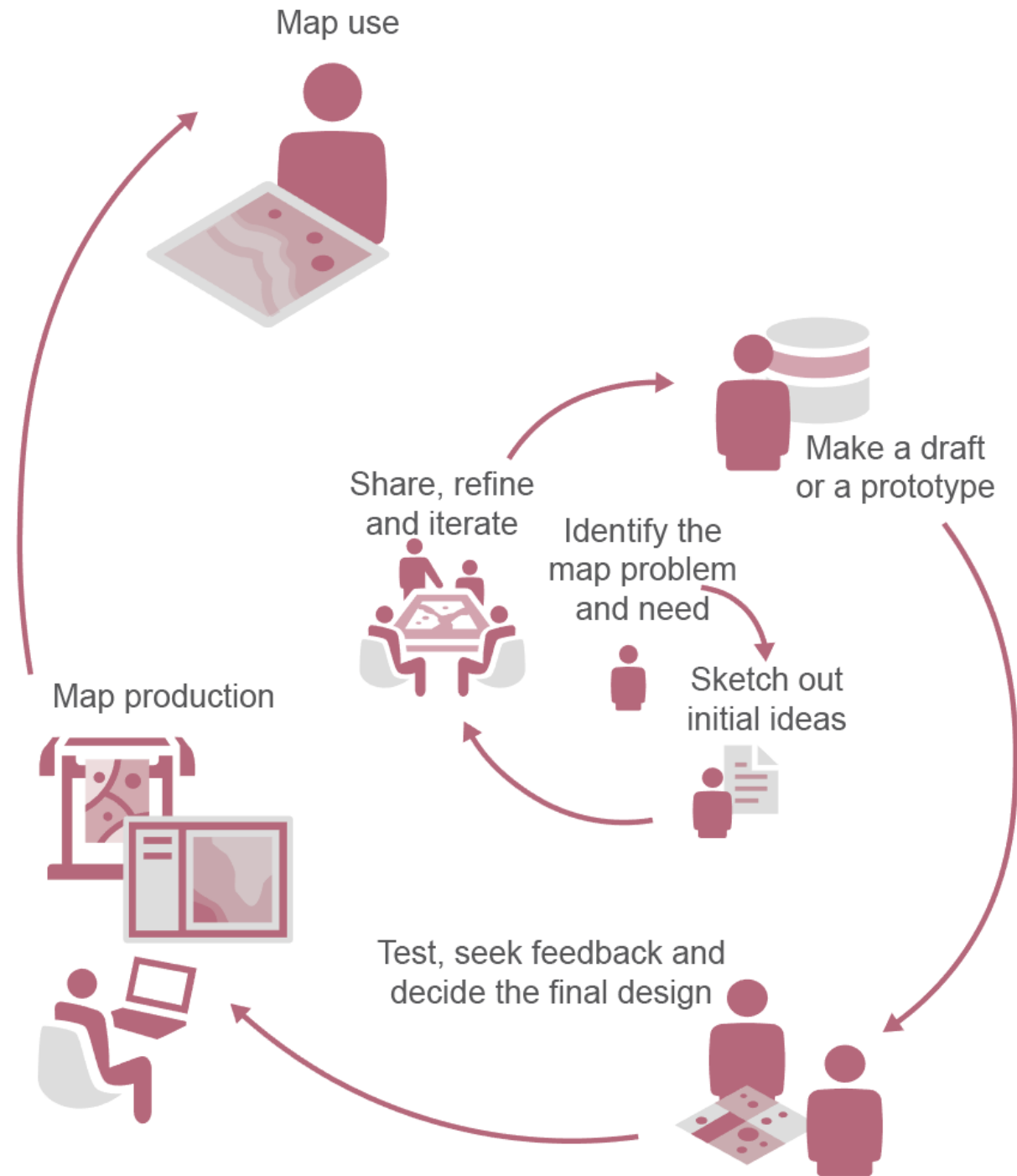




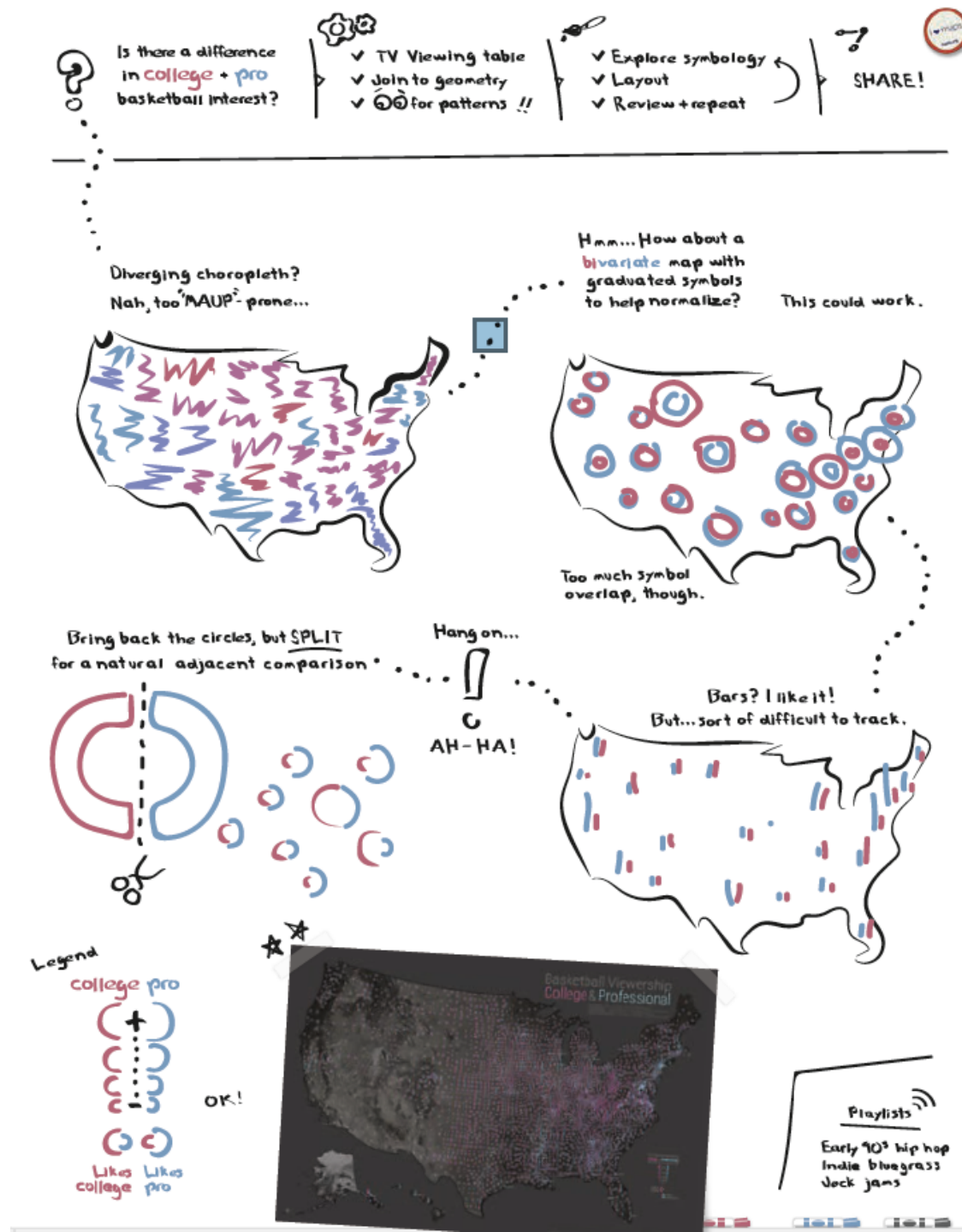
Some principles of map design

1. **Concept before compilation**
2. **Hierarchy with harmony**
3. **Simplicity from sacrifice**
4. **Clutter to clarity**
5. **Emotion expresses, engages, and elucidates**

The design process



Wireframing and Storyboarding



Constraints

Audience

Media resolution

Viewing distance

Output medium

Anticipated level of understanding

Conditions of use

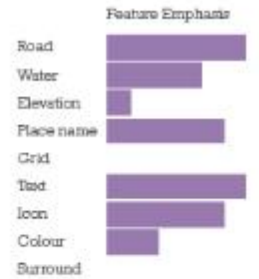
One map or multiple maps

What areal extent to show

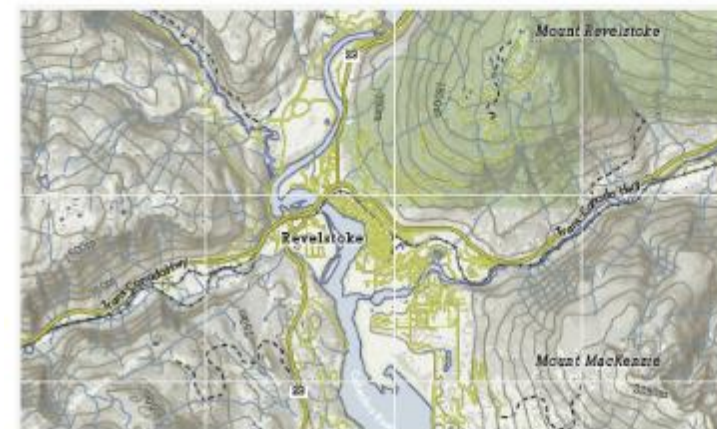
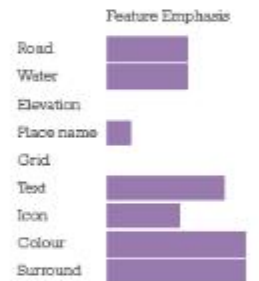
Insets/multiscale



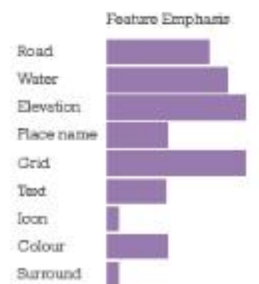
ROAD MAP



TOURIST MAP
These 80a tourist placement sort of maps

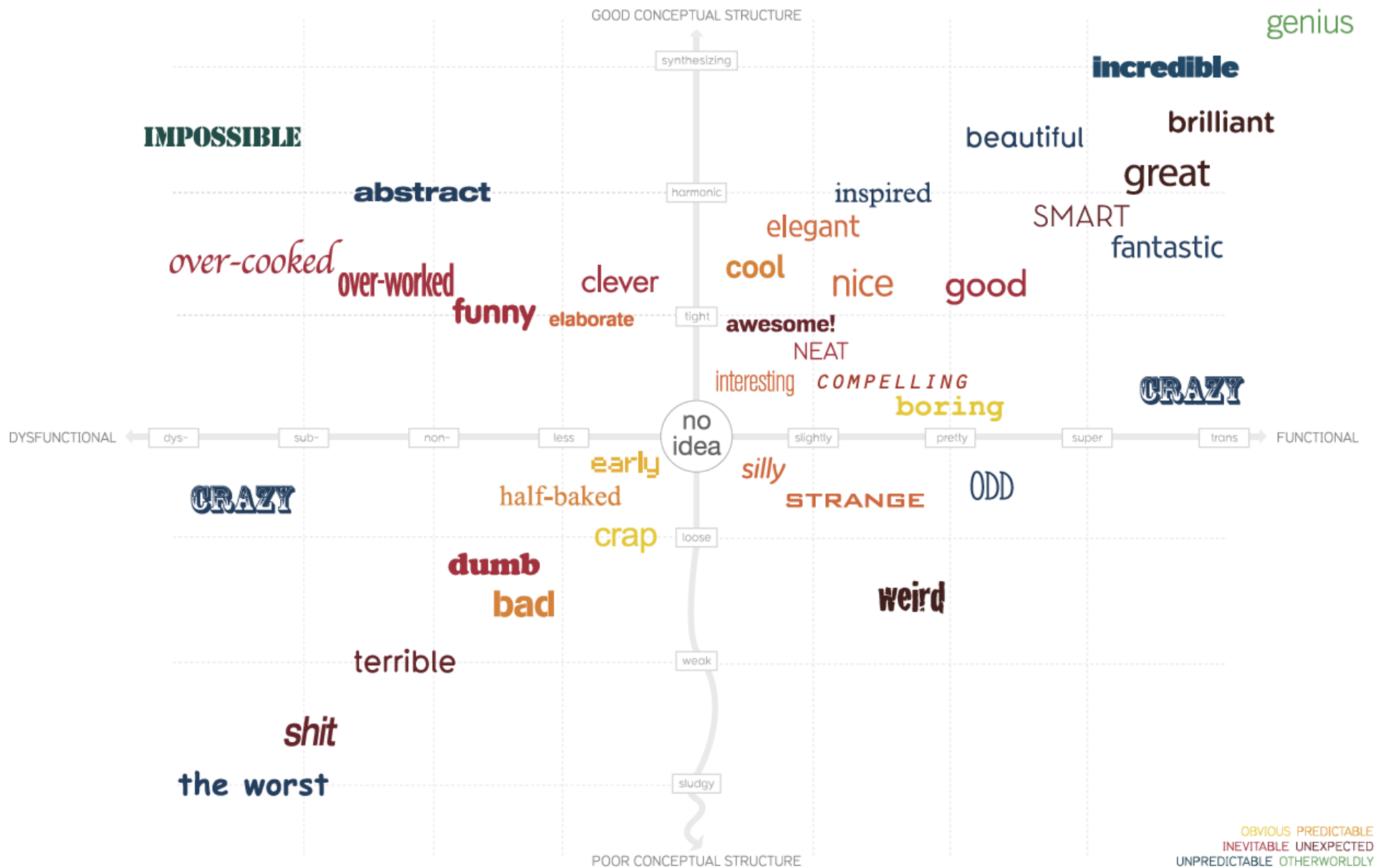


HIKING MAP



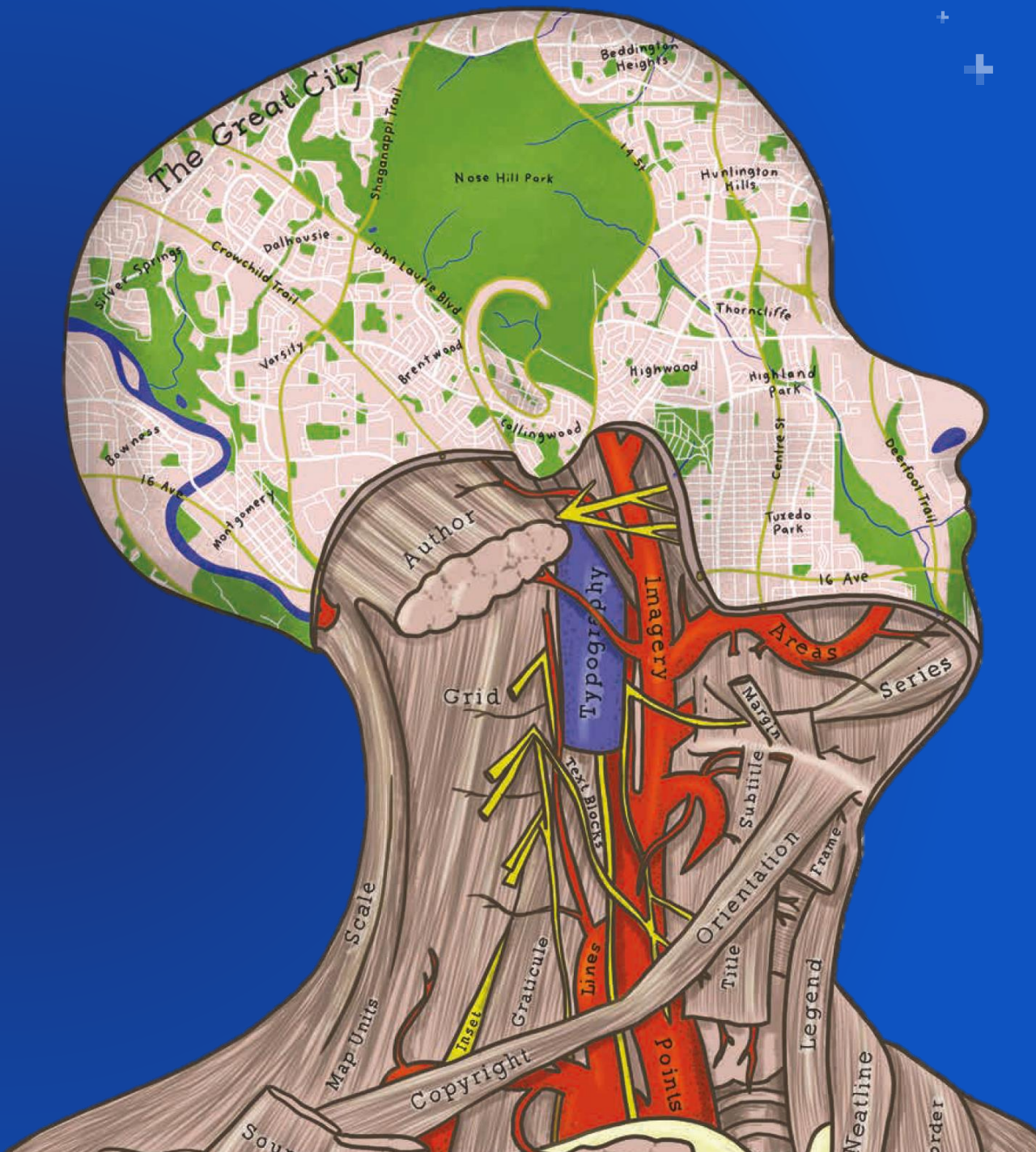
A Taxonomy of Ideas

Structure + Functionality + Unpredictability?

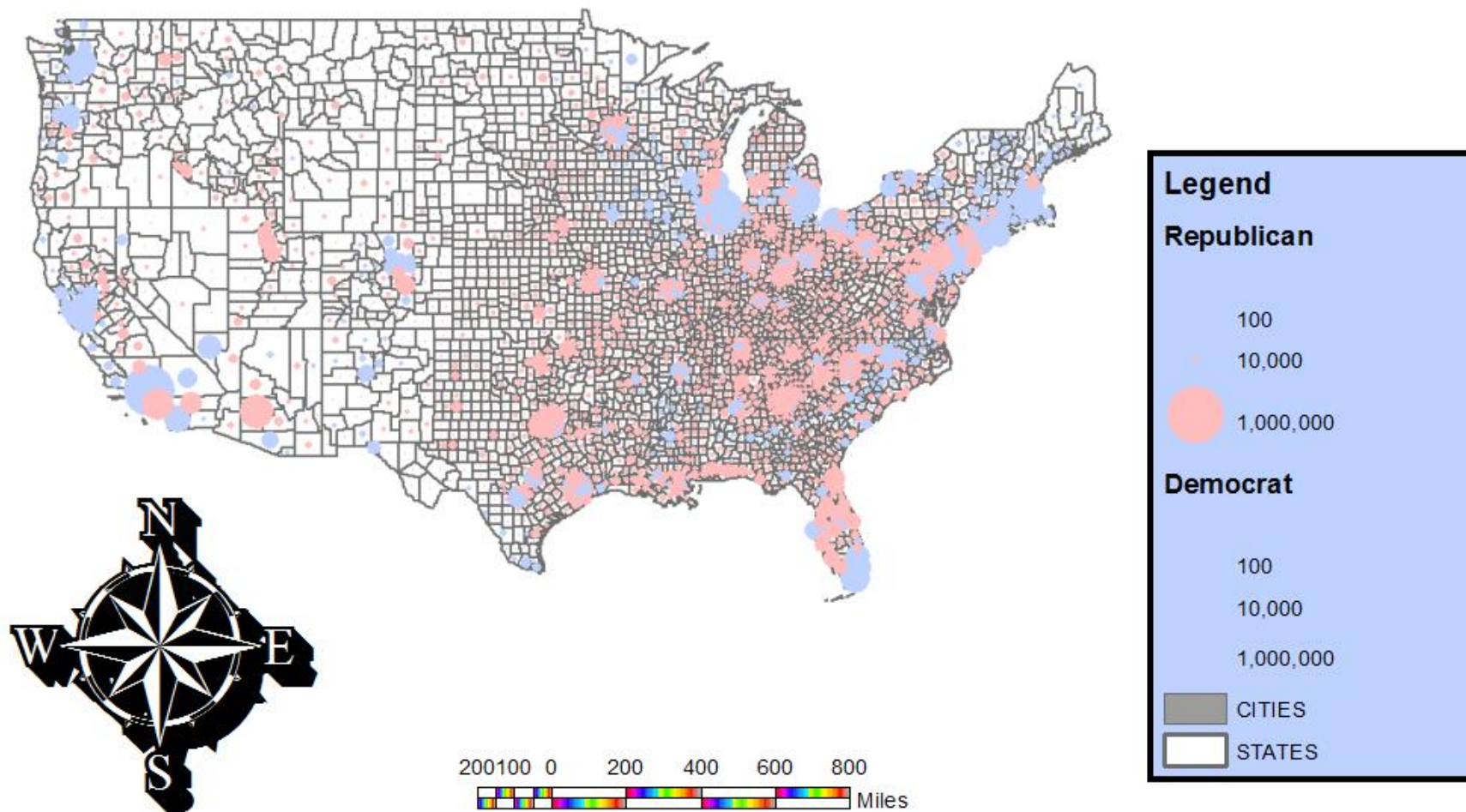


OBVIOUS PREDICTABLE
INEVITABLE UNEXPECTED
UNPREDICTABLE OTHERWORLDLY

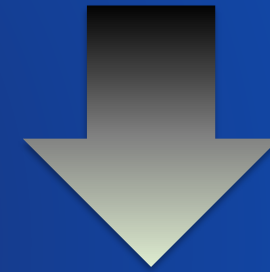
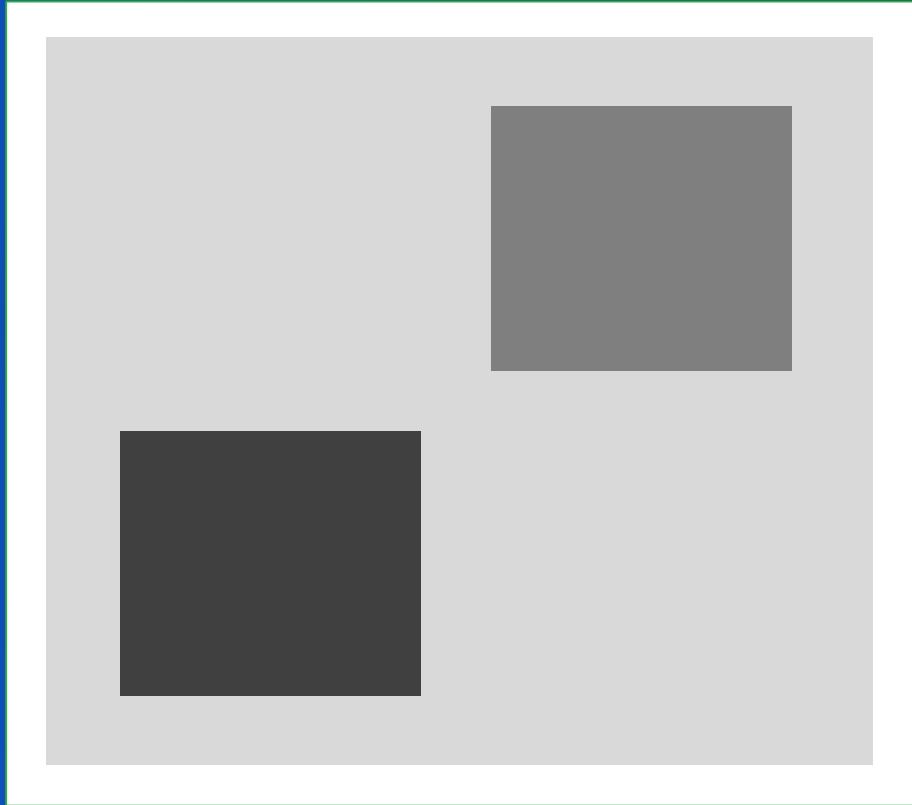
Design hierarchy



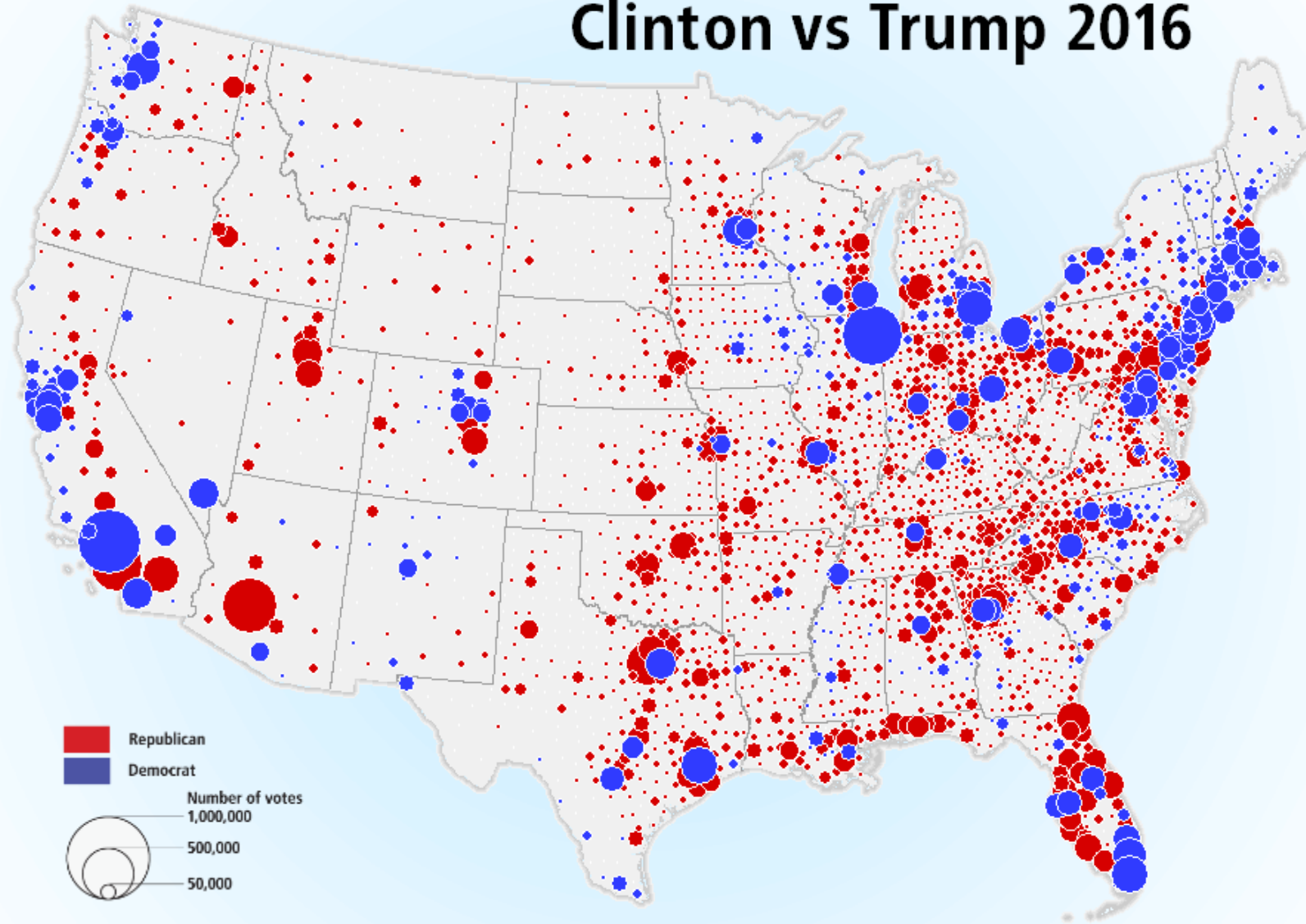
CLINTON vs TRUMP 2016



Hierarchy, contrast and figure-ground



Clinton vs Trump 2016



Better hierarchy



Poorer hierarchy



Better hierarchy greyscale



Poorer hierarchy greyscale



Better hierarchy squint



Poorer hierarchy squint



Better hierarchy small



Poorer hierarchy small

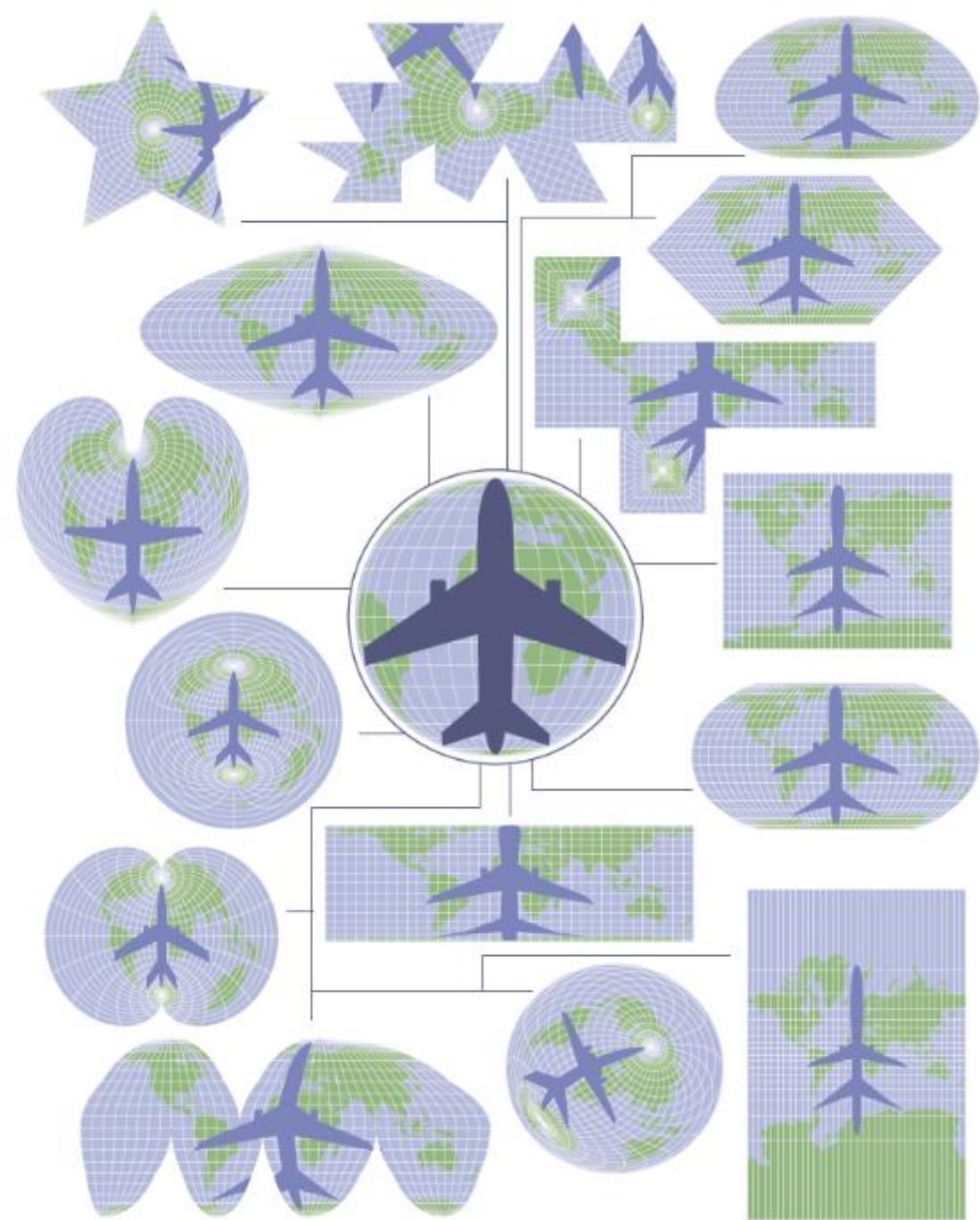


What's hierarchical in the map?



Design projections



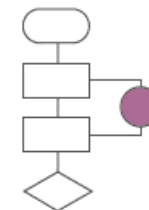
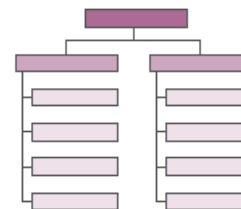
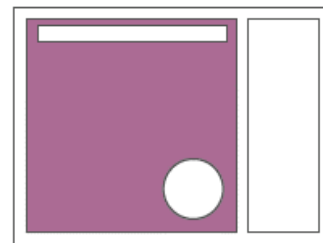
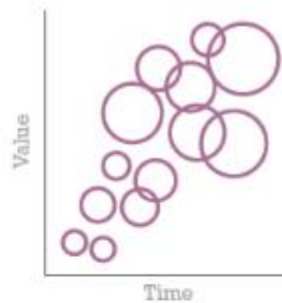
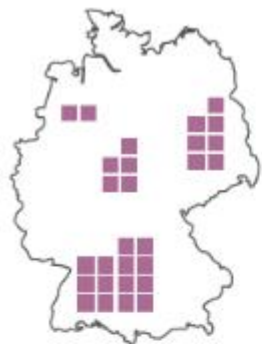


Have you considered projections?

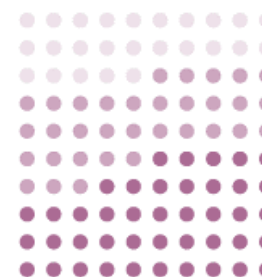


Design symbols


































	52	83	13
	48	62	16








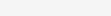














































During the 1975-1993 Brian Clough years, Nottingham Forest went from champions 1st  22nd to relegation.

During this period they won         and were  runners-up. They went 42 games unbeaten between Nov 1977 and Dec 1978, a record that stood until 2004.



Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Literal (words, numbers)	Single	airport, stadium, factory	small, medium, large	5 ton 100 people 20 births	5 ton per sq km 100 people per minute 1.2 births per family
	Multiple	City River Monument	CITY Town Village	Nottingham 100k—500k Newark 10k—99k Stapleford 0—9k	Nottingham 311,500 people Newark 27,700 people Stapleford 1,979 people
Point (geometric, pictorial)	Single	Shape  airport  emergency phone  picnic site	Crispness  low  medium  high	Value  < 19  20—29  30+	Size  50%  75%  100%
	Multiple	Shape & Hue  international airport  regional airport  airport (disused)	Size & Hue  train  boat  plane	Shape & Value 	Hue & Arrangement  units sold 2x 4x ● 1st quarter ● 2nd quarter

Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Line	Single	Shape & Hue <div>  road  railway  river </div>	Shape, Size & Hue <div>  motorway  main road (dual)  A road  B road  track </div>	Size <div>  10 vehicles  10 vehicles  10 vehicles </div>	Size & Transparency <div>  1 per hour  4 per hour  8 per hour </div>
	Multiple	Shape & Value <div>  railway  abandoned railway </div>	Orientation <div>  steep incline  moderate incline  no incline </div>	Shape, Orientation & Size <div>  45 miles W by air  70 miles E by road </div>	Size & Orientation <div>  base speed  2x speed  4x speed </div>
Area	Single	Shape & Hue <div>  lake  building  forest </div>	Resolution <div>  smallest  medium  largest </div>	Saturation <div>  500  1,000  2,000 </div>	Size <div>  25%  75%  100% </div>
	Multiple	Hue, Shape & Arrangement <div>  industrial  greenbelt  urban </div>	Size <div>  class 1  class 2  class 3 </div>	Size & Transparency <div>  100  500  1,000 </div>	Value <div>  0–9%  10–19%  20–29% </div>

Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Volume		Hue  vote A vote B vote C	Transparency  third second first	Height  5 50 500	Size  10m³ 100m³ 1,000m³

How did you design the symbols?



Design generalisation



Feature generalization



1:147,914,382



1:577,791



1:72,224

Large
scale

Small
scale

1:18,489,298



1:144,448



1:4,514



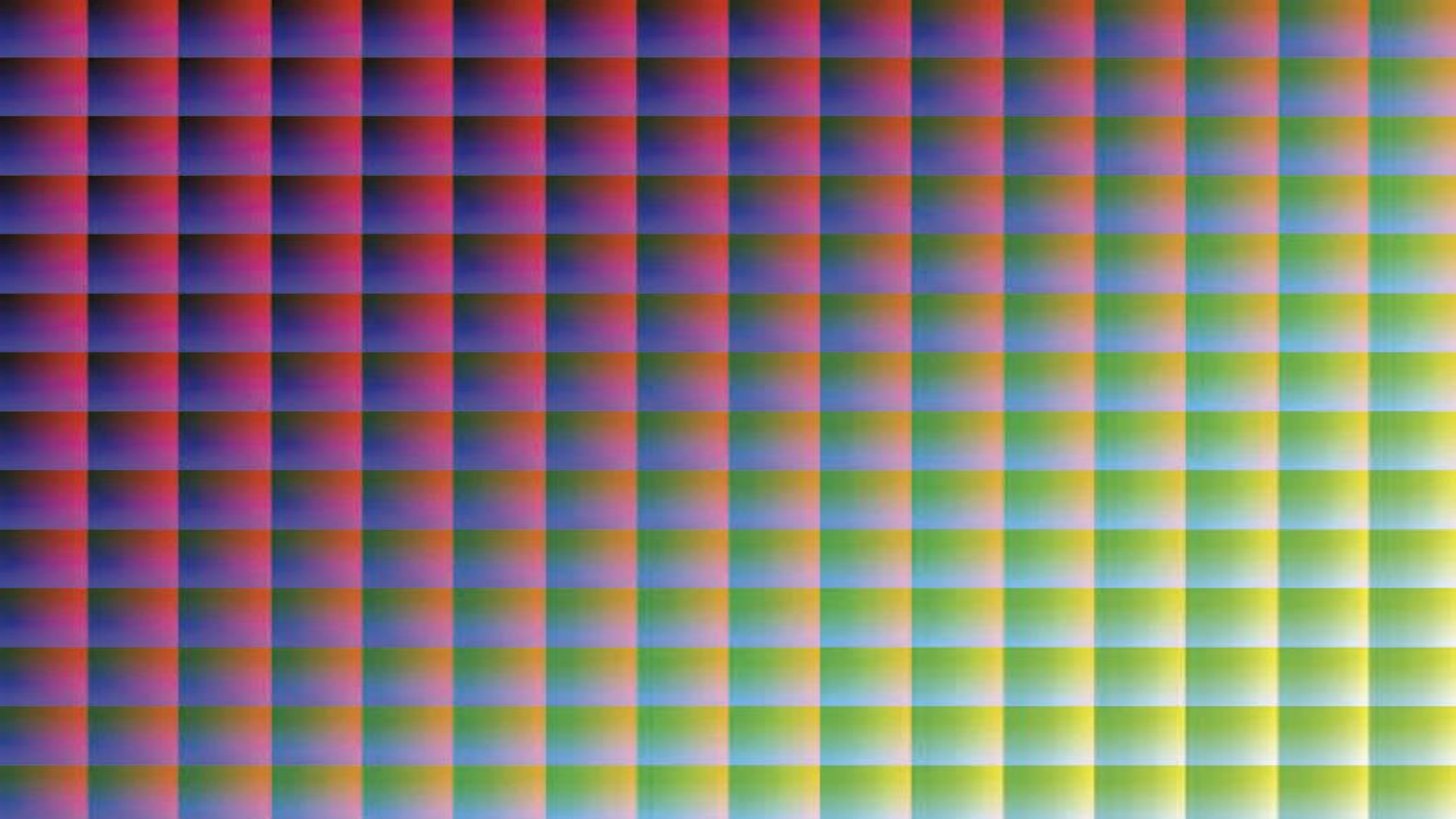


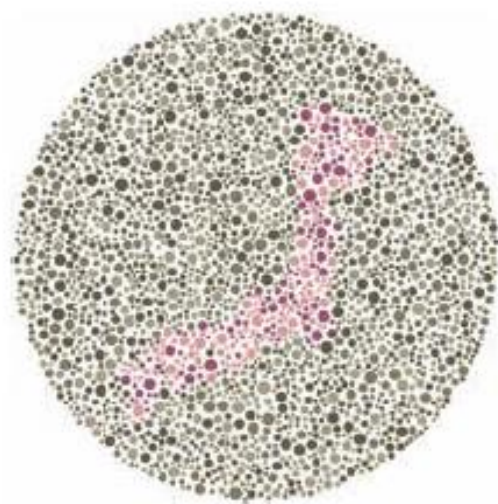
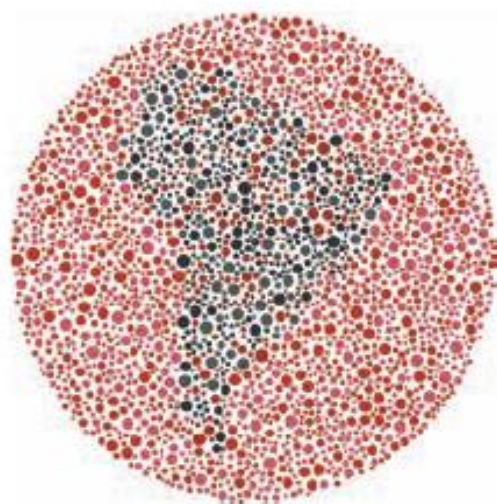
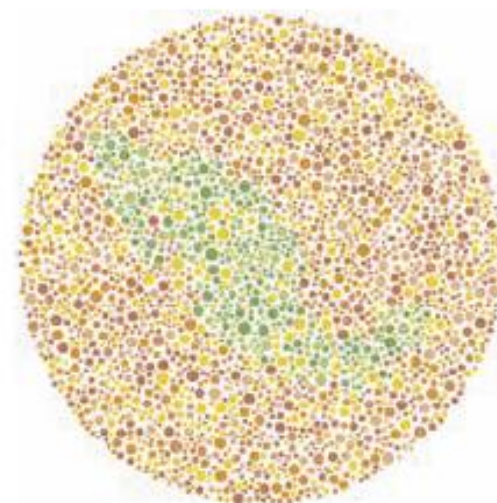
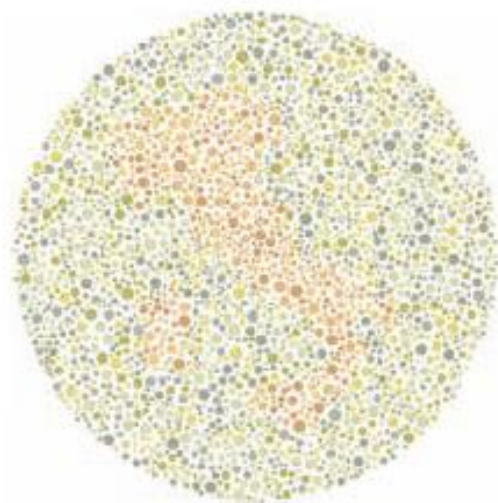
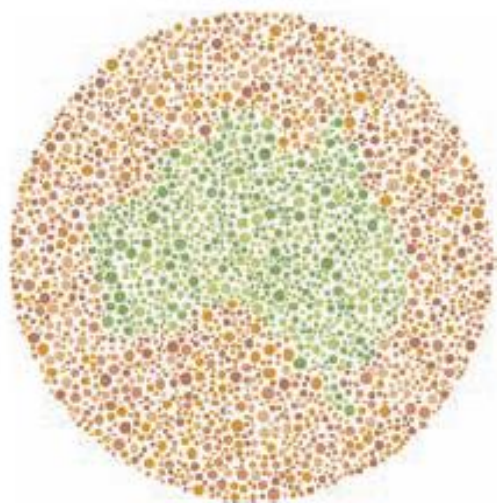
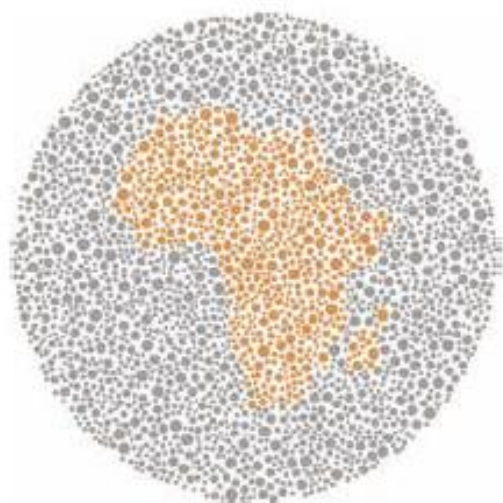
Generalisation Wheel
A Cartographer's Generalisation Palette



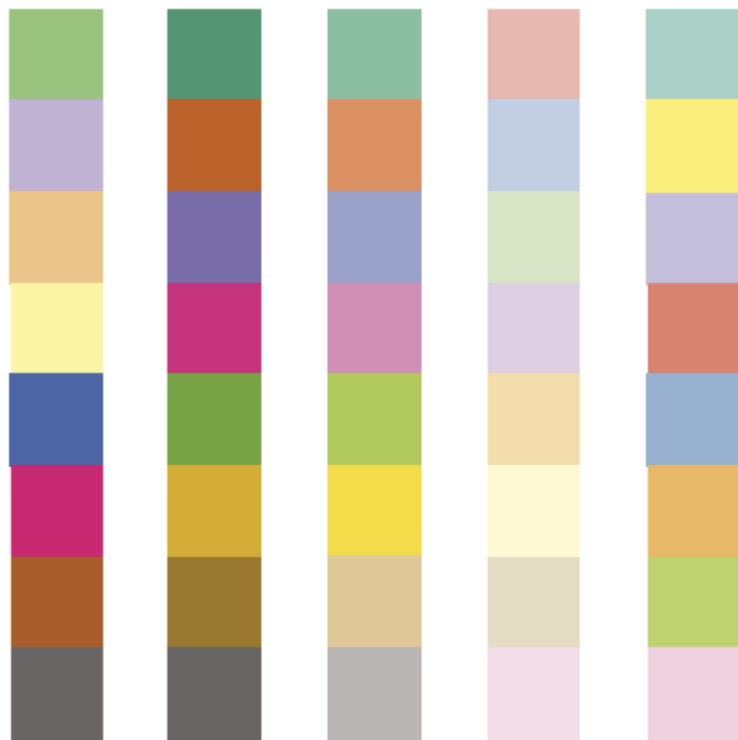
Design color







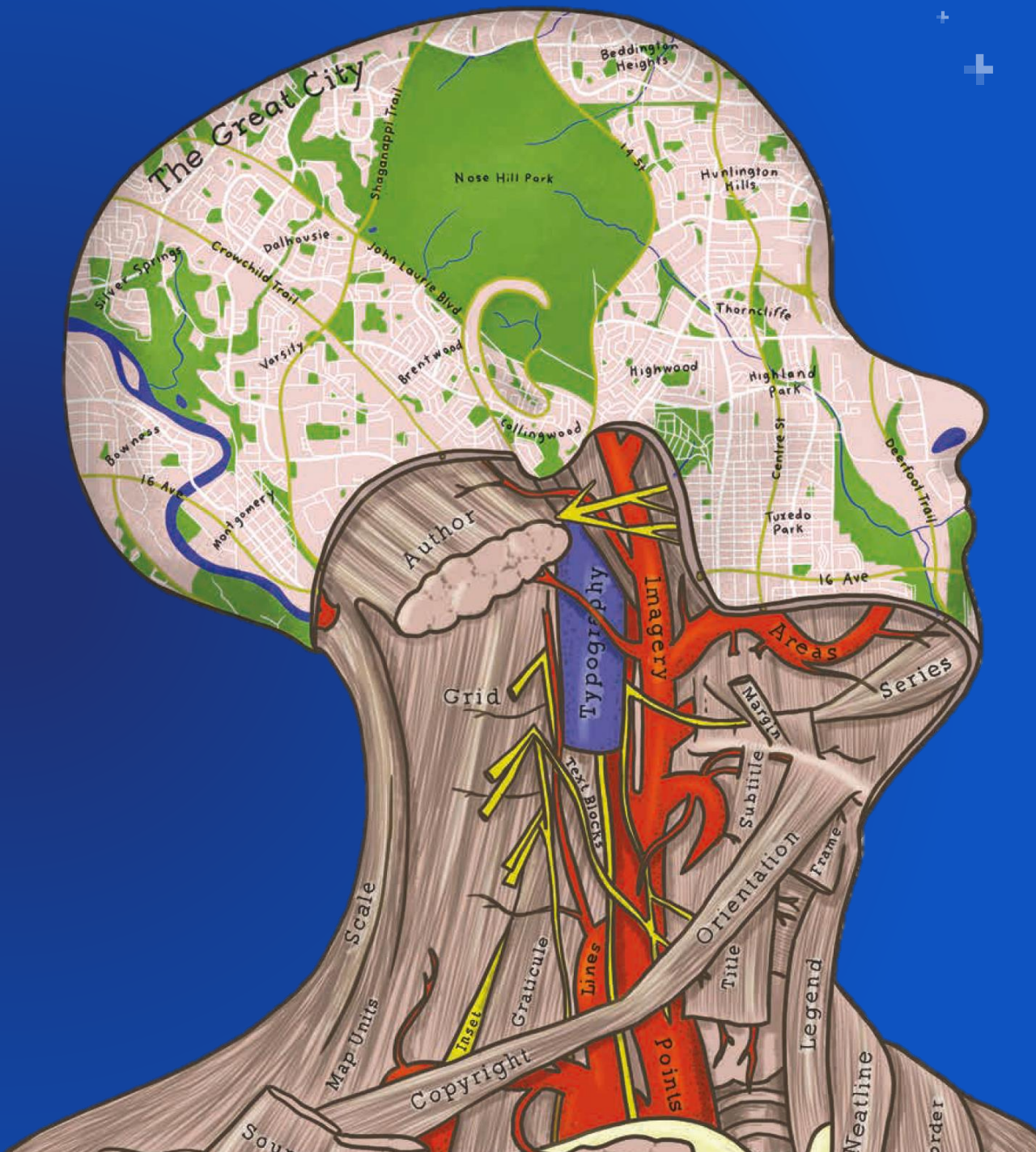
Qualitative



How have you used color?



Design typography





How have you designed the lettering?



Comic Sans walks into a bar

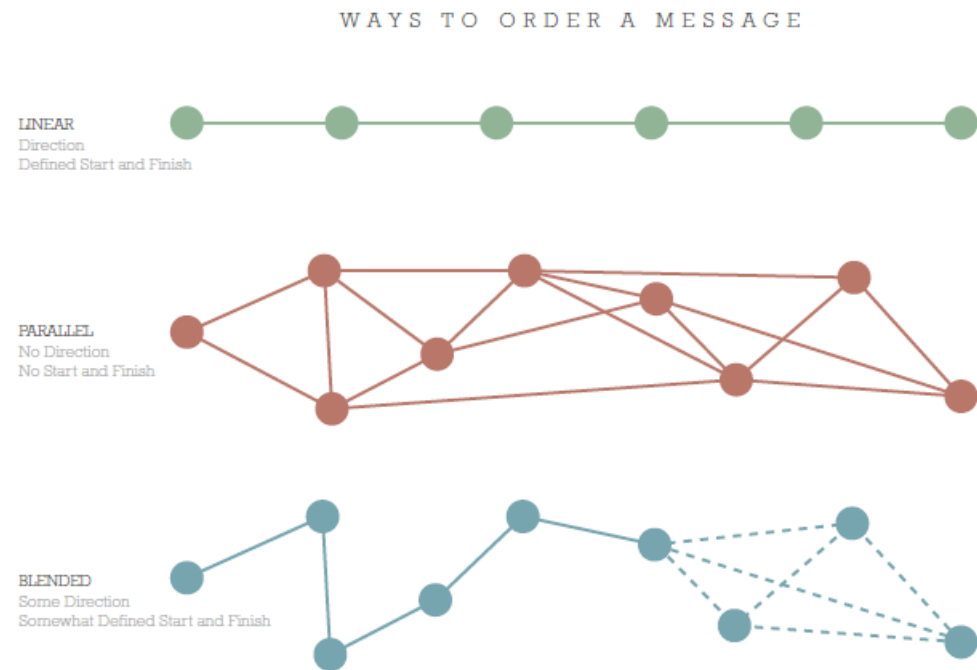
Barman says

"sorry, we don't serve your type"



Design layout





Skeletal grid column

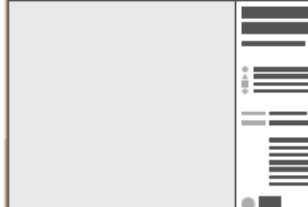
Title and subtitle at top



All marginalia beneath the map



Map bleeds off page, detail in a column



Map shape, detail in a column



Interval grid column

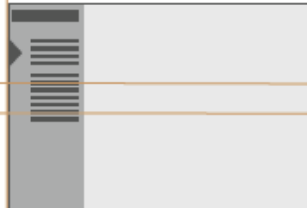
Map shape, detail around



Web map, marginalia in drop-down



Web map, marginalia in pop-outs



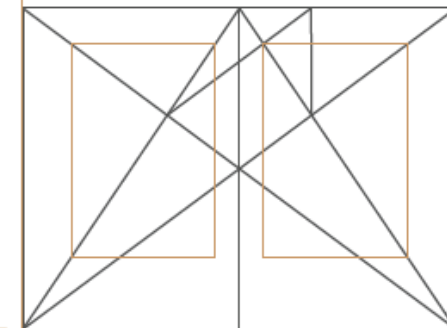
Web map, click, hover, floating pop-ups



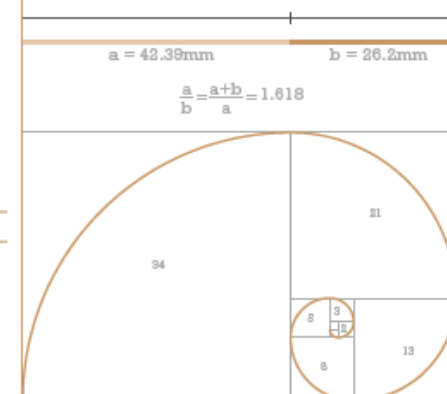
Web map, storytelling template



Golden ratio



Golden spiral



In mathematics a Fibonacci number sequence is that where each number is the sum of the preceding two numbers:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ...

The golden spiral is based on an approximation of the sequence of Fibonacci numbers which equate to length of the edges of successive squares. This creates identically proportioned rectangles, each of which has a ratio of 1.618 of the length of the long side to that of the short side.

Mapped area: the map itself comprising symbolised points, lines, and areas and typographic components, possibly with the use of imagery.

Inset/locator map: showing the larger mapped area in context or detail of a small part of the mapped area.

Title and subtitle: the wording that communicates the theme of the map.

Neatline, frame, or border: a line that bounds the active map area, frequently constructed from lines of an underlying graticule or grid.

Graticule: lines of parallels of latitude and meridians of longitude.

Grid lines: a reference grid unrelated to latitude or longitude.

Graticule or grid line labels: specifying coordinates in degrees or map units.

Margin: an area between the active map and the edge of the display, sometimes literally used to contain marginalia on map sheet series.

Scale: a statement of the distance range of the map, graphical or a verbal statement, often not required on small-scale thematic maps or where scale differs across the map because of coordinate system or perspective.

Legend: list of symbols and their descriptions used to assist map interpretation.

Orientation: a north arrow or other similar symbol to orient the viewer to the map, often unnecessary if a graticule is included or for thematic maps or where the coordinate system means north varies across the map.

Source: statement of the origin of data

Copyright: statement of permissions granted or of the copyright holder of the map.

Map series legend: used if the map is part of a sheet series.

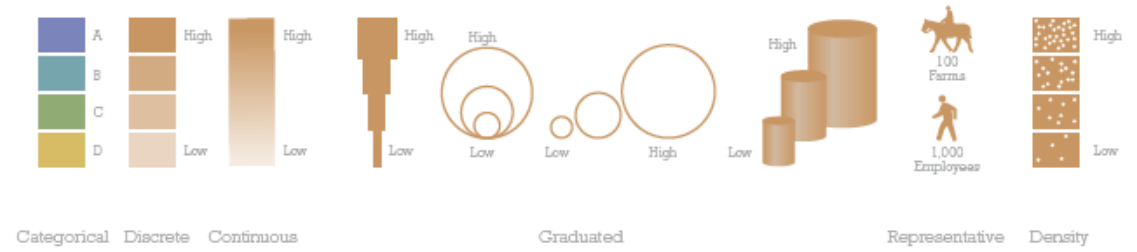
Text blocks: description and/or statements of datums and coordinate systems used or of the date of data and revisions.

Author details: a statement on who made the map helps give it authority.

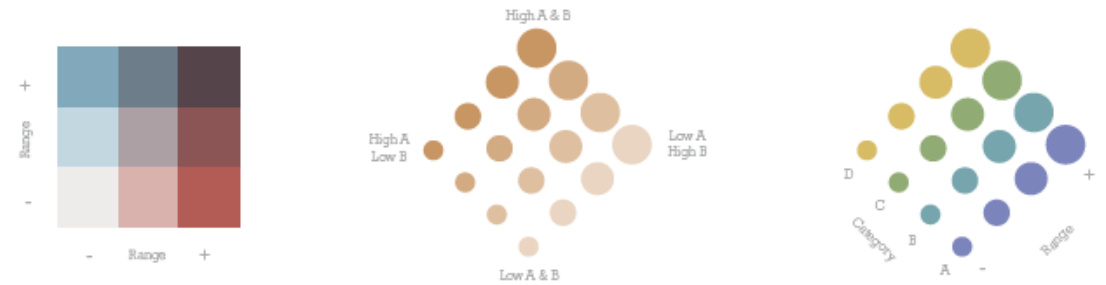
Features Key



Thematic Legends



Multivariate Legends



Multipurpose Legends



A checklist can help with critique and review

Map Evaluation Checklist

Questions to consider when performing map critique

Name of author

Date of evaluation

Title of map

Map sheet (if in a series)/URL

Cartographic Requirement

What is the rationale for the map?

What is the purpose of the map (i.e. the substantive objective)?

What is the "look and feel" of the map (i.e. the affective objective)?

Who is the audience for the map?

What is the expected educational level of the audience for the map?

What are the expected conditions of use for the map (medium, distance, light, etc.)?

Cartographic Compilation and Design

Have all required themes and features been included?

Does the map have appropriate figure-ground organisation?

Is there appropriate visual hierarchy among all themes and within each theme?

Is there appropriate visual emphasis on the important theme(s)?

Is the symbology for qualitative and quantitative data effectively applied?

Do the colours and symbols support the substantive and affective objectives?

Do the font styles, size, and colour support the substantive and affective objectives?

Are the symbols and labels legible?

Are the symbols intuitive and easy to decipher or do they have good explanation?

Is there appropriate use of graphics, images, text blocks, and other supporting information?

Can the map be placed in context both geographically and thematically?

Is the map projection suited to the map's purpose (equal area, conformal, etc)?

Has the map projection been appropriately modified (central meridian, standard parallels, etc.)?

Map Elements and Page Layout

Does the page look balanced?

Do all the map elements support the substantive and affective objectives?

Are the map elements placed logically on the page?

Are the map and map elements aligned to the page and to each other?

Does the map have appropriate borders?

Orientation Indicator

Is the grid or graticule appropriately aligned?

Does the grid or graticule have appropriate labeling?

Does the map require a north arrow?

Scale Indicator

Is the scale appropriate to the map?

Is the scale bar appropriately designed, positioned, and sized?

Are the scale units logical?

Legend

Have all the necessary symbols and details been included in the legend?

Do the symbols in the legend appear exactly as they do on the map (size, colour, etc.)?

Is there a logical structure related to the function of the legend?

Are the patches, symbols, labels, and descriptions appropriately sized and positioned?

Are the labels logical?

Titles and Subtitles

Are the titles and/or subtitles relevant?

Are the titles and/or subtitles suitably descriptive (area mapped, subject, date, etc.)?

Are the titles and/or subtitles suitably positioned and sized?

Production Notes

Are production notes included?

Are the production notes dated correctly?

Are the production notes placed appropriately?

Have copyrighted sources been correctly attributed?

Has the map's assertion to copyright been included?

Have attribution and/or revision details been included?

Synopsis and Final Check

Given your responses to the above, provide an overall evaluation of the extent to which the design of the map meets its intended aims. You might also include here comments made by independent reviewers of the map as a new perspective that often reveals areas that the map author may have overlooked.

The Four Point Plan

Comment on four areas that work well and four that might require attention.

What works well?

What doesn't work so well?

One more thing

Actually...a few more things



The book

esripress.esri.com

Cartography.

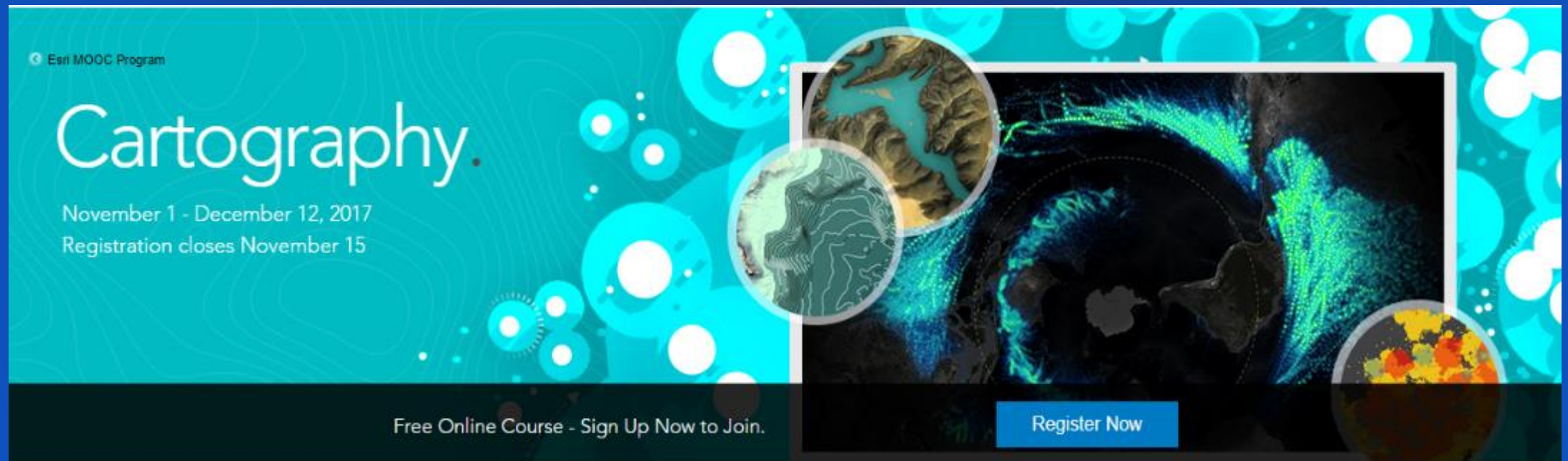


Kenneth Field



The MOOC

esri.com/mooc/cartography

A promotional banner for the 'Cartography' MOOC. The background is a teal gradient with white and light blue circular patterns of varying sizes. On the left, the text 'Esri MOOC Program' is in small white font, followed by 'Cartography.' in a large, elegant white serif font. Below this, the dates 'November 1 - December 12, 2017' and 'Registration closes November 15' are listed in a smaller white sans-serif font. At the bottom left, a dark teal bar contains the text 'Free Online Course - Sign Up Now to Join.' in white. On the right side, there is a large, dark rectangular area featuring a stylized world map with glowing green and blue lines representing data or connections. Overlaid on this are three circular inset images: the top one shows a topographic map of a mountain range, the middle one shows a map with green and blue data points, and the bottom one shows a map with yellow and orange data points. A blue button with the text 'Register Now' in white is positioned at the bottom right of the banner.

Esri MOOC Program

Cartography.

November 1 - December 12, 2017
Registration closes November 15

Free Online Course - Sign Up Now to Join.

Register Now

The URLs

esri.com/arcgis-blog

carto.maps.arcgis.com

cartonerd.com

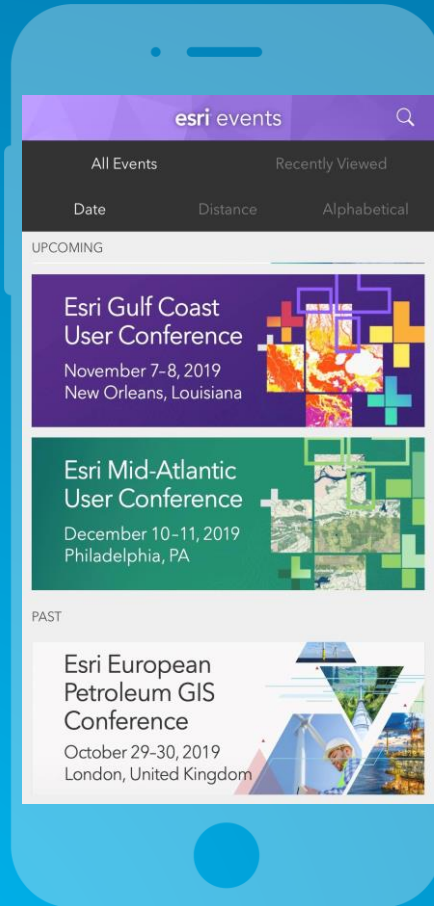
adventuresinmapping.com

mapdesign.icaci.org

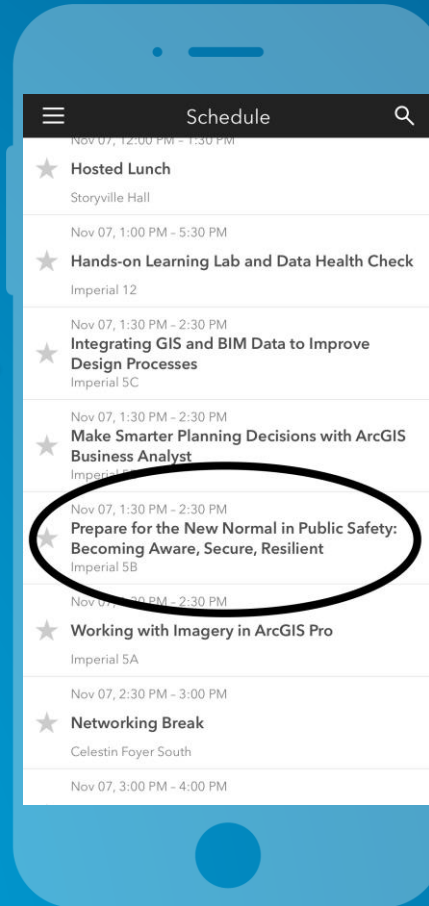


Give Us Your Feedback

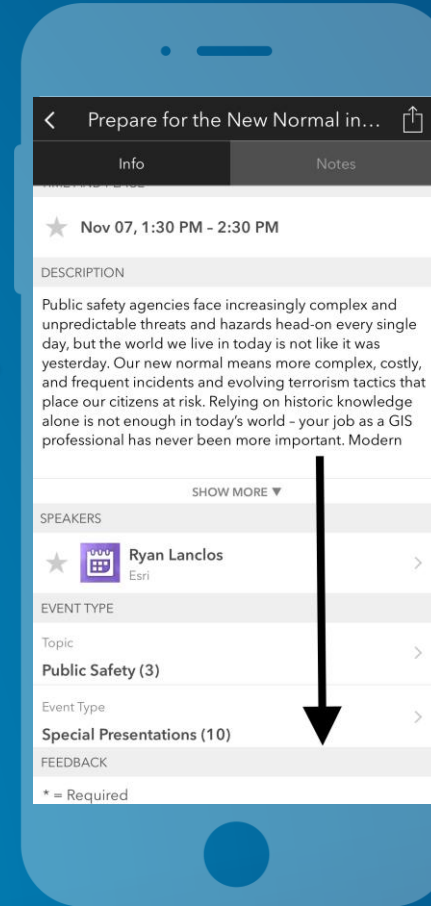
Download the Esri Events app and find Gulf Coast UC



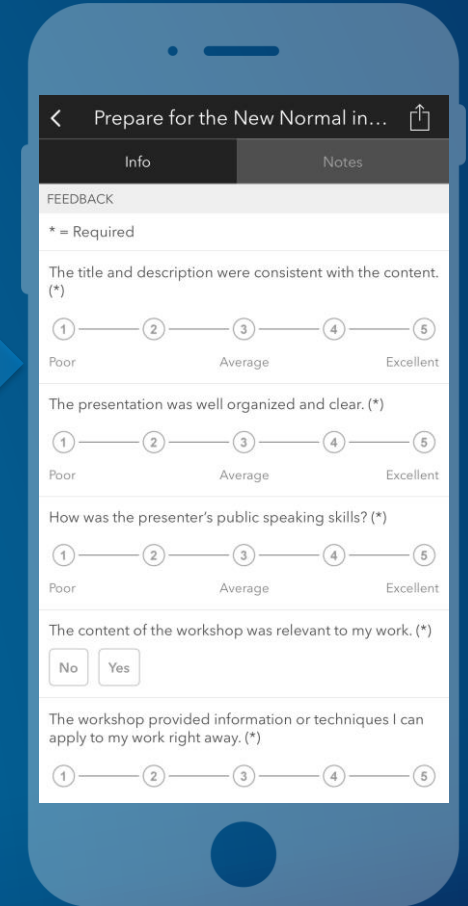
From the schedule, select the session you attended



Scroll down below the description to find the feedback section



Complete answers and select "Submit"





esri

THE
SCIENCE
OF
WHERE