Visualizing Geographic Information

A map is the greatest of all epic poems. Its lines and colours show the realization of great dreams.

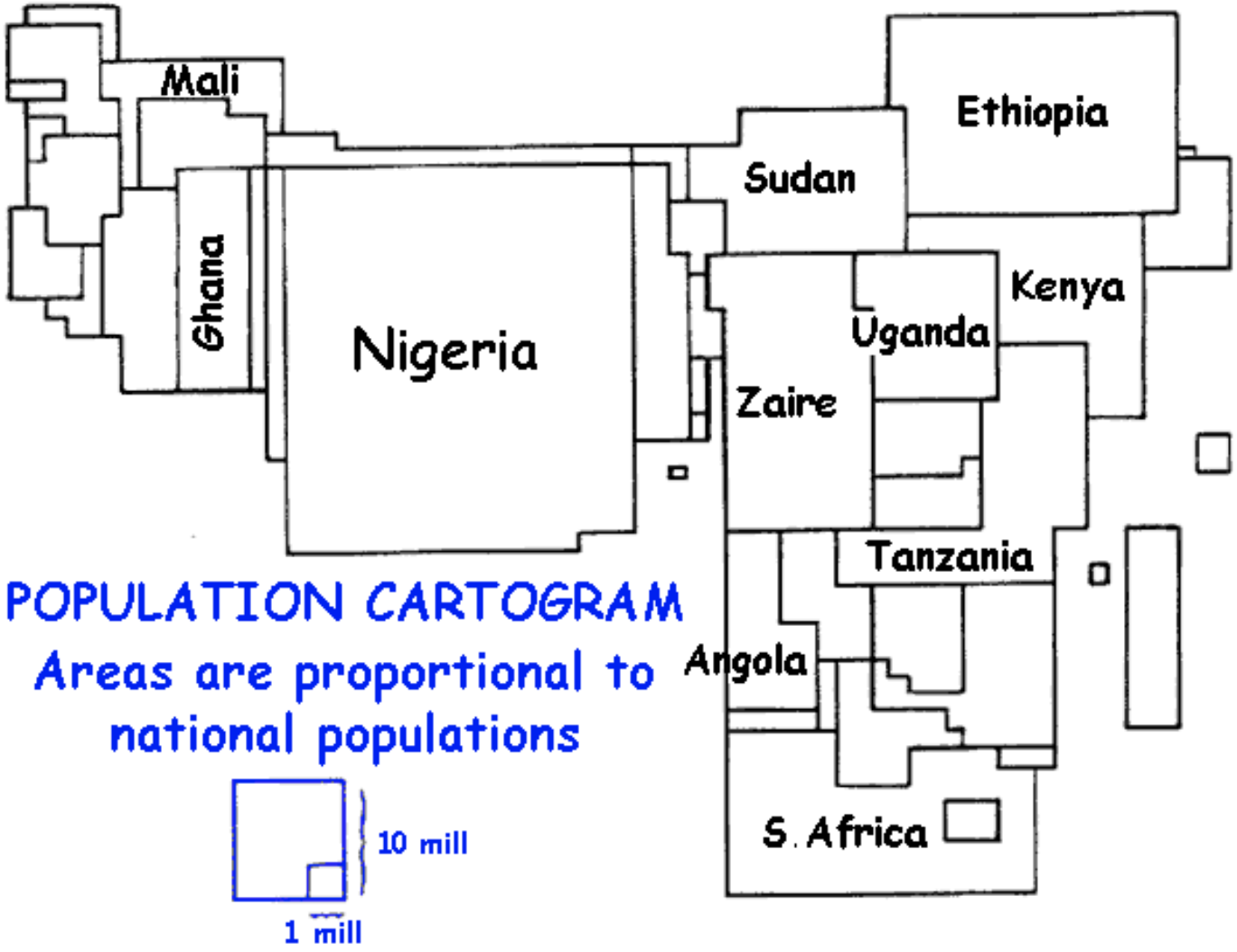
- Gilbert H. Grosvenor, National Geographic

Outline

- What is geographic data?
- Geographic principles
- Cartographic design
- Computer map visualization (tools)
- Internet-based tools
- Exercise

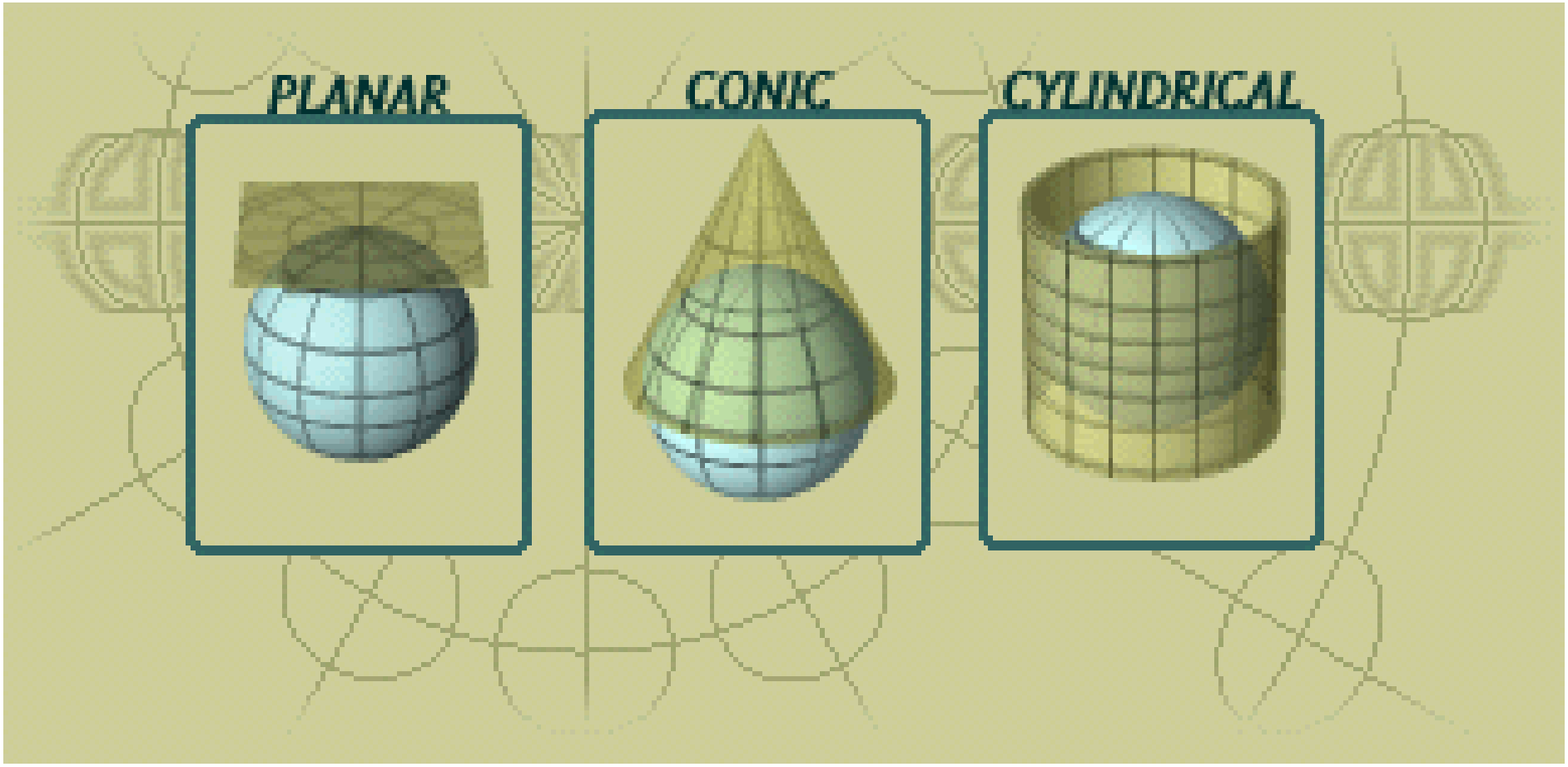
Mapping geographic data

- Visualizing information which has a spatial component
- Graphic representations of our environment
- Types of maps:
  - Chloropleth
  - Cartogram
  - Topographic
  - Nautical charts
  - Image
  - Thematic
  - etc. etc.
- Considerations:
  - Ellipsoid, projection and datum
  - Scale


Mali
Ghana
Nigeria
Sudan
Ethiopia
Kenya
Uganda
Zaire
Tanzania
Angola
S. Africa
POPULATION CARTOGRAM
Areas are proportional to national populations
10 mill
1 mill

Map Projections

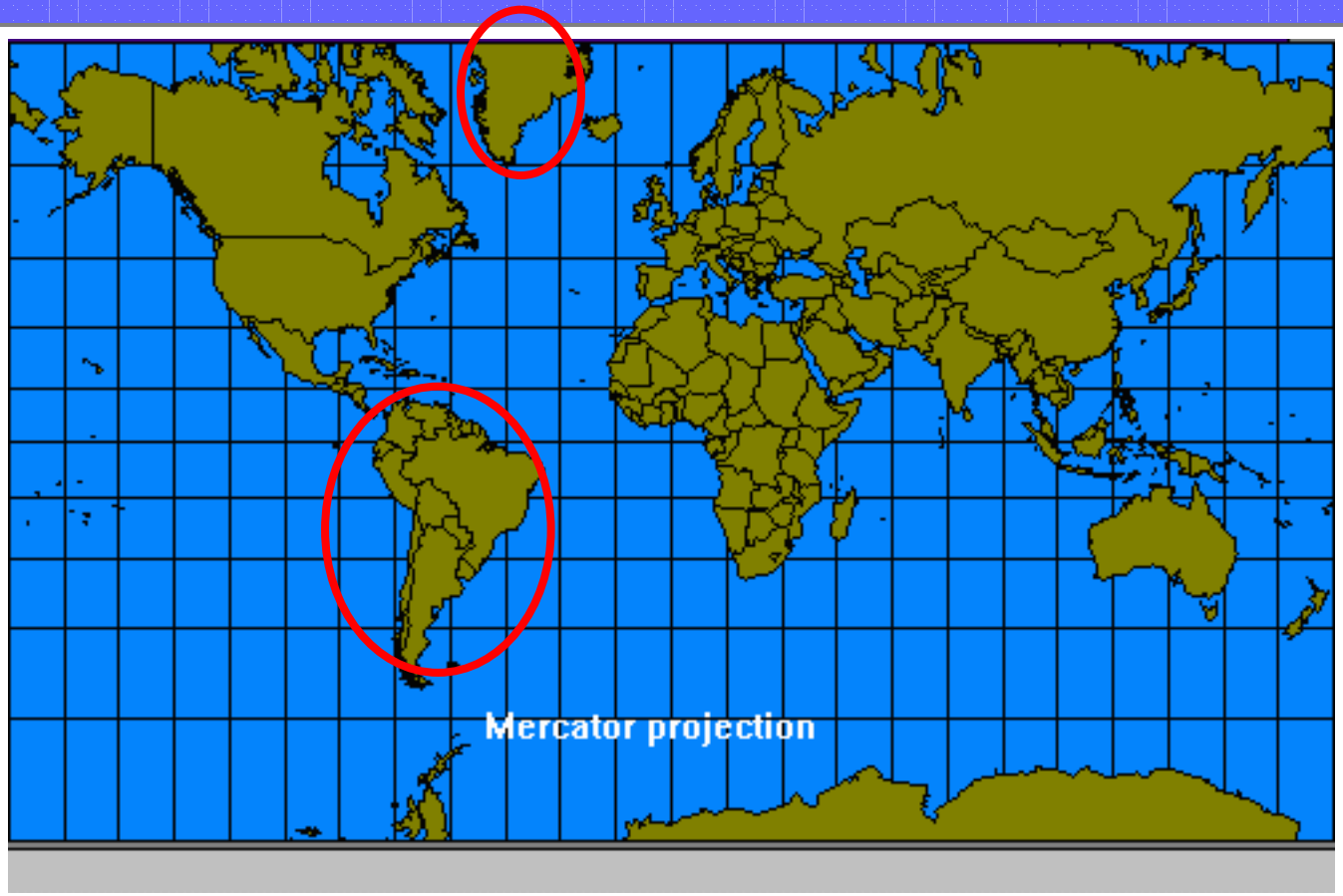
- When mapping the earth, we must consider how to transform the 3D sphere (geoid) into a 2D plane
- Map projections are geometric transformations which do this
- Infinite number of projections, yet there are three major variants.
  - Conic, using a cone touching the sphere on a line (or two)
  - Planar (azimuthal), contact at one point on the sphere, accurate at that point
  - Cylindrical, contact at a line


PLANAR
CONIC
CYLINDRICAL

Preserving spatial characteristics

- There are four major features we may wish to preserve on a map:
  - Shape – feature shapes are maintained (conformal) (but we lose accuracy of size)
  - Area – the size of features are the same as in reality (lose shape)
  - Distance – the distance from a point to other points is preserved (typically on azimuthal projections)
  - Direction – the way to get from A to B is preserved as a straight line

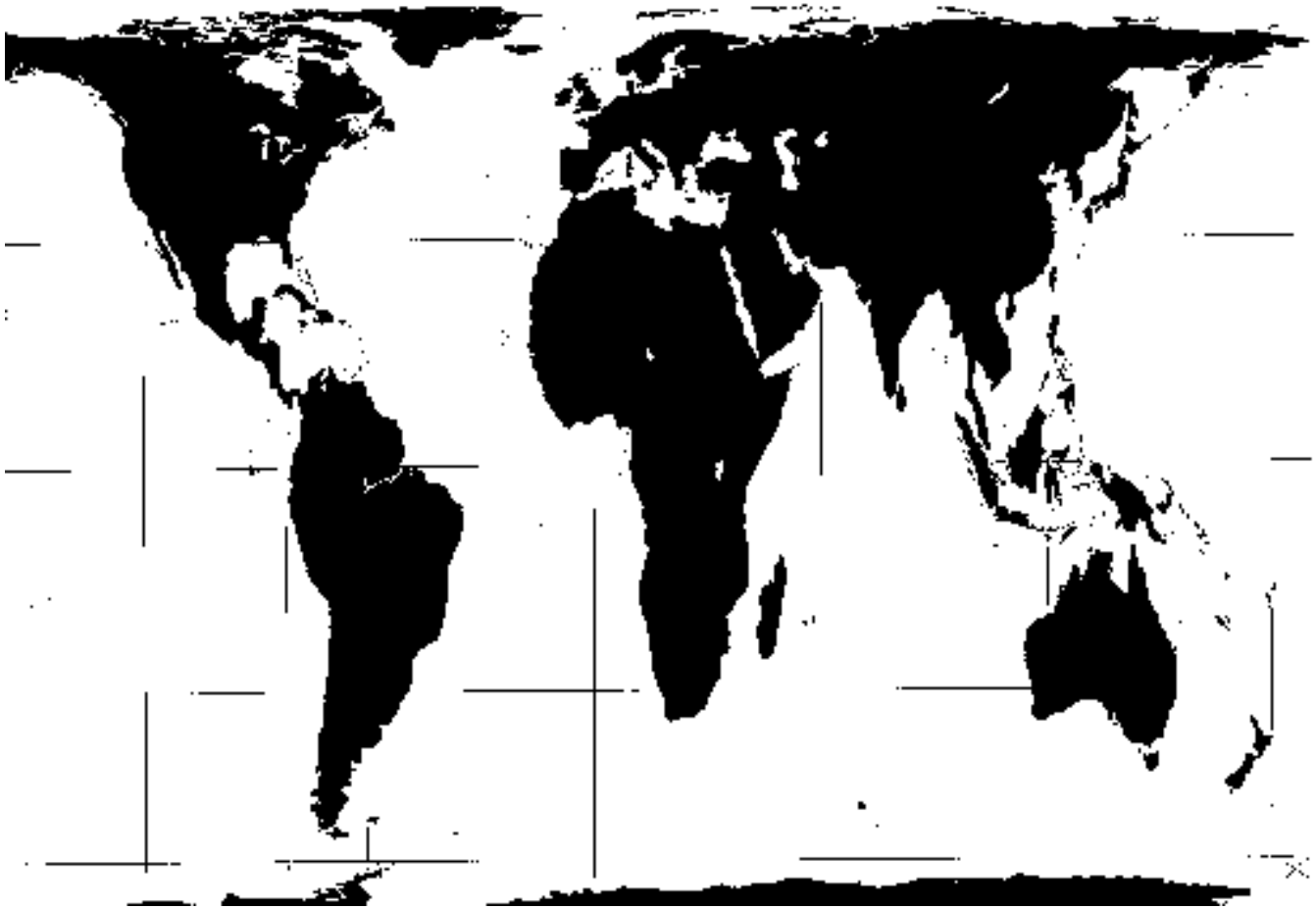
Direction-preserving: Mercator map projection



- What are some problems with this projection?

Area of Greenland: 2,166,086 sq km
Area of South America: 17,819,000 sq km – around 8 times larger!
This projection has often been accused of furthering tensions between North and South

Area-preserving: Peters



Reference Systems

- Scale states the ratio of map size to actual size
  - in the digital domain, is variable (see terraserver)
  - Nevertheless an accurate statement is important (How far to the airport? How big is the yard?)
  - Consider the problems with photocopy or image editing
- Also require a coordinate system to locate objects
  - E.g. geoURL, geocaching, GPS
  - Examples: UTM, Lat/Long

Geographic Data Models - Raster

- Raster
  - Models spatial areas by recording the locational patterns of a variable
  - Uniformly spaced grid of discrete cells (pixels)
  - Simple model, simple storage, 1-1 mapping with display devices
  - Examples: digital photography, passive and active remote sensors (Landsat, Radarsat)
  - Terraserver example

Vector Data Models

- Vector data model
  - Based on the objects that populate a space
  - Typically broken into four categories
    - Points – a city on a small-scale map
    - Lines - a hiking trail
    - Areas - a wildlife area
    - Volumes – 3d modelling (TINs)
  - Spatial objects have topological relationships
    - Near, beside, inside, bounds…
  - We can also operate at a higher level of abstraction:
    - River is composed of line 2 and line 4

Geographic Information Systems

- A computer-based approach to managing digital spatial data (layering)
- Most powerful programs combine vector and raster tools (ArcInfo, Grass)
- Using topology, the GIS can be used for spatial query and inference
  - Show me what features are 50 metres from this cutblock
  - In what census tracts > 100 sq km is the median age less than 40?
- ArcExplorer example

Spatial Information Visualization

- Information visualization is well suited to spatial data
  - Large volumes of data
  - Novice users may need clear explanations
  - Expert users may need great detail (e.g. Napoleon's march)
- Map design process

  1 – visualize different solutions

  2 – specific plan: classes, symbols, etc.

  3 – implement details on map construction
- Emphasis for symbols
  - Point, line, area, volume emphasis
  - Is 3D a viable visualization metaphor? Why or why not?

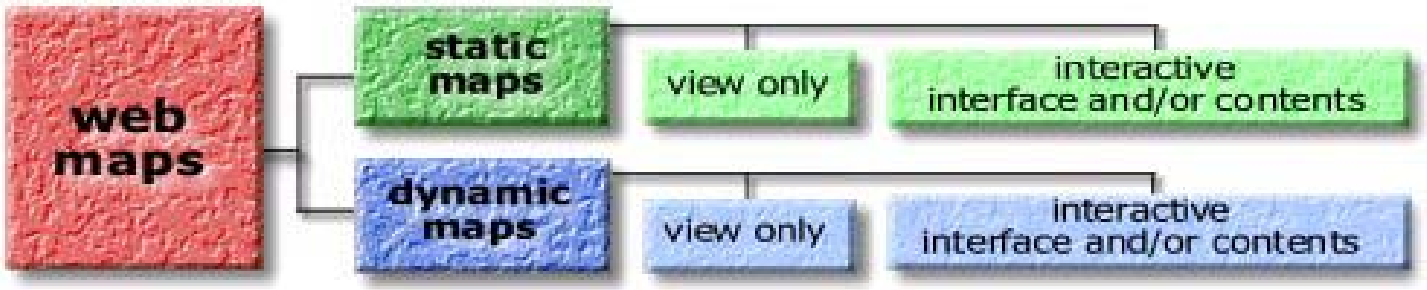
Cartographic Design Principles

- Enhance legibility
  - Clear and accurate text and graphics
  - Leverage familiarity
- Ensure visual contrast
  - Symbols need to be distinguishable
- Maintain figure-ground organization
  - Differentiation
  - Gestalt principles
- Use hierarchical organization
  - Good graphic structure essential

Cartographic abstraction

- Generalization is the technique of abstracting information at various levels (e.g Rob's tool) 
- Four major techniques in cartography (more?)
- Classification – order, scale, group
- Simplification – reduce amount of information
- Exaggeration – enlarge to capture essence
- Symbolization – stylize attribute values (Bertin)
- Finally, the user's inductive processes take place.

Internet mapping and web cartography



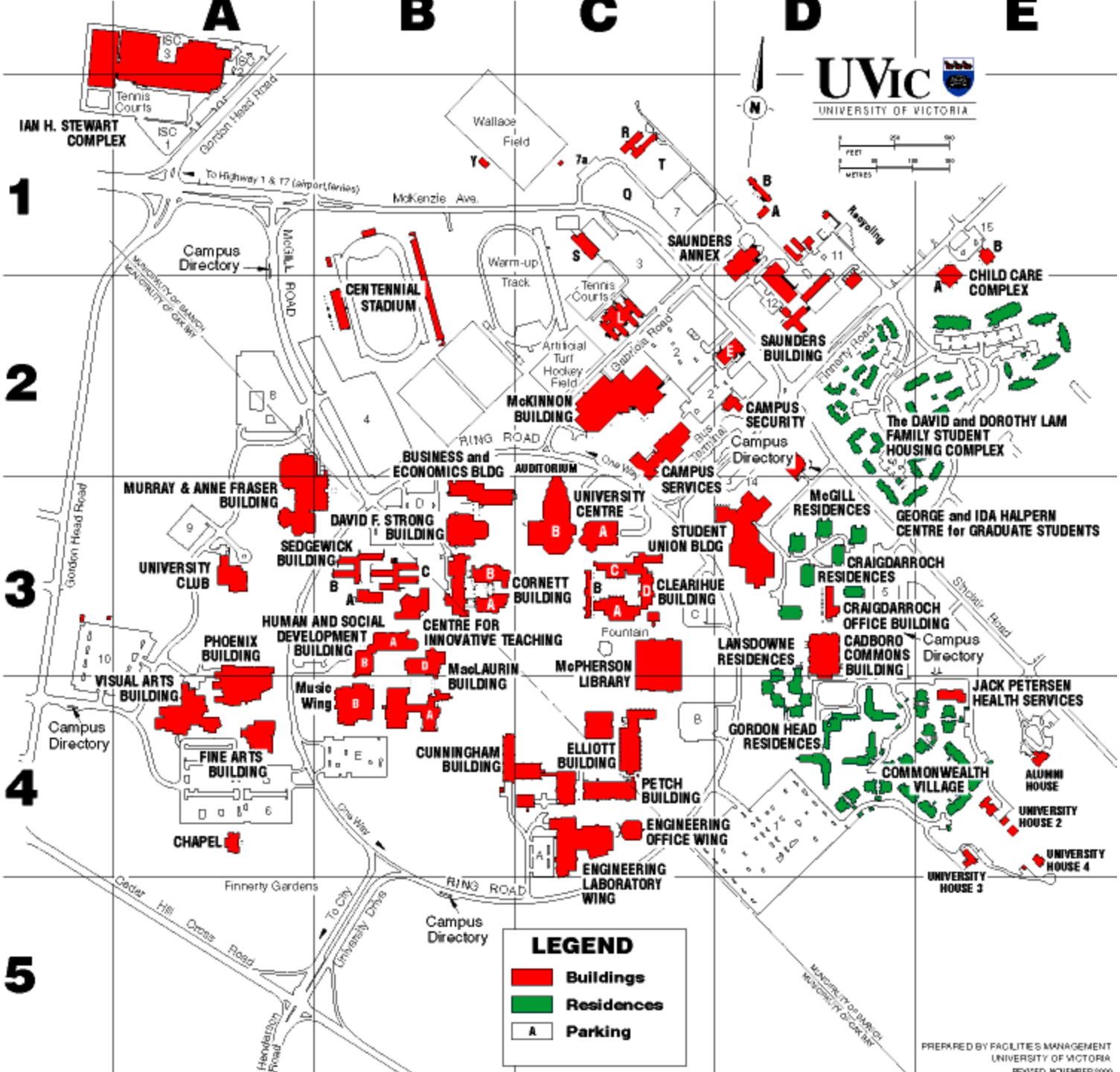
- Static maps – historical images (Baghdad), translations of paper maps, limited interactions (e.g. mouseover)
- Dynamic maps – movies such as Flash, animations, possibly combined with interactions using scripting (Cancer, Netherlands, Chicago traffic)
- Dynamic maps really leverage the power of the computer
- Like other web technologies, we move from a push model to a user-centered pull model
- Examples: to do

Web mapping tools

- Flash and SVG – the vector drawing packages
  - An SVG example
- Internet map servers
  - Custom technology designed to interface a GIS with the internet (publish the data)
    - ESRI IMS
    - MapInfo
- Where is this area headed?
  - OpenGIS.org
  - 3D viewers (mars)
    - VRML / X3D

Exercise

- In small groups, with some paper and pencils,
  - Draw a map for a visitor to our class
  - She is dropped off at the parking lot for ELW and told to make her way to Cornett where you will meet her
- Consider:
  - What features need to be shown?
  - What tasks should the map serve?
  - What characteristics of the user need to be considered?
- Discuss results and examples


A
B
C
D
E
1
2
3
4
5
UVic
UNIVERSITY OF VICTORIA
IAN H. STEWART COMPLEX
ISC 3
ISC 2
ISC 1
Tennis Courts
Gordon Head Road
To Highway 1 & 17 (airport/ferries)
McKenzie Ave.
Wallace Field
Campus Directory
McGILL ROAD
CENTENNIAL STADIUM
Warm-up Track
Tennis Courts
Artificial Turf Hockey Field
Gabriola Road
SAUNDERS ANNEX
SAUNDERS BUILDING
Regrolling
CHILD CARE COMPLEX
Finnerty Road
The DAVID and DOROTHY LAM FAMILY STUDENT HOUSING COMPLEX
McKINNON BUILDING
RING ROAD
CAMPUS SECURITY
Bus Terminal
CAMPUS SERVICES
BUSINESS and ECONOMICS BLDG
AUDITORIUM
One Way
UNIVERSITY CENTRE
McGILL RESIDENCES
GEORGE and IDA HALPERN CENTRE for GRADUATE STUDENTS
MURRAY & ANNE FRASER BUILDING
DAVID F. STRONG BUILDING
SEDGEWICK BUILDING
UNIVERSITY CLUB
STUDENT UNION BLDG
CRAIGDARROCH RESIDENCES
CORNETT BUILDING
CLEARIHUE BUILDING
CRAIGDARROCH OFFICE BUILDING
Shelley Road
HUMAN AND SOCIAL DEVELOPMENT BUILDING
CENTRE FOR INNOVATIVE TEACHING
Fountain
PHOENIX BUILDING
MacLAURIN BUILDING
McPHERSON LIBRARY
LANSDOWNE RESIDENCES
CADBORO COMMONS BUILDING
JACK PETERSEN HEALTH SERVICES
VISUAL ARTS BUILDING
Music Wing
GORDON HEAD RESIDENCES
FINE ARTS BUILDING
CUNNINGHAM BUILDING
ELLIOTT BUILDING
PETCH BUILDING
COMMONWEALTH VILLAGE
ALUMNI HOUSE
UNIVERSITY HOUSE 2
UNIVERSITY HOUSE 4
UNIVERSITY HOUSE 3
CHAPEL
ENGINEERING OFFICE WING
ENGINEERING LABORATORY WING
Finnerty Gardens
Cedar Hill Cross Road
To City
University Drive
Henderson Road
MUNICIPALITY OF SAANICH
MUNICIPALITY OF OAK BAY
LEGEND
Buildings
Residences
A Parking
PREPARED BY FACILITIES MANAGEMENT
UNIVERSITY OF VICTORIA

Links and References

- Grass - http://grass.baylor.edu/
- GeoVRML.org
- Examples: http://www.socsci.umn.edu/~koeh0017/3dgeography.htm
- Terraserver - http://terraserver.microsoft.com/image.aspx?t=2&s=15&x=71&y=838&z=10&w=1
- GeoURL.org