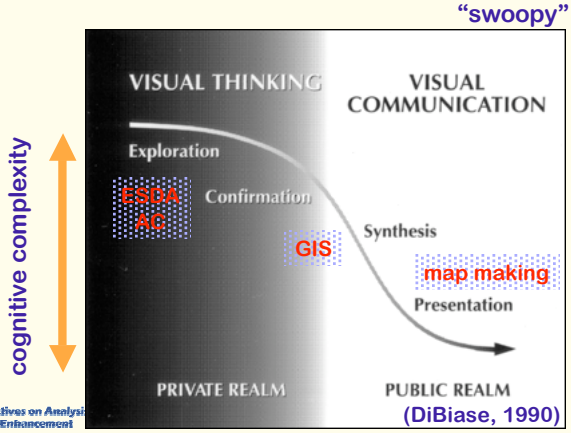
use of visual methods in research

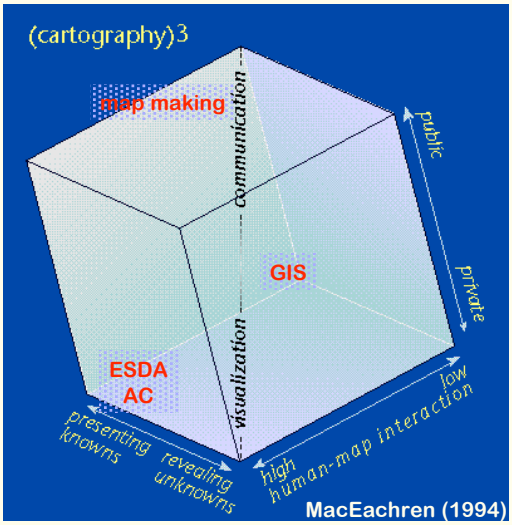
- in/transformation/out process from AC (Tobler)
- "exploration" etc. from E(s)DA (Tukey)
- "private" vs. "public" from GIP (Bertin)

"swoopy"



(DiBiase, 1990)

GeoVis



MacEachren (1994)

Spatial Perspectives on Analysis for Curriculum Enhancement

sara irina fabrikant

the art in cartography

design issues

"maps are products of *art* clarified by science"

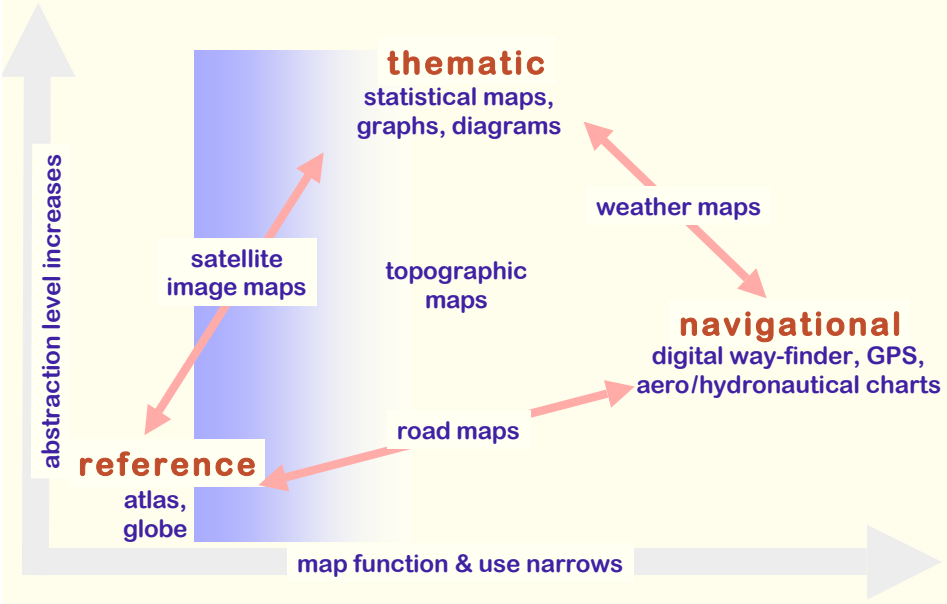
Max Eckert (1908)

science?

"Watch! Three folds left, two folds up, one fold down, two folds at a 57-degree angle ... I'm tellin' ya, it's beautiful! No one can ever refold it!"

outline

- map types
- cartographic process
  - generalization
- design issues
  - the visual variables
  - symbolization



modified from B. Buttenfield

reference maps

- storage of spatial information
- show location, type and variety of tangible features in the environment
- general purpose: a dictionary of features
- geographic features
  - land: coastlines, mountains, roads
  - water: rivers, lakes etc.
  - landmarks
- give answers to spatial questions
  - where?
  - what?
  - when?

a reference map

thematic maps

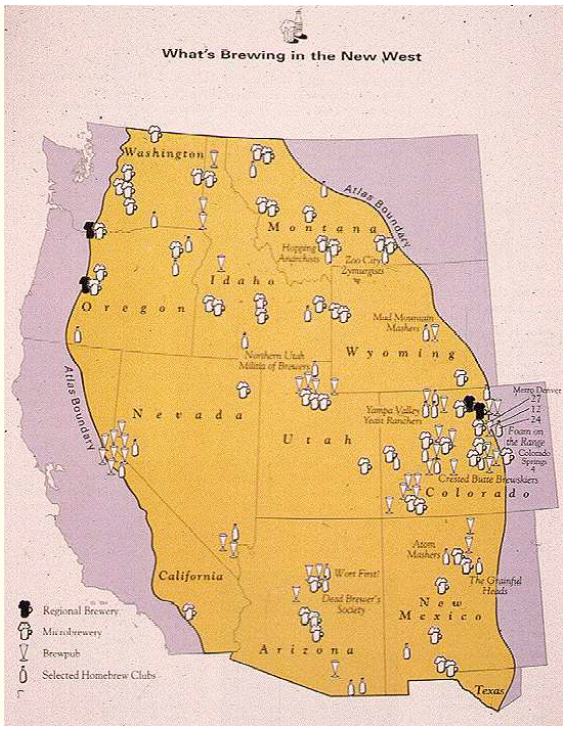
- tell a story: show distribution of phenomena in space
- specific purpose: a graphic theme, or essay

story types...

- to illustrate spatial patterns
  - base map as reference - blue transition in handout
  - thematic overlay
- qualitative: distribution maps
  - what, when and where?
  - category membership
- quantitative: statistical maps
  - what, when, where and how much?
  - category membership
  - sequence, ranks, magnitude

distribution maps

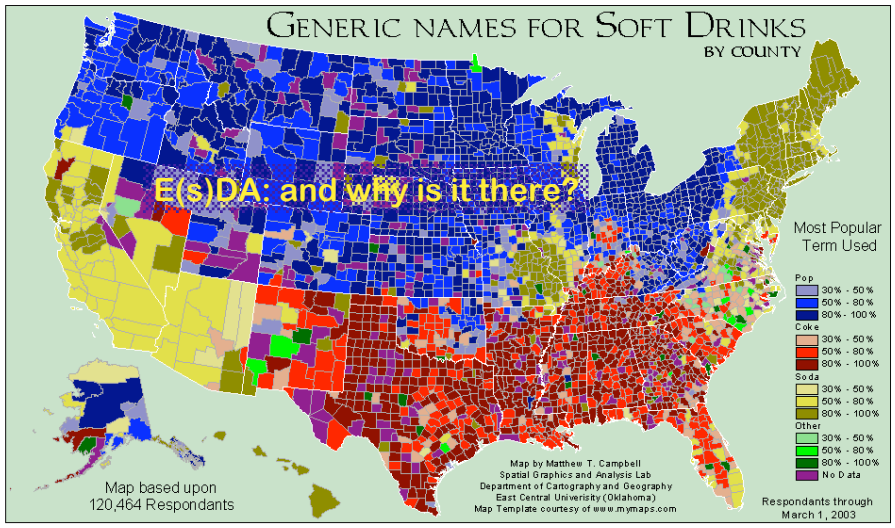
illustrate spatial patterns"
what is where?



SPACE Spatial Perspectives on Analysis for Curriculum Enhancement

statistical maps

illustrate and quantify spatial patterns: what and how much is where?

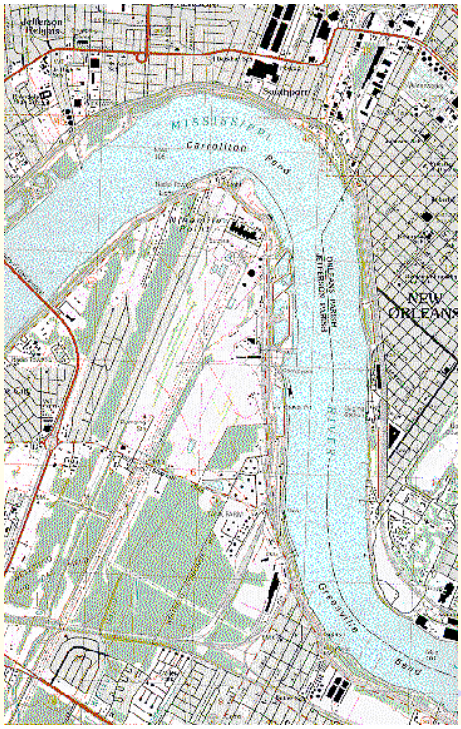


navigational charts/maps

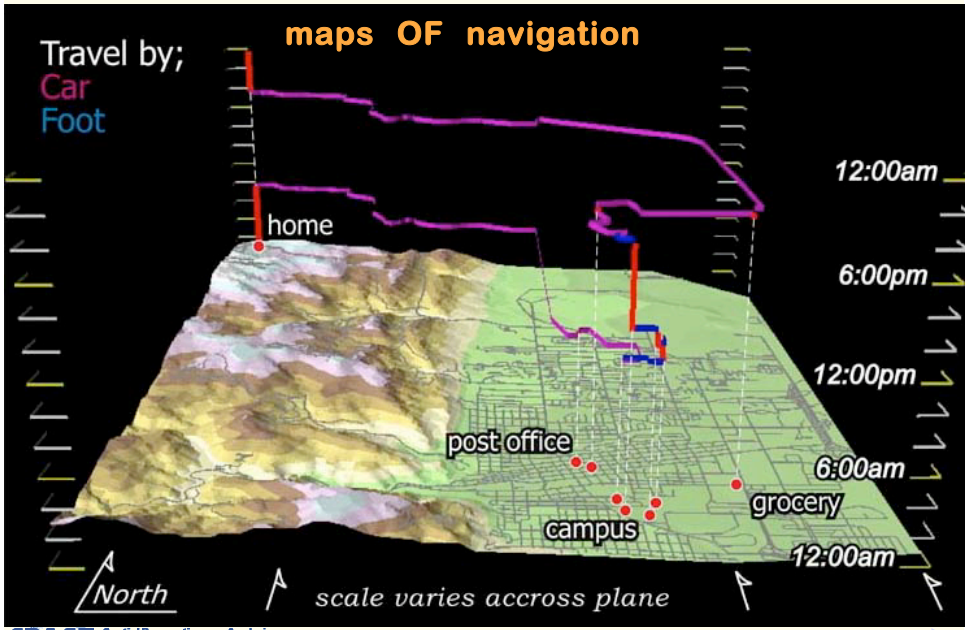
- help guide movement in space:
  where to go? how far? how to get there?

- aid in decision-making, guide spatial behavior
  - tourist maps/charts/plans
  - GPS maps
  - location based services (LBS)

maps FOR navigation



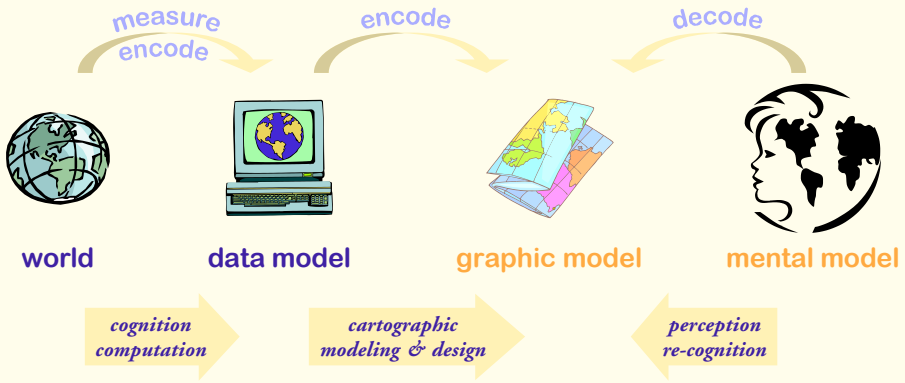
maps OF navigation

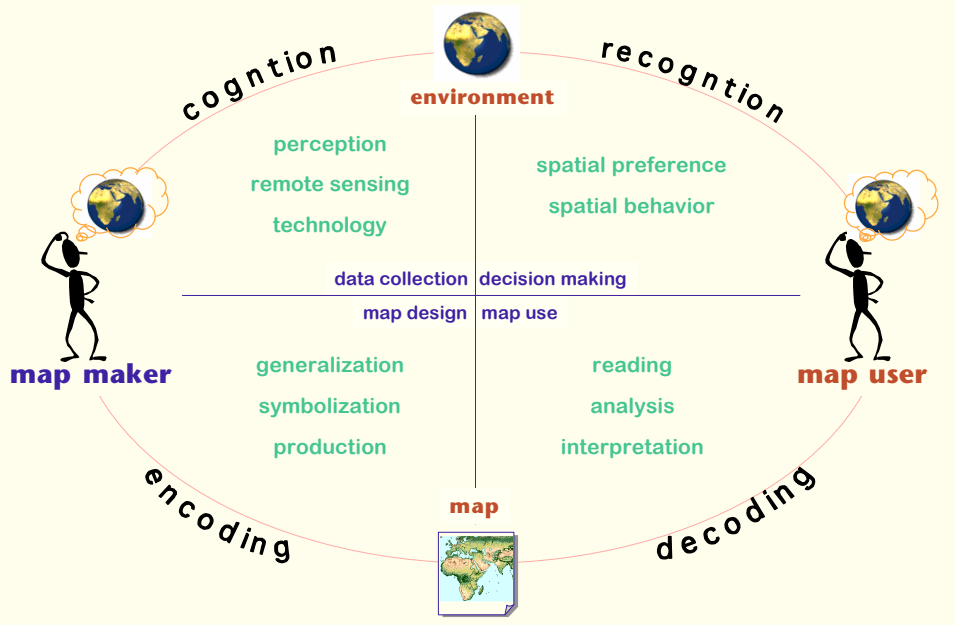


outline

- map types
- cartographic process
  - generalization
- design issues
  - the visual variables
  - symbolization

cartographic process





modified from B. Buttenfield, Muehrke

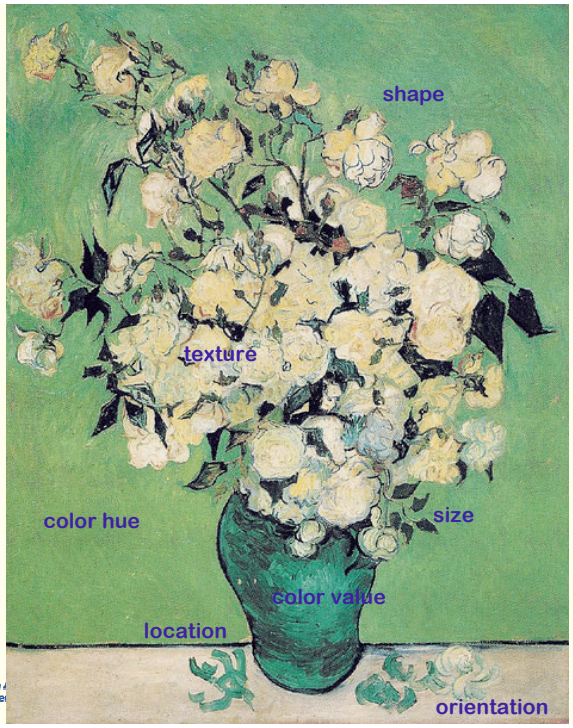
the three pillars of map design...

- theme
  - what needs to be represented?
- audience
  - for whom?
- purpose
  - what for?
- (potential design restrictions)
  - format and scale
  - technical details: paper, digital etc.

outline

- map types
- cartographic process
  - generalization
- design issues
  - the visual variables
  - symbolization

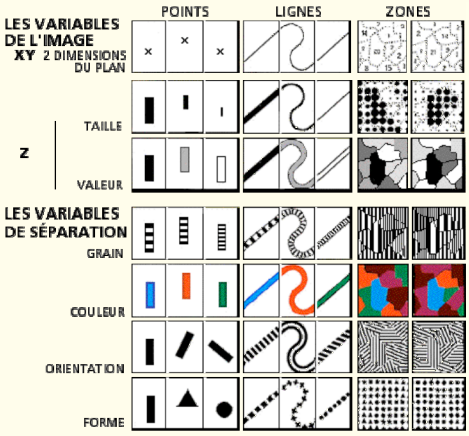
art...



Van Gogh,
Vase of Roses, 1890

the visual variables

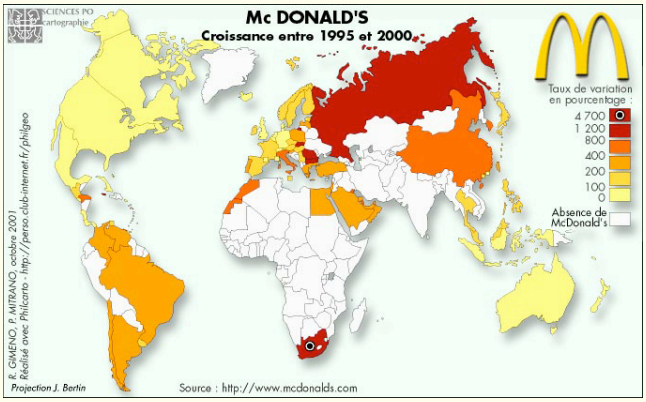
Jacques Bertin's Sémiologie Graphique (1967, 1998)



Picasso, Girl before a Mirror, 1932

visual communication

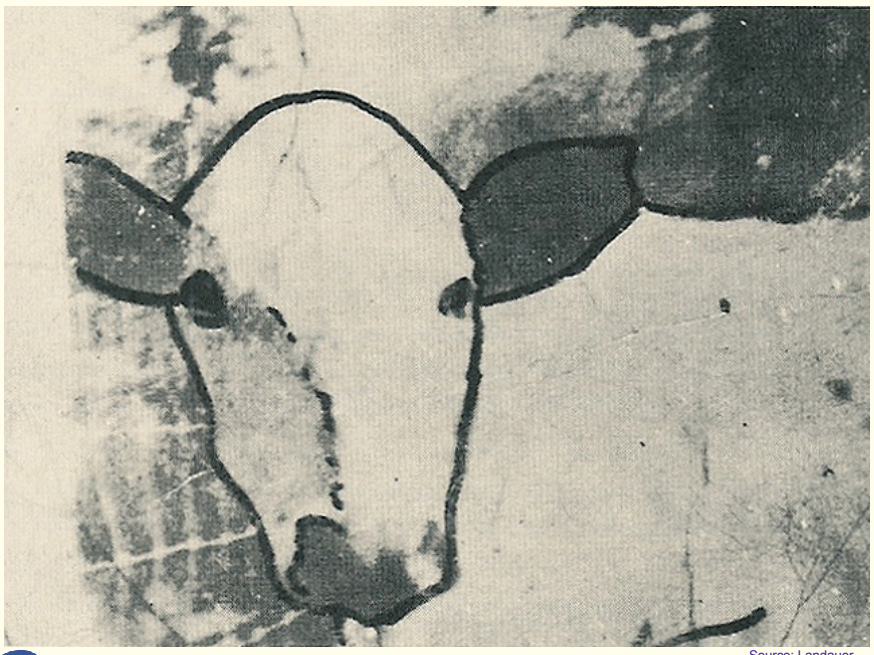
art: visual emotions



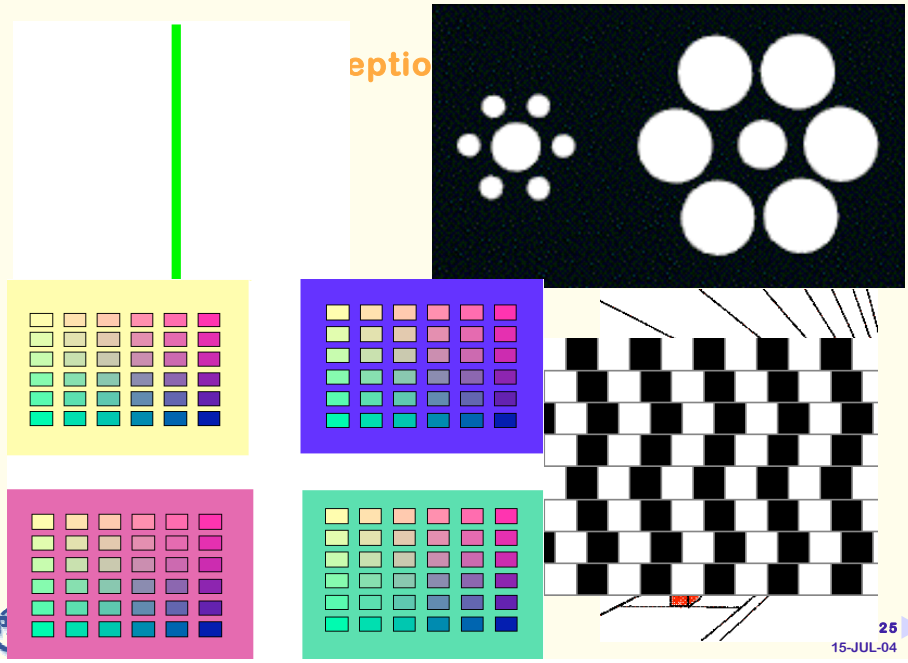
thematic mapping: visual data relationships

1st design law of cartography?

thematic relevance = perceptual salience



Source: Landauer



seeing vs. looking

inattentional blindness

- failure to “see” presence of unexpected items

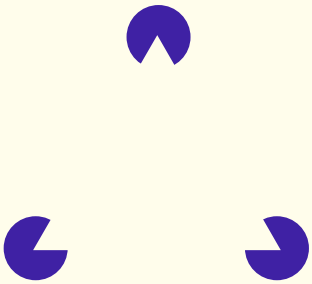
change blindness

- failure to “see” large changes in display, occurring simultaneously with a persons’ eye movements or flicker of display

principles of perceptual organization

"all features are equal, but some are more equal than others"

Gestalt Laws of Organization

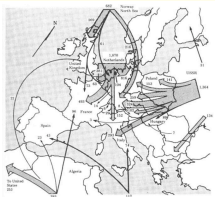


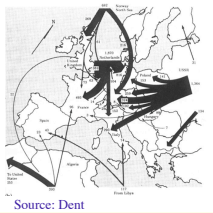
1. figure and ground

- a figure
  - part of the visual field
  - has meaning, stands out form the rest
- the ground
  - part of the visual field
  - has less relevance, remains in background
- including grouping, closure, good continuation, common fate, etc.

this means for cartography...

- figure-ground: the three map planes
  - foreground
  - middle ground
  - background
- visual and semantic hierarchies
  - visual: darker features stand out
  - semantic: roads are most important on a road map
- foreground
  - most important visual plane





Source: Dent

outline

- map types
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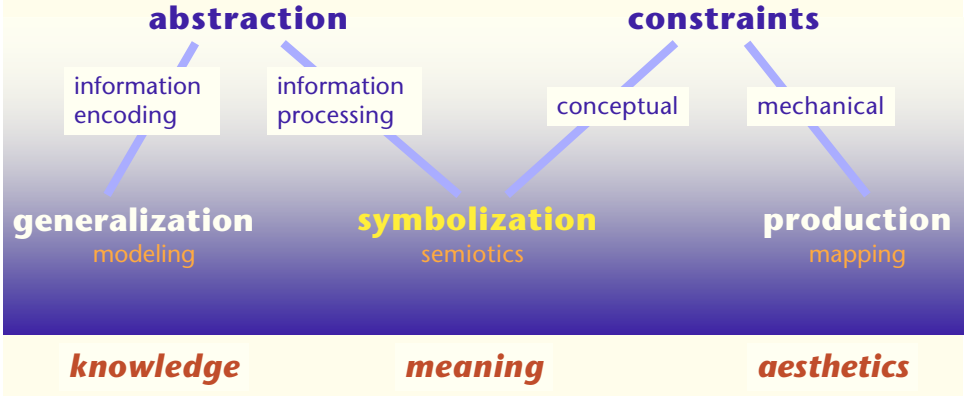
  - generalization
- design issues
  - the visual variables
  - symbolization

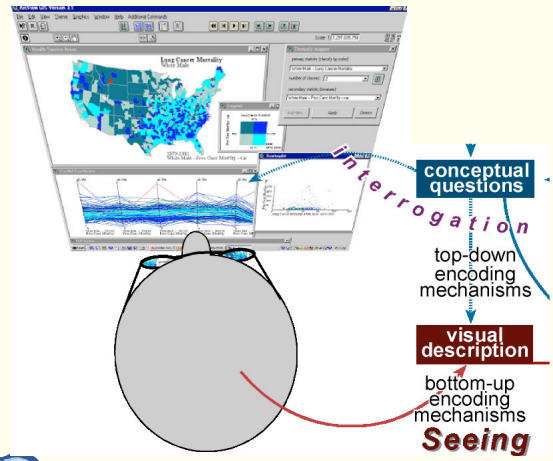
map design



(redrawn from B. Buttenfield)

geovisualization

- matching representation to support cognition…



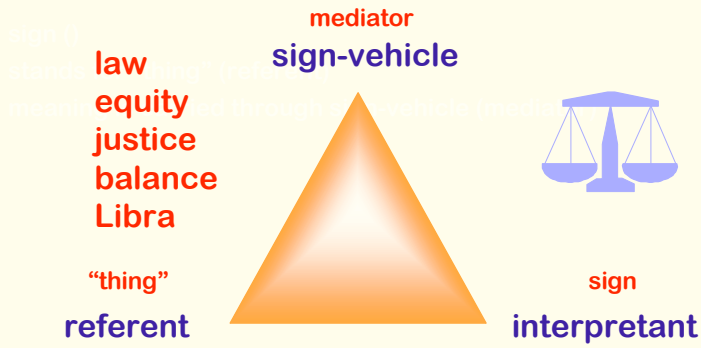
map symbolization

functional approach to visualization:

- how to communicate knowledge with graphic marks?
- how to logically and coherently link data to graphics?
  - cartographic language is not like natural language
- semiotics
  - the study of sign systems

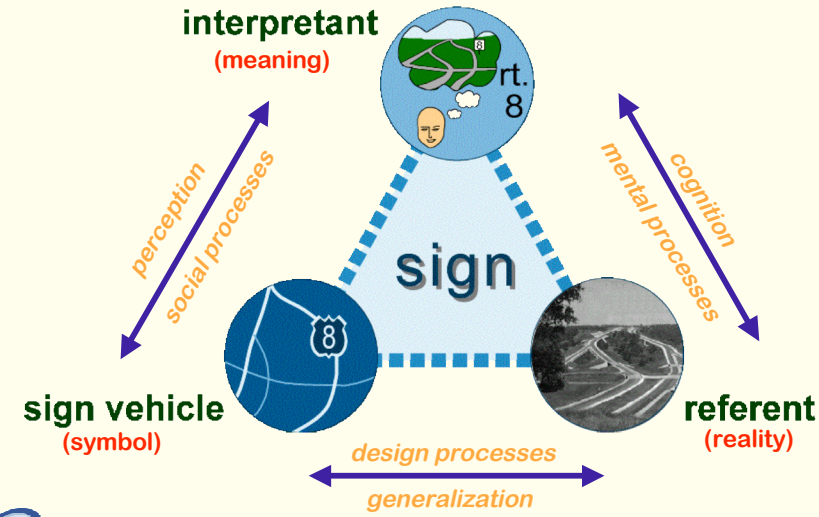
semiotics

relationships of symbols and and their contribution to meaning



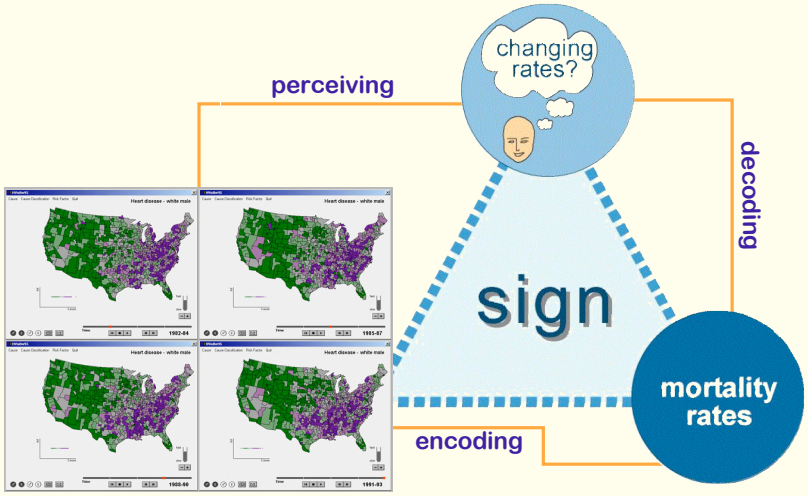
(after Pierce, de Saussure)

map semiotics



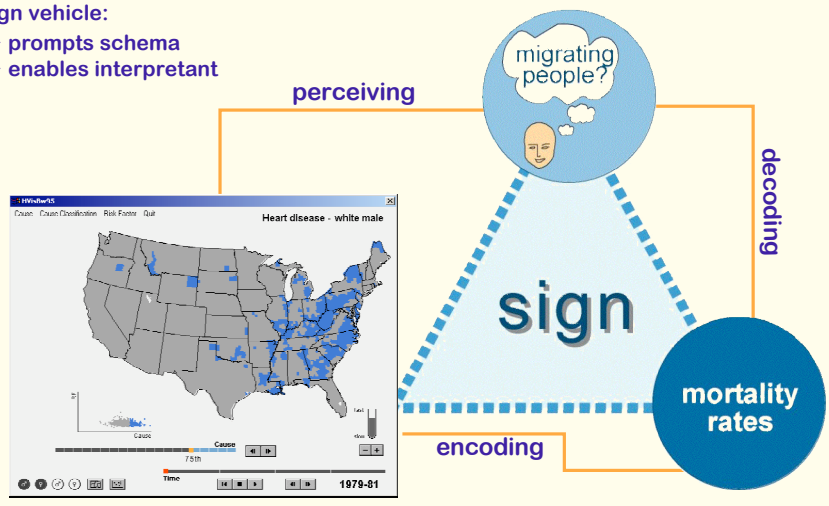
after MacEachren (1995)

map semiotics



map semiotics

sign vehicle:
- ➔ prompts schema
- ➔ enables interpretant



map abstraction process

- based on feature characteristics
- levels of measurements
- visual variables

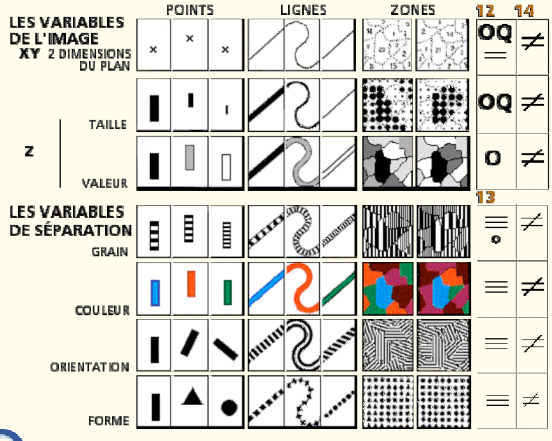
➔ semantic generalization

➔ geometric generalization

geometric feature class	feature characteristic	measurement levels	map symbols	visual variables
point line area	discrete discontinuous continuous mosaic stepped smooth	nominal ordinal interval ratio	points vectors polygons	size shape orientation texture color hue value

the visual variables

- Jacques Bertin's Sémiologie Graphique (1967, 2000)



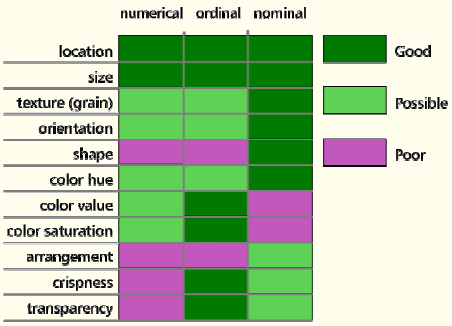
quantitative (magnitude)
Q : proportion (interval/ratio)

qualitative (relationships)
O : order (ordinal)
≠ : association (similarity)
≡ : distinction (difference)

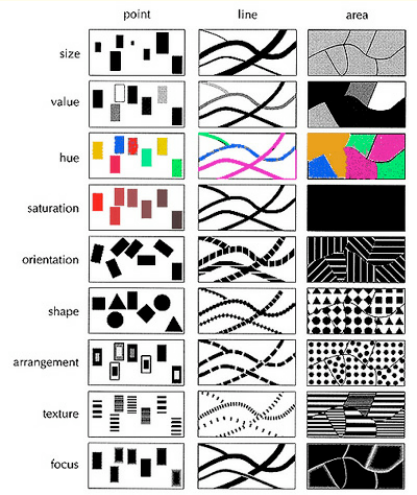
Proportionnalité : Q
Ordre : O
Associativité : ≠
Sélectivité : ≡

the visual variables

- example of modifications
  - Spiess (1990)
  - MacEachren (1994)
  - Buttenfield (1999)



MacEachren & others



MacEachren (1995)

map symbolization

goal: graphic model vs. data model ➔best fit

- data model: e.g., volumes (continuous, 3D) at points & areas

2D gm

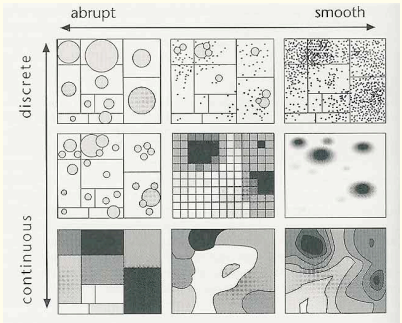


FIGURE 6.53. A syntactics of map forms. *Reproduced from MacEachren (1992b, Fig. 9, p. 16). Reprinted by permission of* Cartographic Perspectives.

3D gm

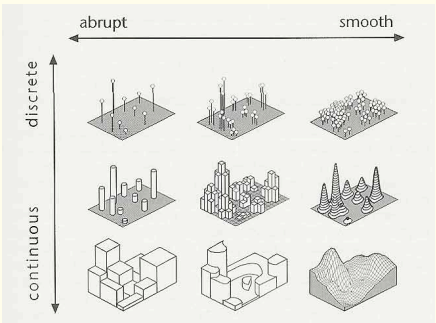
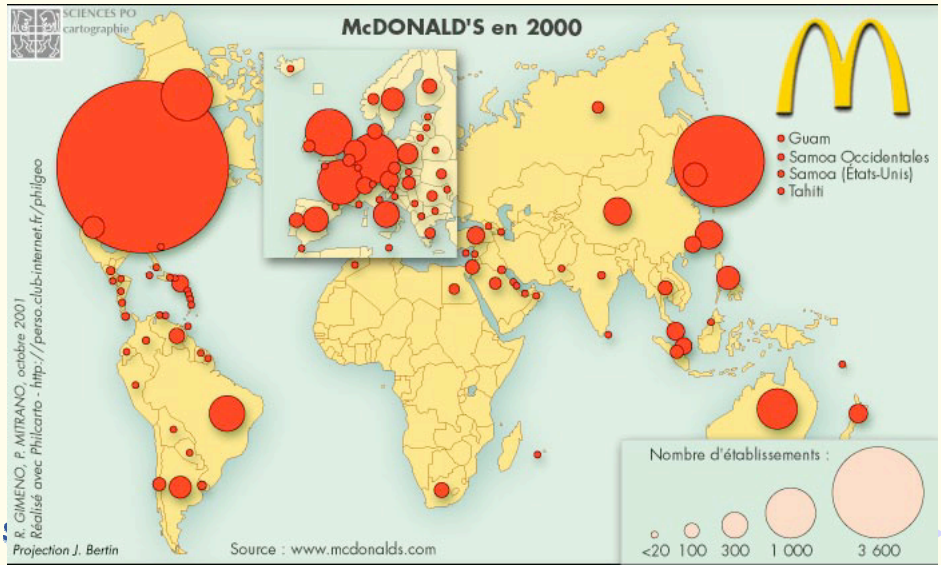


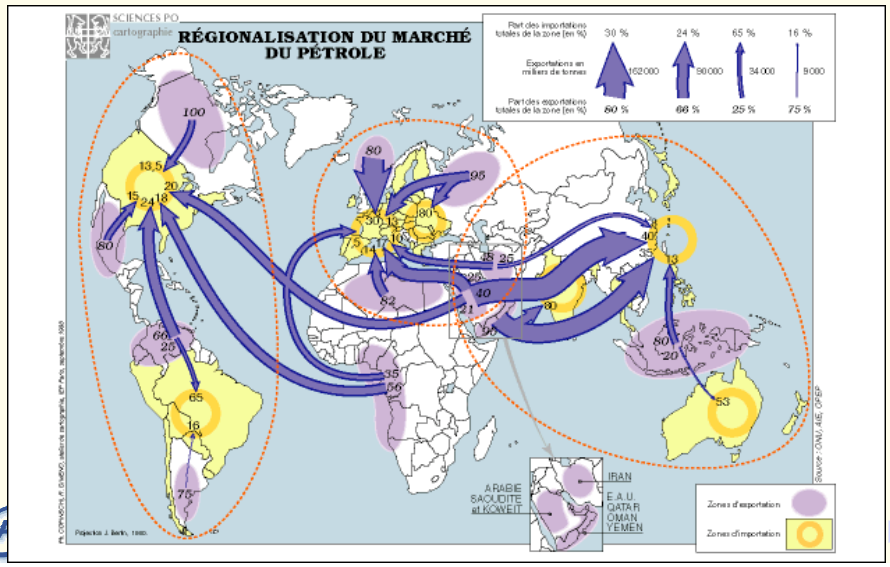
FIGURE 6.52. A typology of data models. *Reproduced from MacEachren (1992b, Fig. 8, p. 16). Reprinted by permission of* Cartographic Perspectives.

MacEachren (1995)

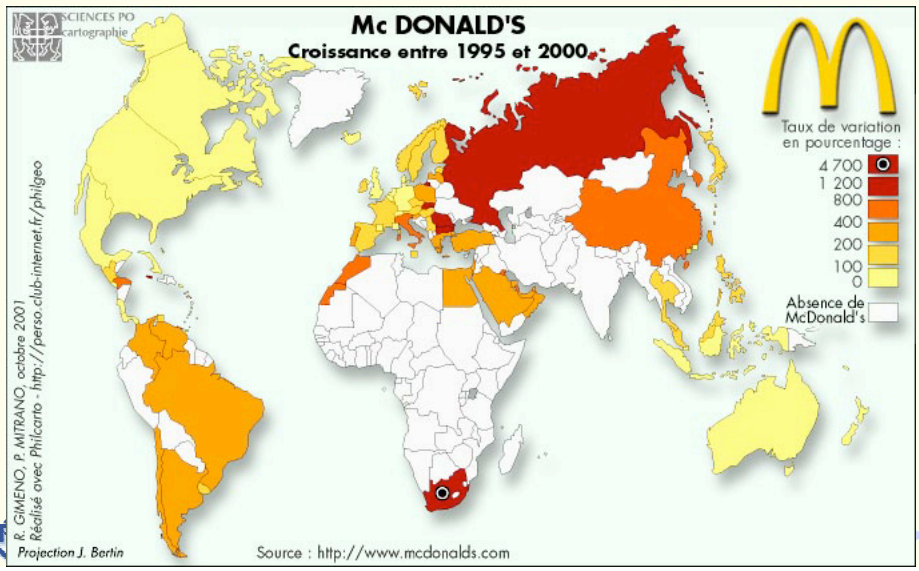
points



lines

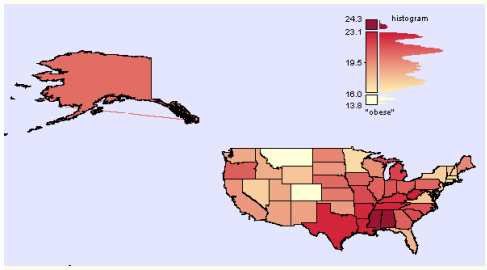


areas

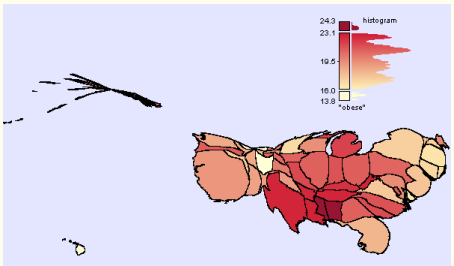


thematic relevance = perceptual salience

U.S. obesity in 2000
(BMI ≥ 30, or ~ 30lbs. overweight for a 5' 4" woman)

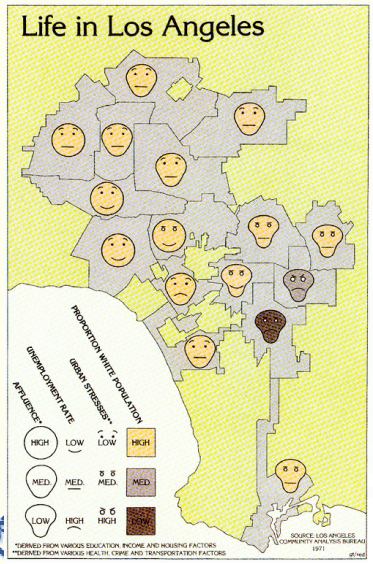


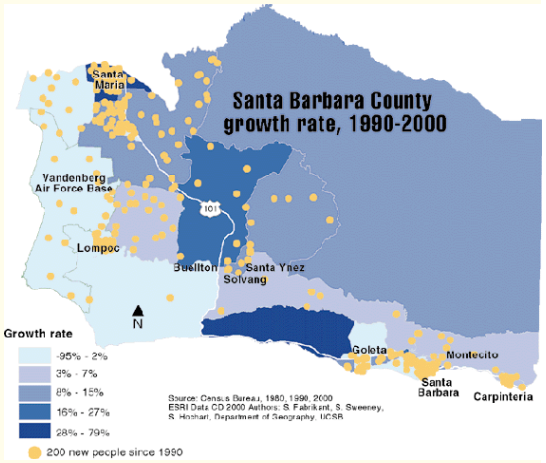
choropleth



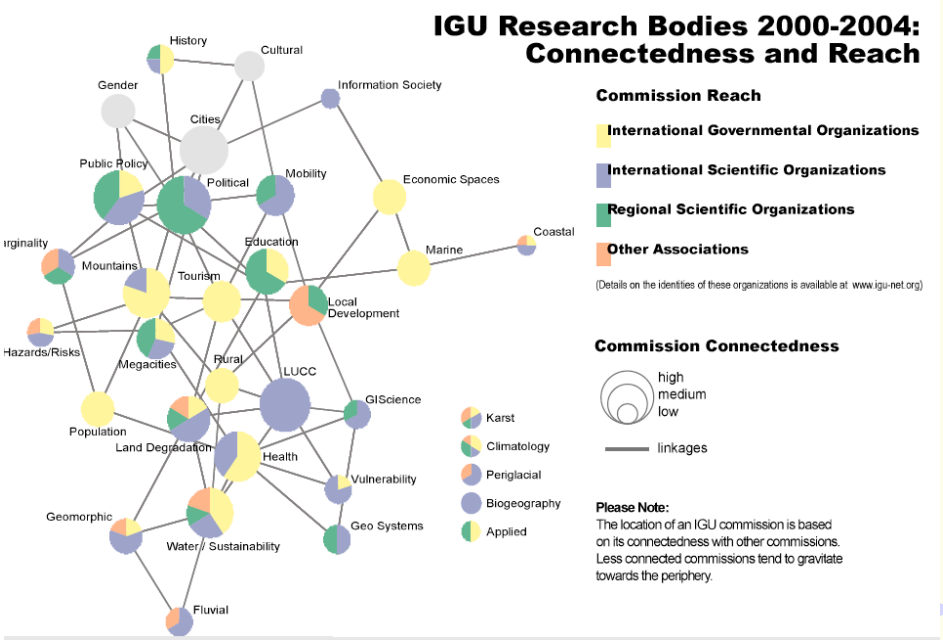
cartogram

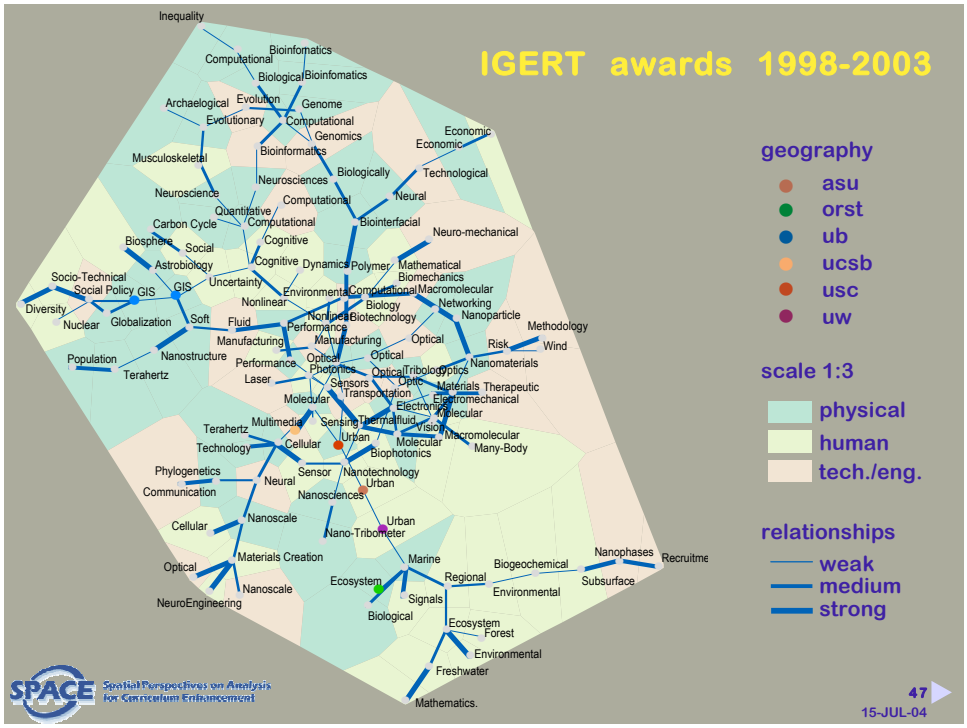
multivariate





non-geographic maps




IGERT awards 1998-2003
geography
asu
orst
ub
ucsb
usc
uw
scale 1:3
physical
human
tech./eng.
relationships
weak
medium
strong
Inequality
Bioinformatics
Computational
Biological
Bioinfomatics
Archaeological
Evolution
Genome
Evolutionary
Computational
Genomics
Economic
Economic
Bioinformatics
Musculoskeletal
Biologically
Technological
Neurosciences
Neuroscience
Neural
Computational
Quantitative
Carbon Cycle
Computational
Biointerfacial
Biosphere
Social
Cognitive
Neuro-mechanical
Astrobiology
Cognitive
Dynamics
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Mathematical
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Biomechanics
Social Policy
GIS
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Soft
Fluid
Performance
Nonlinear
Biotechnology
Nanoparticle
Methodology
Manufacturing
Manufacturing
Optical
Risk
Wind
Population
Nanostructure
Performance
Optical
Optical
Nanomaterials
Terahertz
Photonics
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Sensing
Thermal
fluid
Vision
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Molecular
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Many-Body
Phylogenetics
Sensor
Nanotechnology
Neural
Urban
Communication
Nanosciences
Cellular
Nanoscale
Urban
Nano-Tribometer
Materials Creation
Marine
Nanophases
Recruitme
Optical
Biogeochemical
Regional
Ecosystem
Subsurface
Nanoscale
Environmental
Signals
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Biological
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SPACE
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47
15-JUL-04