Geovisualization II

GEOG380 FA2018

Outline

- Geovisualization I
  - Visualization and geovisualization
  - Geovisualization and cartography
  - Visualization techniques
  - Examples

- Geovisualization II
  - Visualization techniques (cont.)
  - 3D geovisualization
  - Map animation
  - Web mapping
  - Virtual environments

3D geovisualization: Early developments

- Symbolizing topography
  - Oblique views
    - Block diagram

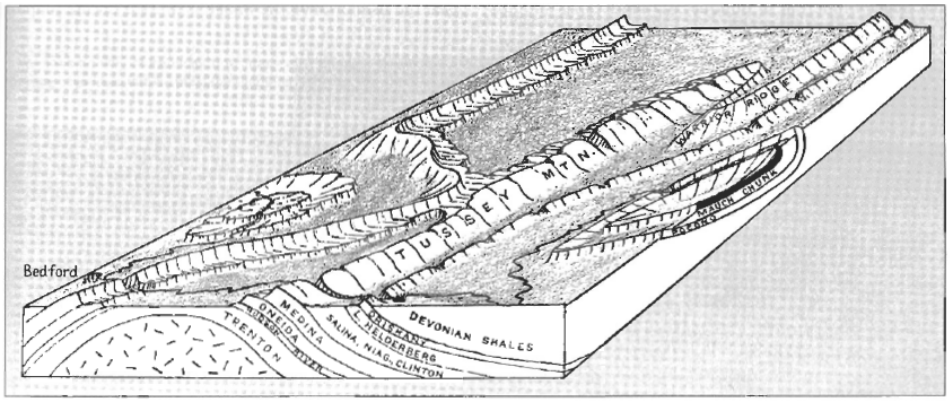


FIGURE 15.17 Example of a traditional block diagram. (From Figure 98, p. 69 of Lobeck, A. K. (1958) *Block Diagrams*. Second Edition. Amherst, MA: Emerson-Trussel Book Company.)

    - Draped images

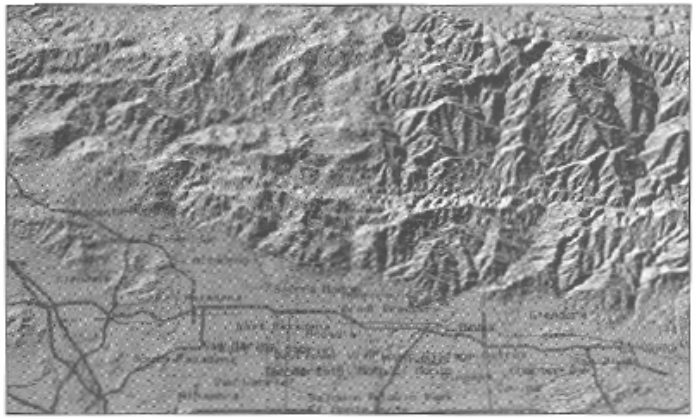
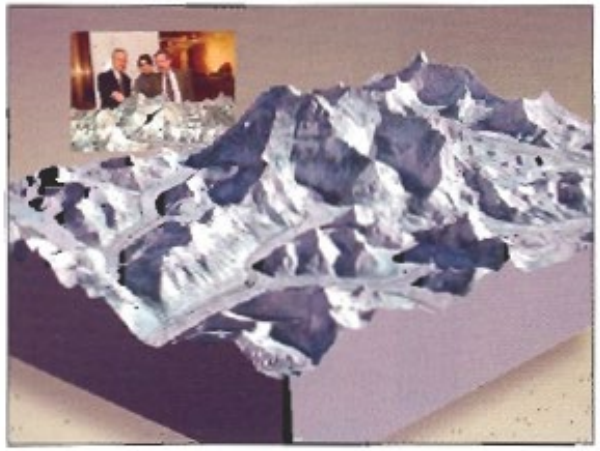


FIGURE 15.19 An example of a frame from a fly-by. The original illustration was in color, and was created using TruFlite software (*http://www.truflite.com/*). (Courtesy of Keith Clarke.)

(source: Slocum et al. 2009)

Early Developments

- Symbolizing topography
  - Physical models such as a real 3D object
    - Using 3D Printing technology
      (http://www.youtube.com/watch?v=sNyIOPrXhd8&NR=1 (concept) ;
      http://www.3ders.org/articles/20131009-van-gogh-2d-sunflowers-transformed-into-3d-with-3d-printer.html (painting); https://www.youtube.com/watch?v=emUlHFWcHck (handheld);
      http://www.youtube.com/watch?v=s2h1k0cpgzQ topographic 1:10~;
      http://www.youtube.com/watch?v=KaZjKF4zB-4 topographic 1:30~)

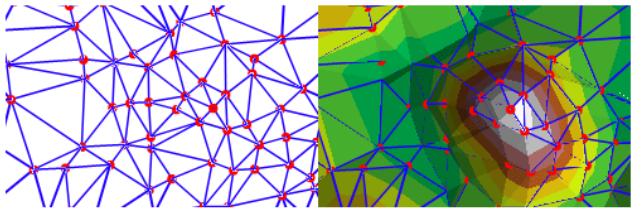


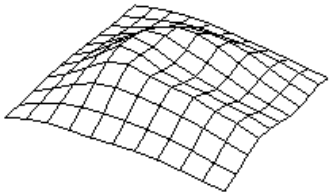
COLOR PLATE 13.10 Examples of physical models created using technology developed by Solid Terrain Modeling: Mt. Everest is on the left, and Hurricane Floyd is on the right. (Courtesy of Solid Terrain Modeling.)

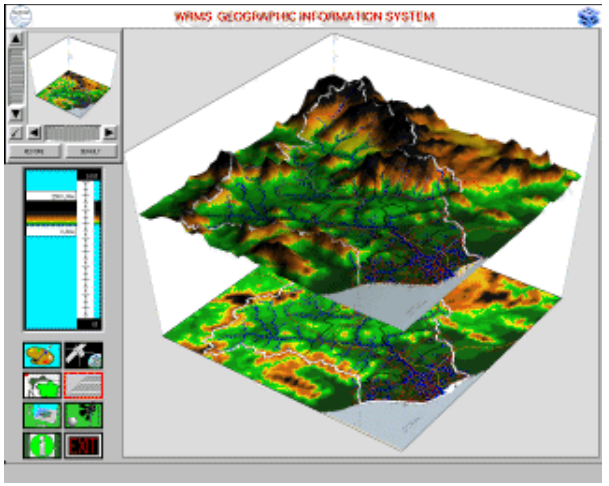
(image source: Slocum et al. 2009)

3D models of geographic phenomena

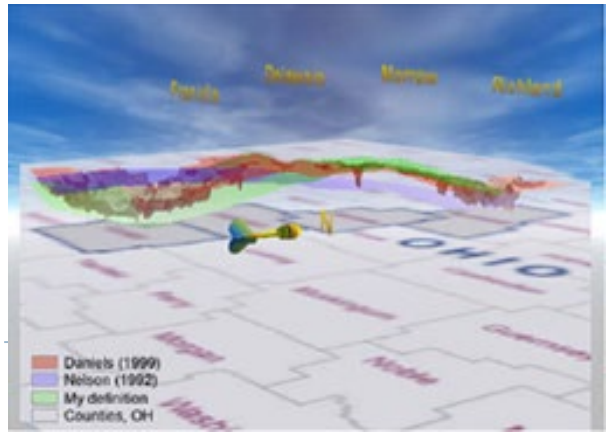
- Types of the 3D model
  - TIN (Triangular Irregular Network), DEM (Digital Elevation Model)
  - Point, line, polygon plane, tube, torus, sphere, cube, etc.
  - E.g., *chorodot map* (next slide)







- General procedure of 3D geovisualization
  - Create GIS data using a 3D data model
  - Represent the data in 3D
    - A variable using height (z) values
    - Apply colors, textures, additional symbolizations, and functionalities (i.e., interactivity)



(sources: ArcGIS Help; Ban and Ahlqvist, 2009, http://www.ess.co.at)
http://www.fountainware.com/Products/estierra/howworks.htm

3D models of geographic phenomena (cont.)

- Chorodot map (choropleth map + dot density map)
  - To keep discrete-continuous continuum

(source: Slocum et al. 2009)

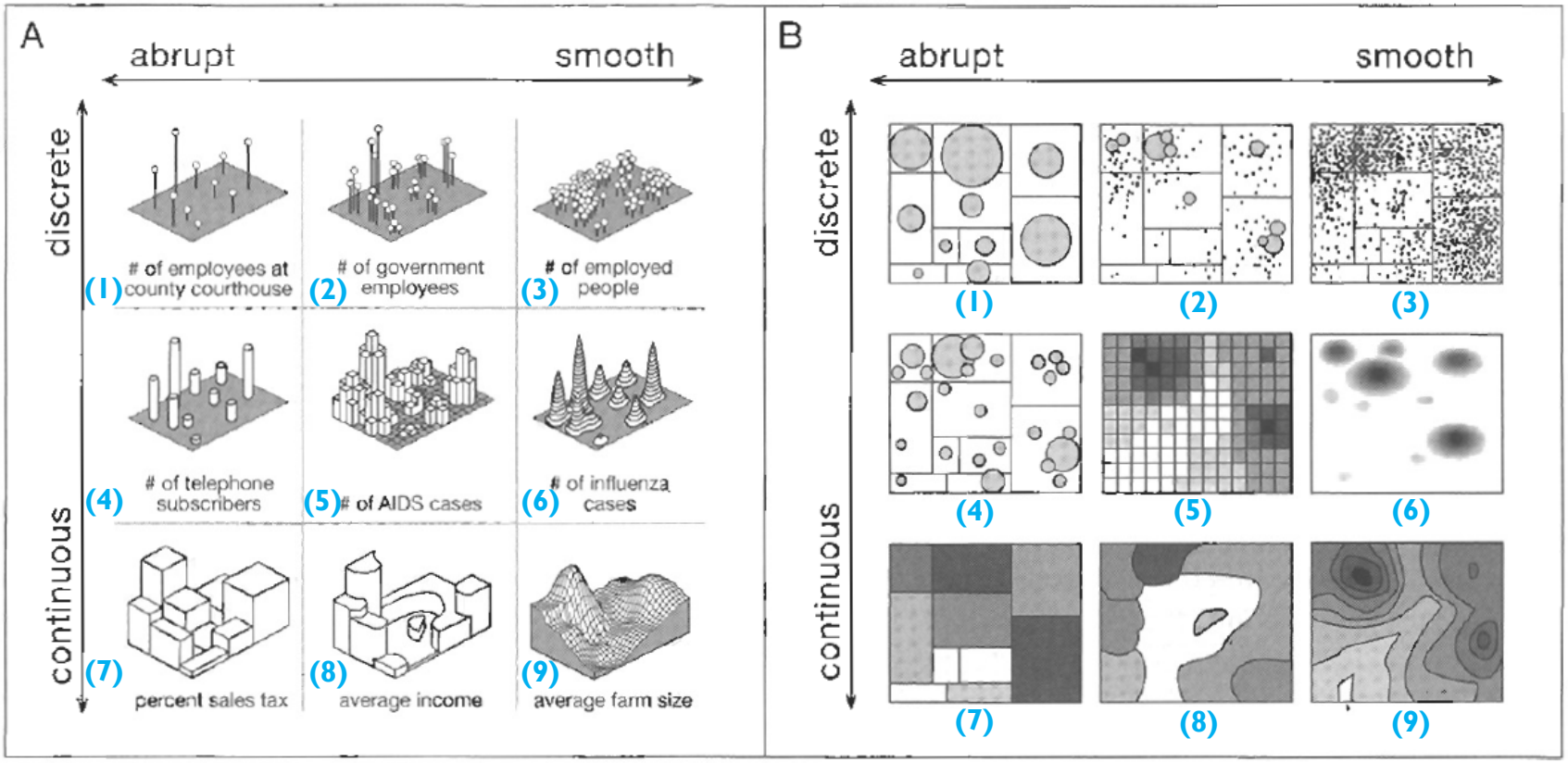
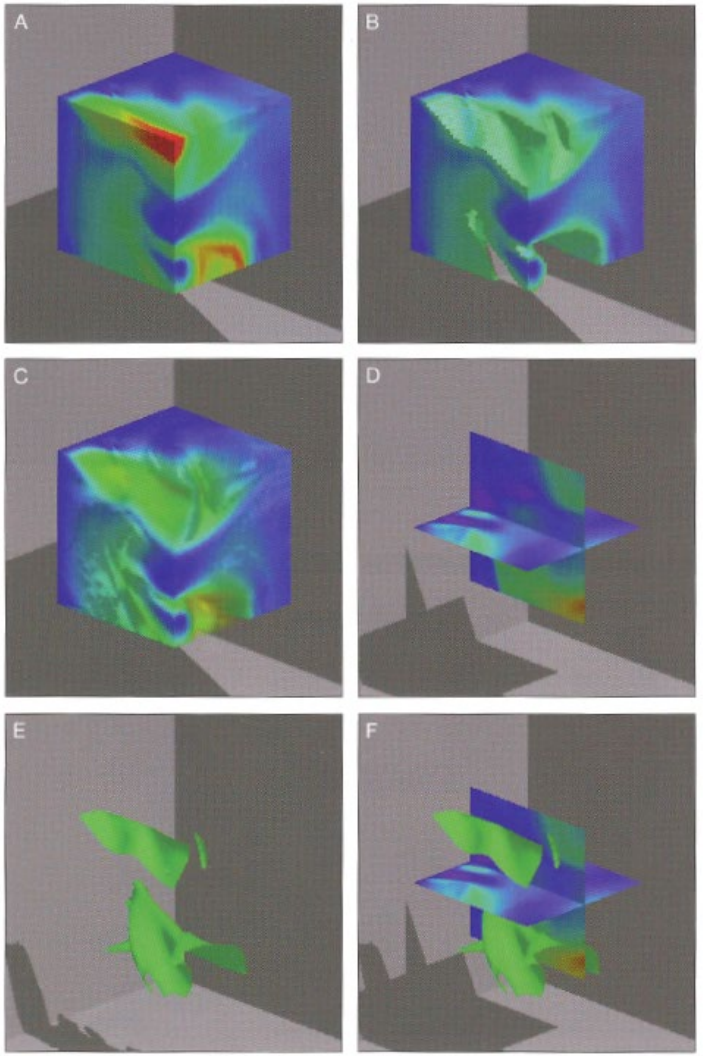


FIGURE 19.16 (A) MacEachren and DiBiase's models for representing geographic phenomena. (B) A set of symbolization methods that MacEachren and DiBiase argued would be appropriate for the models shown in A. (After MacEachren 1992, p. 16; courtesy of North American Cartographic Information Society and Alan MacEachren.)

Some characteristics of 3D geovisualization

- Mapping 3D phenomena
  - Z-values for each X and Y locations
- Users can "peer" into 3D data by some manipulations such as
  - Applying transparency and color schemes
  - Slicing through the data
  - Rotation/animation
- Spatial algebra for 3D-objects
  - Subtract, cut, merge, morph, etc.
  - http://www.youtube.com/watch?v=77qVDp7QqA4 (4:40~)

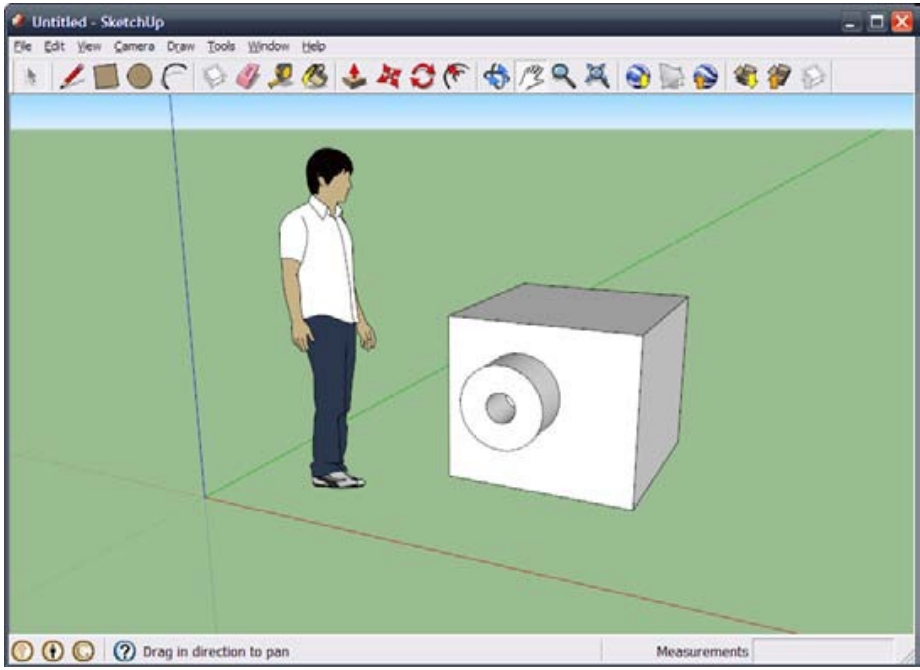
(source: Slocum et al. 2009)



COLOR PLATE 19.3 Using T3D to visualize a true 3-D data set, upflows and downflows within a thunderstorm: (A) an opaque default rainbow color scheme is used; (B) a portion of the color scheme is made transparent; (C) the transparency of the color scheme is varied continuously; (D) examples of slices taken through the 3-D surface; (E) an example of an isosurface, the 3-D equivalent of a contour line; (F) combining isosurfaces and slices. (Images created with Noesys Visualization Pro, courtesy of Fortner Software LLC.)

Using 3D in geovisualization

- Geovisualization processes
  - Data management
    - Raw data (2D map, tables, etc.)
  - Data assembly
    - 3D data modeling
      (3D point, line, polygon, etc.)
  - Visual mapping
    - Representation in 3D
  - Rendering
    - Projecting (i.e., 3D data visualized on a 2D map)
  - Display
    - Output media (i.e., a 2D screen or a 3D virtual-environment)



(Sources: Wood et al. 2005; http://geovisualization.wordpress.com/tag/urbanismo/)

2D vs. 3D geovisualization for spatio-temporal data

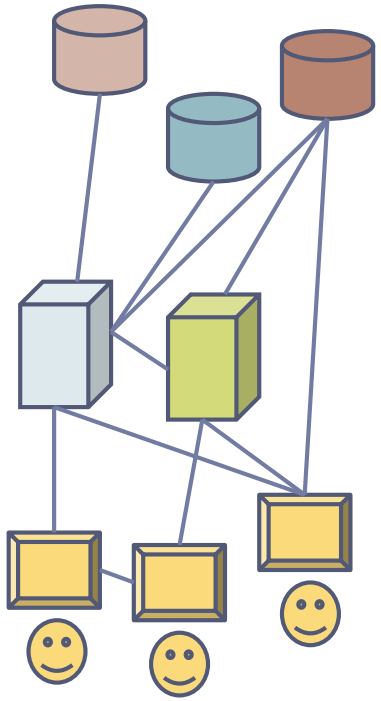
Cartographic animations	Two-dimensional	Three-dimensional
Spatially dynamic	-re-expression -Emphasizing location -Emphasizing attributes (brushing) -Zoom and pan	Same as 2D + -fly-by -Walk through -Rotation
Temporally dynamic	-Change in location -Change in attribute (temporal brushing)	Same as 2D
Spatially and temporally dynamic	- 2D spatio-temporal change	3D spatio-temporal change

2D map emphasizing location: http://www.youtube.com/watch?v=hehDmwqfhWg
3D map fly-by: http://www.youtube.com/watch?v=g5i375CLm2U

(Source: http://cartography.geog.uu.nl/ica/madrid/ormeling.html)

Web-based mapping

- Distributed cyberinfrastructure
  - Distant databases, systems, services, providers, and users online
  - Web-accessibility from tele-present systems and users
- Interactivity
  - Web 2.0: a reciprocal relationship between users and producers
    - *"High-speed computer transmission to-and-fro: the separating line between viewer and producer begins to blur" (Heim 1998)*
  - Immediate feedbacks contribute to participatory GIS (PGIS)
  - Web 3.0: semantic Web technologies based on resource description framework (RDF)



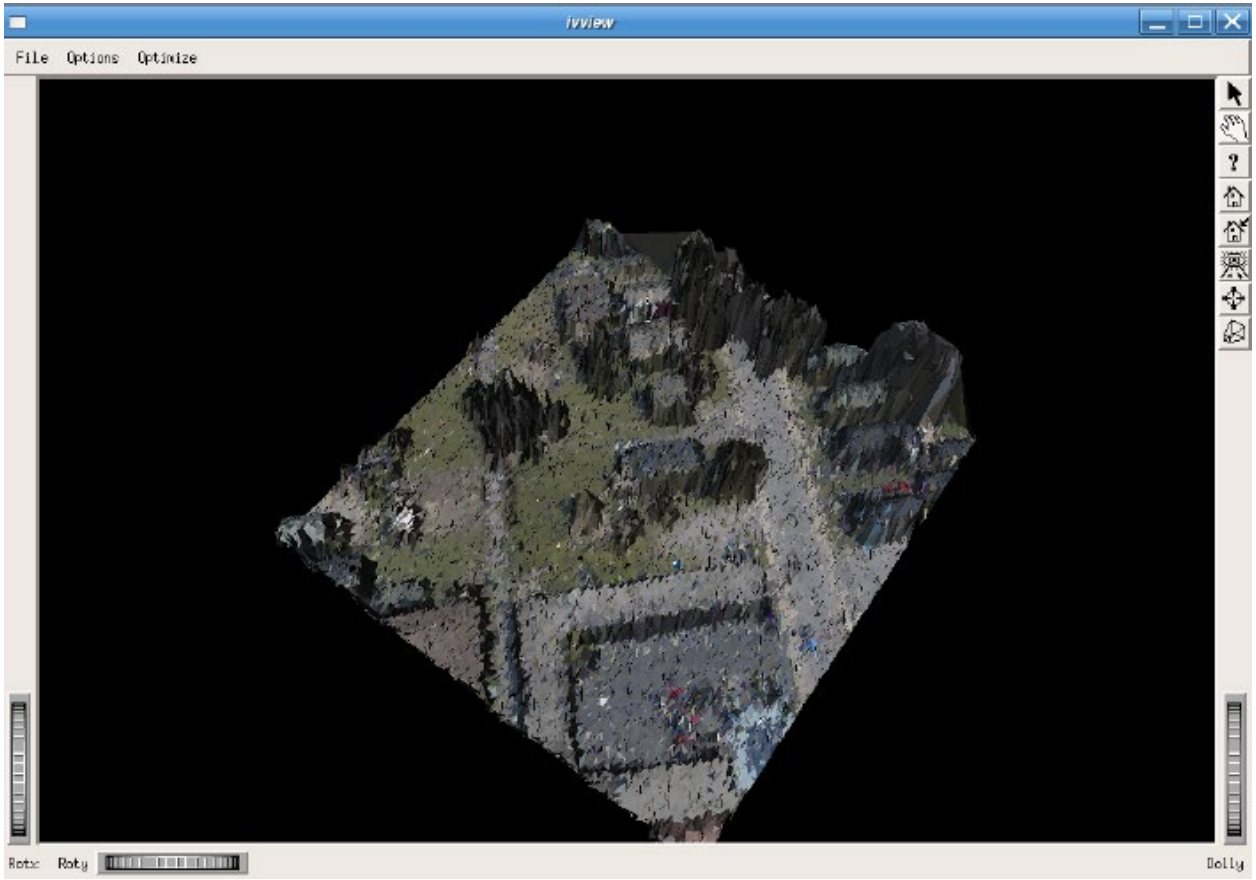
(Source: Heim, M. (1998), Virtual realism, Oxford University Press, New York.; Hendler, J. 2009. Web 3.0 Emerging. IEEE, January 2009, 111-113)

Related techniques

- 3D Animation
  - "The Synchronous Objects project" (http://synchronousobjects.osu.edu/content.html#/movementDensity, the "Explanatory Video")

Related techniques (cont.)

- Remote Sensing
  - LiDAR satellite image data used in 3D geovisualization



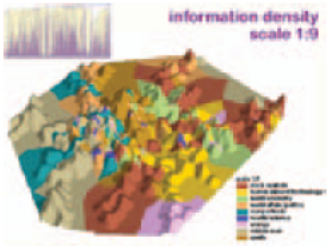
(image source: Ghosh and Lohani ---)

Related techniques (cont.)

- Remote Sensing
  - "House of Cards" (Radiohead, 2008)
  - https://www.youtube.com/watch?v=8nTFjVm9sTQ
  - Q. How was the 3D geovisualization technique used in the music video?

Related techniques (cont.)

- Virtual Environments (VE)

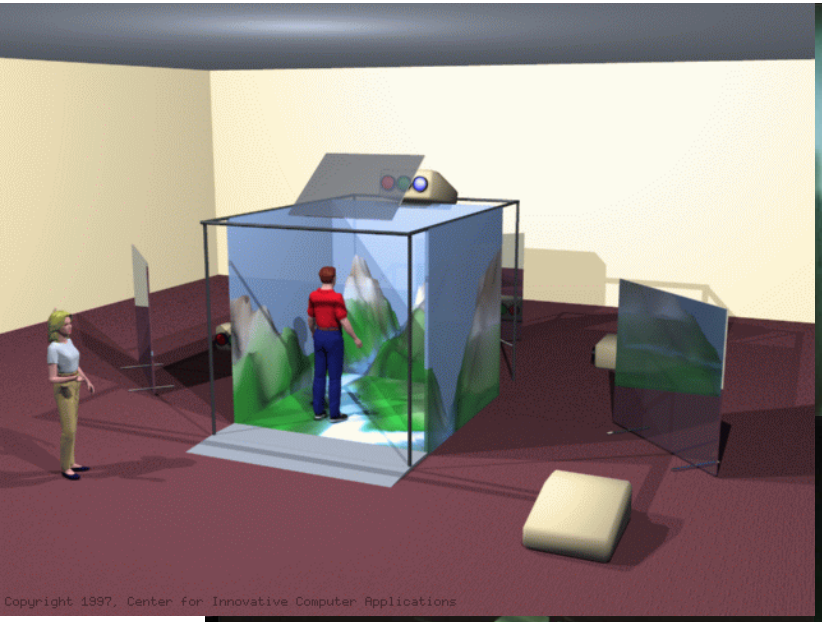
Symbolic and iconic represent-ations		Mapping of Information	SimCity	MUDs, virtual worlds (active worlds – alpha world)
Verisimilar represent-ations		Computer-generated ray-traced land-scapes and urban models. Navigable panoramas	Flight simulation	3D multi-user games
Immersive represent-ations		3D displays Stereoscopic displays	Simulation sequences run in immersive visualization environments	VR – HMDs, panorama, CAVE

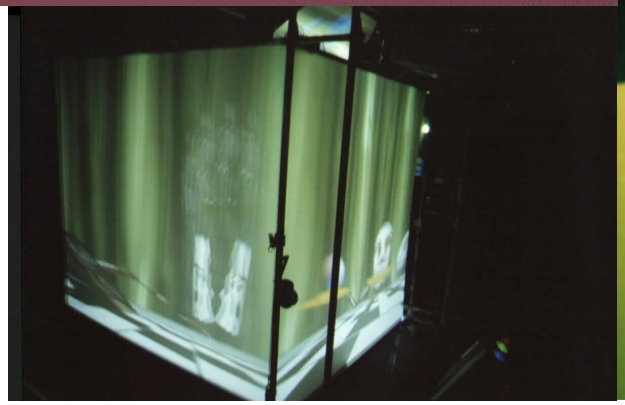
Crayoland (Pape 1998), an "anti-photorealistic" interactive virtual environment created for the CAVE environment

Source: Bodum, L. (2005). Modelling Virtual Environments for Geovisualization: A Focus on Representation. In: J. Dykes, A.M. MacEachren, M-J. Kraak (2005), Exploring Geovisualization, Pergamon, 389-402.

Pape, D., (1998) "Crayoland", SIGGRAPH Video Review, Issue 127/SIGGRAPH '98 Electronic Art and Animation Catalog CD-ROM. Orlando, Florida: ACM, Online: http://www.evl.uic.edu/pape/projects/crayoland/

Cave Automatic Virtual Environment (CAVE)



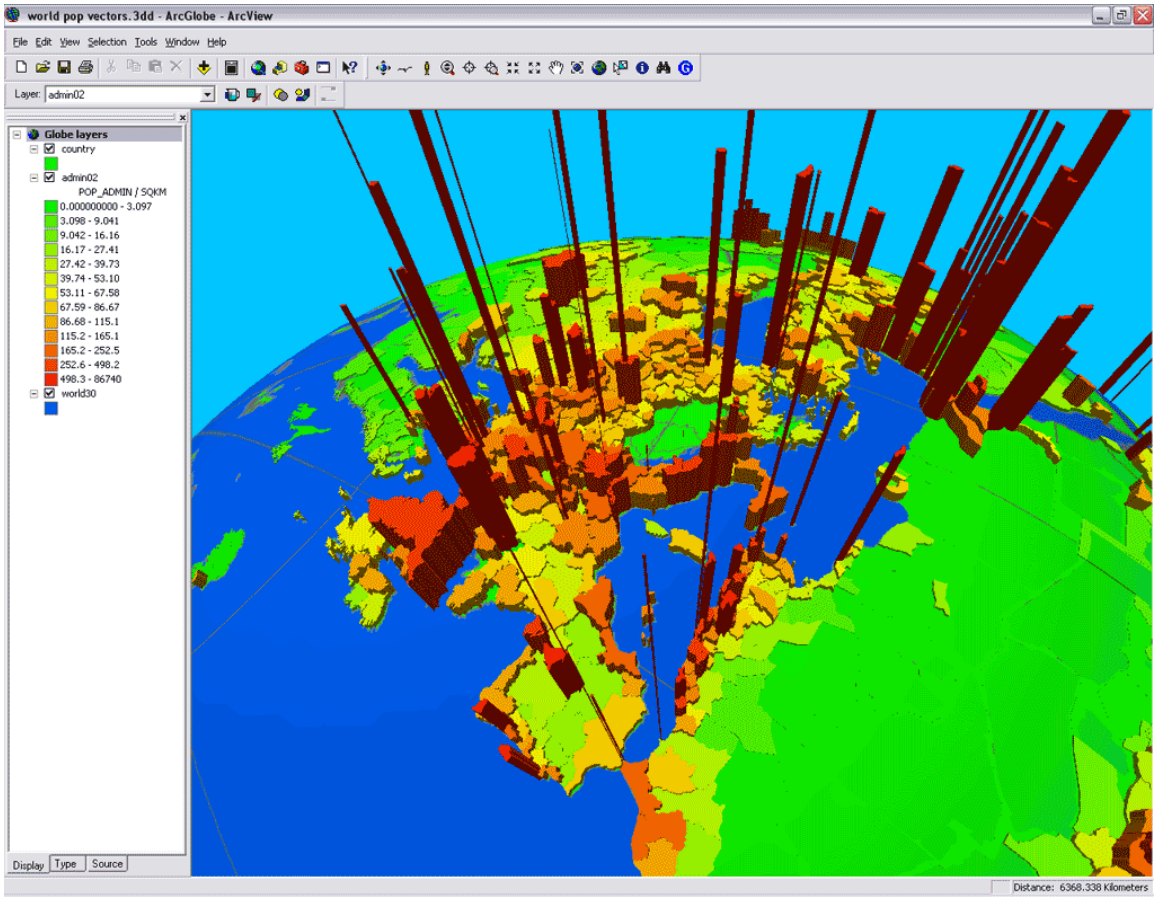


- Source: http://www.evl.uic.edu/pape/CAVE/pictures/AEC/ (Electronic Visualization Laboratory, University of Illinois at Chicago 1992)
  http://www.youtube.com/watch?v=CG__PZzNfkw&feature=fvwrel

Activity: Stereoscopic visualization using a VR headset

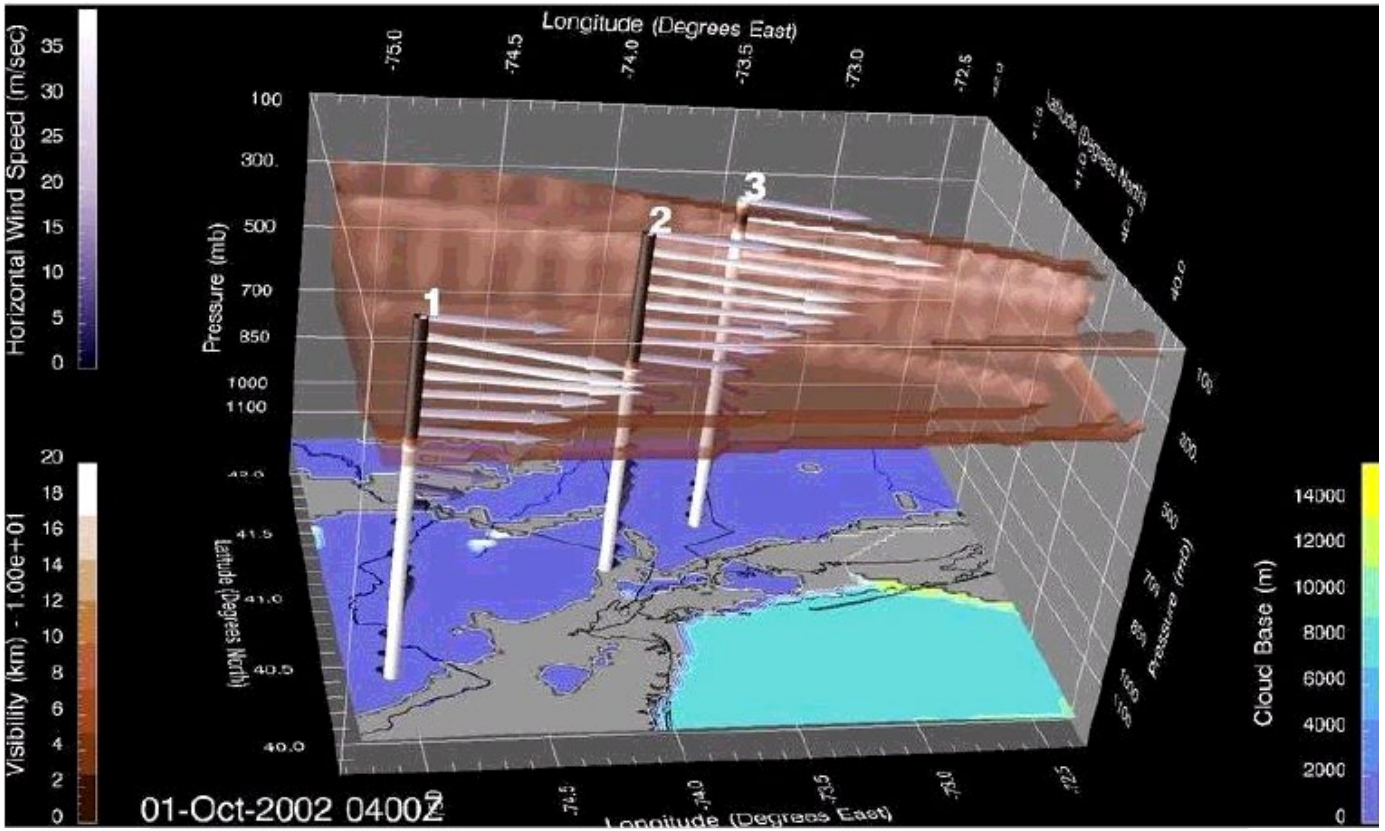
- Experience stereoscopic scenes (either 2D or 3D) through a SYTROS VR headset
  - In your smartphone, load some stereoscopic photographs or videos such as:
    - Stereoscopic 3D Rotating Moon (Hans Zimmer version)
      https://www.youtube.com/watch?v=_FgCK6CdR8s
      Virtual reality travel - 3D extreme stereoscopic - HD
      https://www.youtube.com/watch?v=r3RpfOMwQyM
    - 3D Photos from the 1800's, formatted for a modern VR headset
      https://vimeo.com/128558064
      (watch as stopped photos at 00:01, 00:14, 00:25)
    - Set Auto-Lock function of your smartphone as "Never" or similar option.
    - Carefully mount your smartphone on a SYTROS VR headset. Make sure the position of the screen fits well to the headset.
    - Wear the headset and adjust lenses so that you could see the stereographic scene.
    - Try to focus your sight to feel the depths from the stereoscopic scene.
    - Don't forget to reset the Auto-Lock option of your phone when finished!
    - Please return the headset.

Interactive 3D geovisualization using ArcGlobe



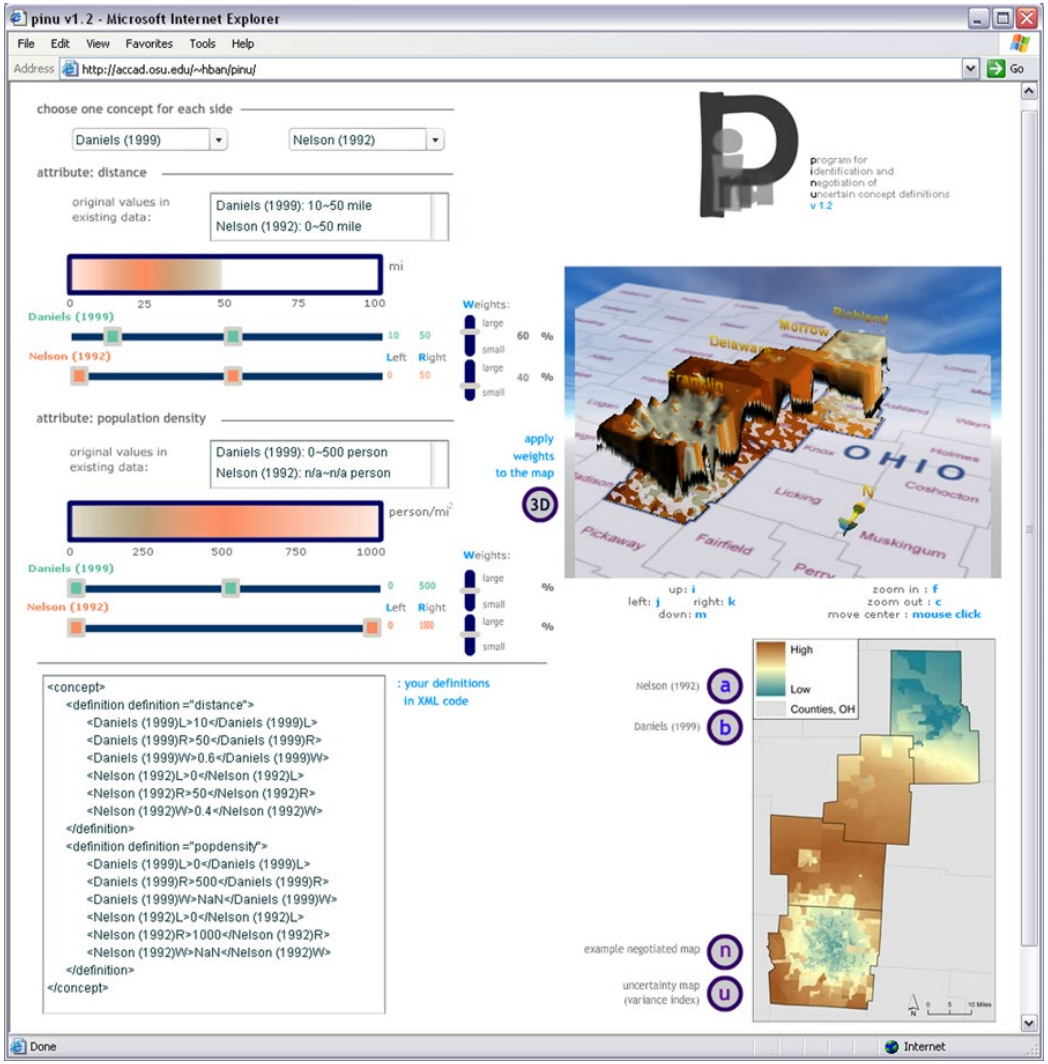
(Source: http://www.esri.com/software/arcgis/extensions/3danalyst/graphics/3d_zoom-global-pop.gif)

Weather models using web-based interactive 3D geovisualization



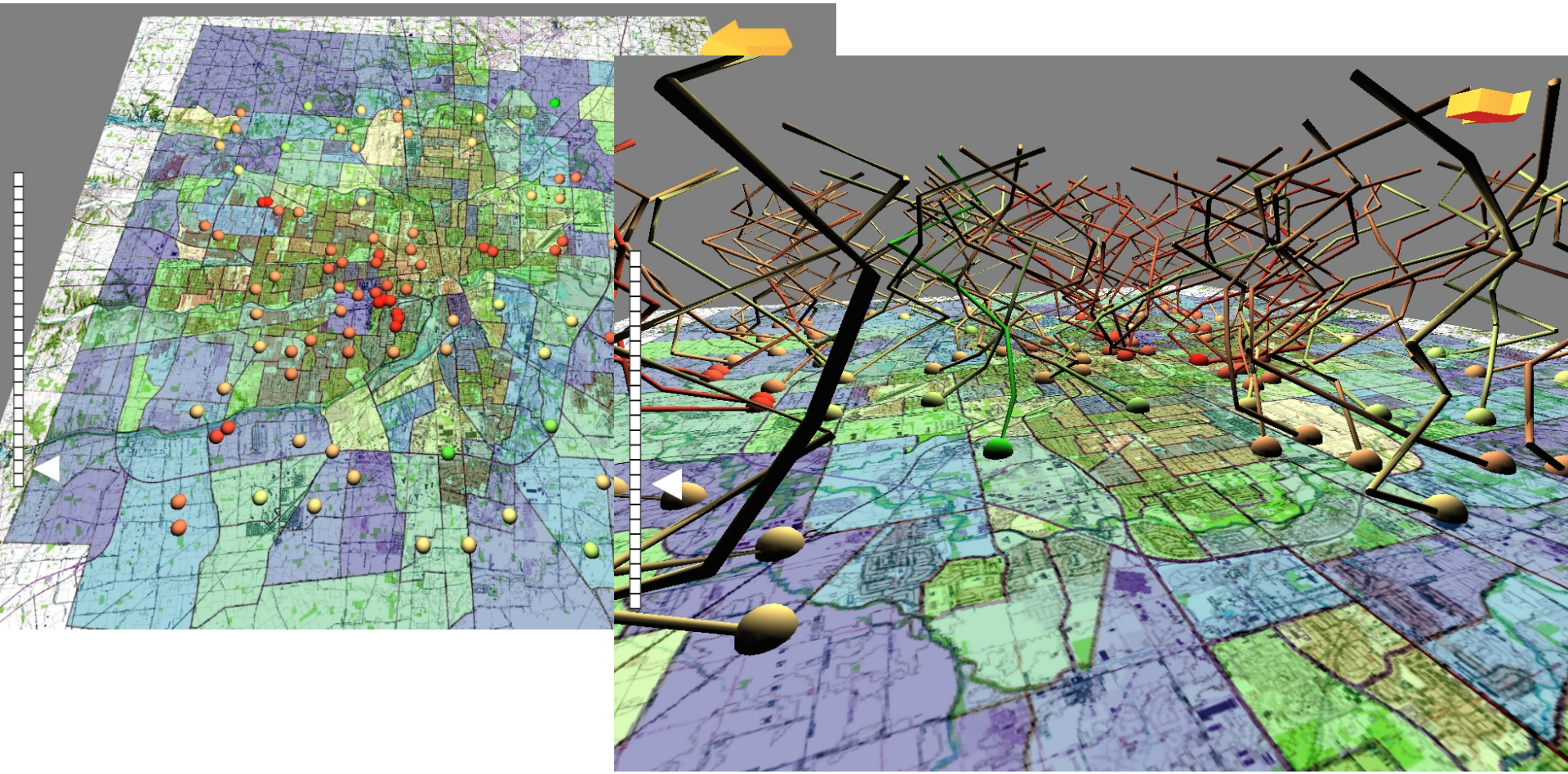
(Source: Treinish, L. (2005). WEB-BASED DISSEMINATION AND VISUALIZATION OF MESOSCALE WEATHER MODELS FOR BUSINESS OPERATIONS. www.research.ibm.com/weather/vis/web_apps.pdf)

Web-based mapping, VE, and interactive 3D geovisualization



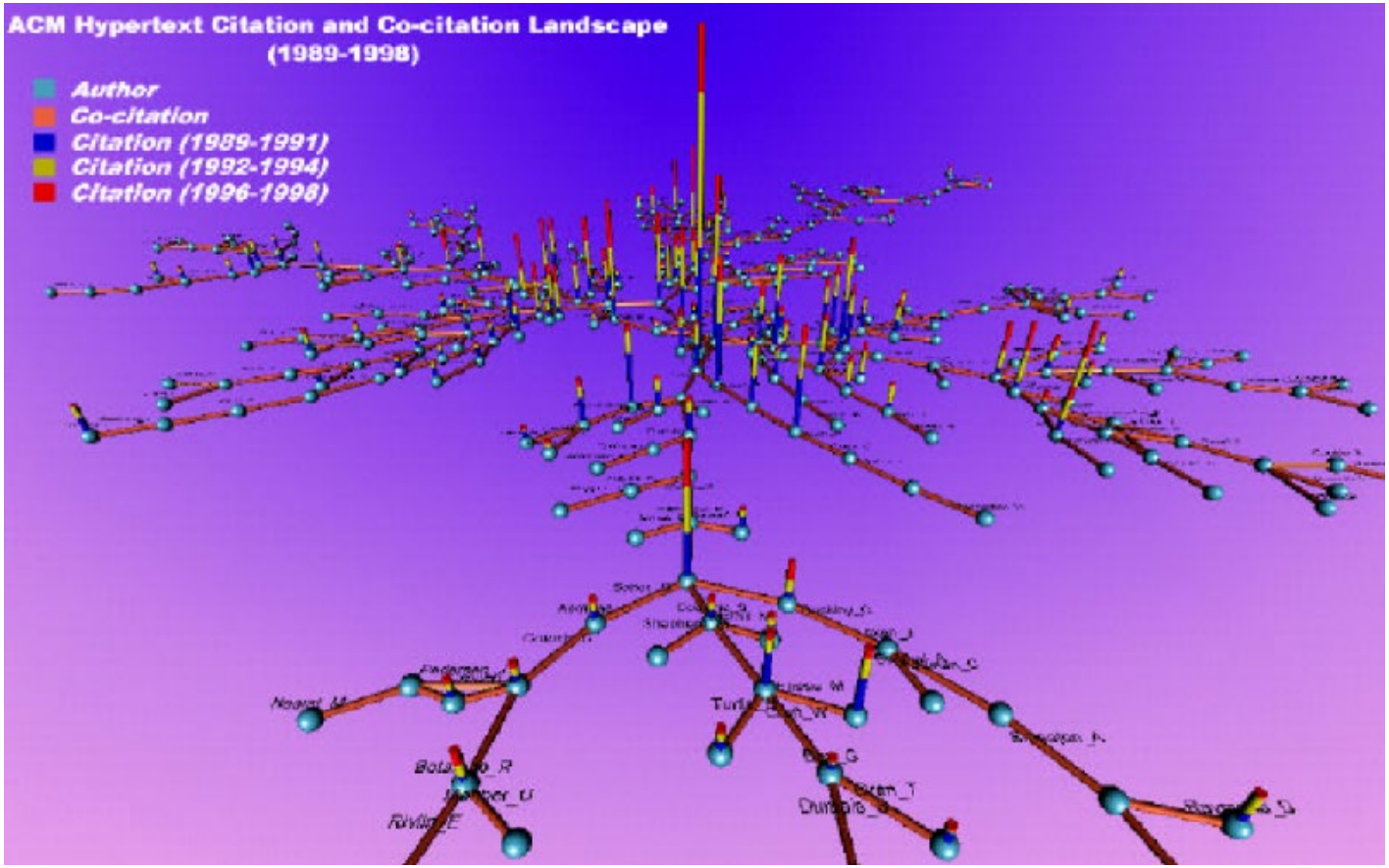
(Source: http://accad.osu.edu/~hban/pinu/)

Interactive 3D geovisualization of space-time path in VE



(Source: Jonathan Rush 2008)

Co-citation “landscape” visualization in VE



Source: Chen, C. and Carr, L. (1999). A semantic-centric approach to information visualization, Information Visualization, 1999. Proceedings. 1999 IEEE International Conference on, 07/14/1999 - 07/16/1999, London, UK, 18-23.

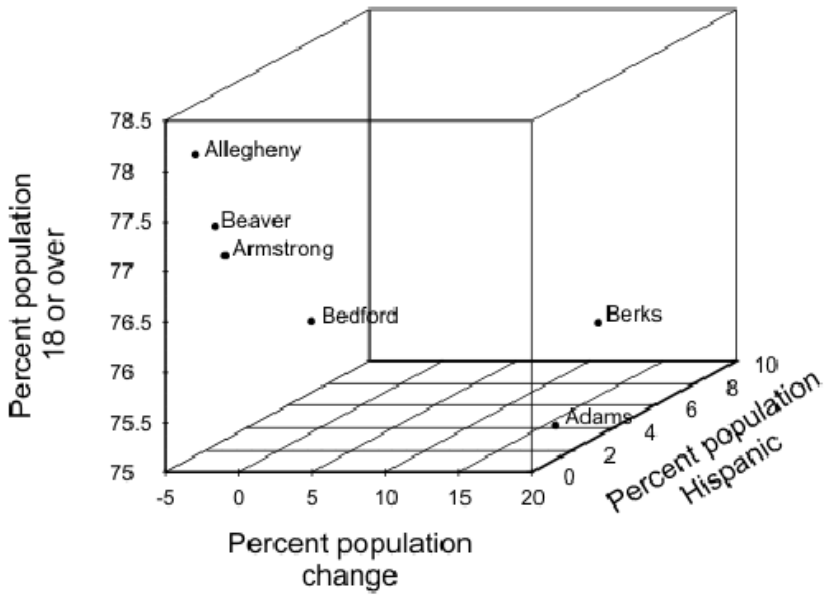
Strengths of 3D geovisualization

- Usually more informative than using 2D
  - The height (z-value) data of each location
- Dynamic data exploration
  - High-quality real-time rendering techniques
- Effectively represent and explore time-dependent data
- Better sense about space by navigating *inside* of space
  - Can use wearable equipments for VE representation
    : head mounted display, data glove, 3-D goggles, 3-D glasses, etc
- Low-cost hardware solutions than before

- Many strengths, *however*…

Challenges of 3D geovisualization

- Hard to identify exact location in a 3D view without additional functionalities
  - E.g., diagonal, animated, or interactive views
  - Recall the "two people in two rooms/buildings" example
- Rendering time and limitation of resource capacity
  - Depends on h/w and s/w specification & size of data
  - Getting better but still
- Large data issue
- Accessibility of viewers



Summary

- Various approaches in geovisualization
- Usefulness/challenges for particular purposes
  - Need to be careful to make a choice
- Still in development with recent technologies

For next time…

- Readings
  - Ch. 24, 25, and 21
- Lab3 due today
- Keep working on PM2
  - Due 11/27