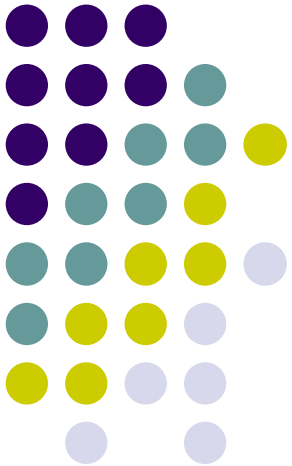
Chapter 11 – Geovisualization

§ 1 Introduction

§ 2 Geovisulazation and spatial query
§ 3 Geovisulazation and Transformation
§ 4 Immersive interaction and PPGIS



Learning Objectives

- After reading this chapter you will be able to:
  - How GIS affects visual communication
  - The ways in which good user interfaces can help to resolve spatial queries
  - Some of the ways in which GIS-based representations may be transformed
  - How 3-D geovisualization and virtual reality improve our ability to understand the world

§ 1 Introduction

- It is through mapping that the meaning of a spatial representation of the real world is communicated to users
- Historically, the paper map was the only available interface between the map-maker and the user: it was permanent, contained a fixed array of attributes, was of predetermined and invariant scale, and rarely provided any quantitative or qualitative indications as to whether it was safe to use
- *Geovisualization* builds on the established tenets of map production and display
- as the creation and use of visual representations to facilitate thinking, understanding, and knowledge construction about human and physical environments, at geographic scales of measurement

§ 2 Geovisualization and spatial query

- Geovisualization allows users to explore, synthesize, present, and analyze their data more thoroughly than was possible hitherto.

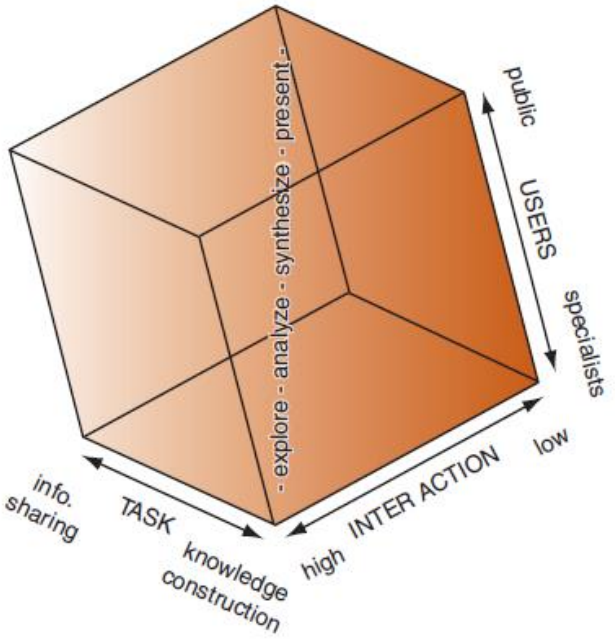


Figure 13.5 Functions of geovisualization (after MacEachren et al 2004) © IEEE 2004. Reproduced by permission.

§ 2 Geovisualization and spatial query(cont.)

- Spatial query and interaction as a loop

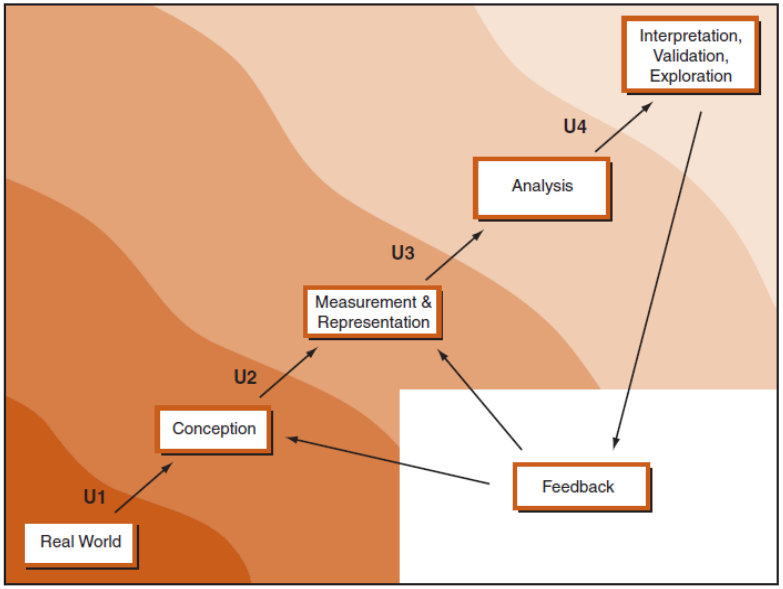


Figure 13.6 Filters U1–U4: conception, measurement, analysis, and visualization. Geographic analysis is not an end point, but rather the start of an iterative process of feedbacks and 'what if?' scenario testing. (See also Figure 6.1.)

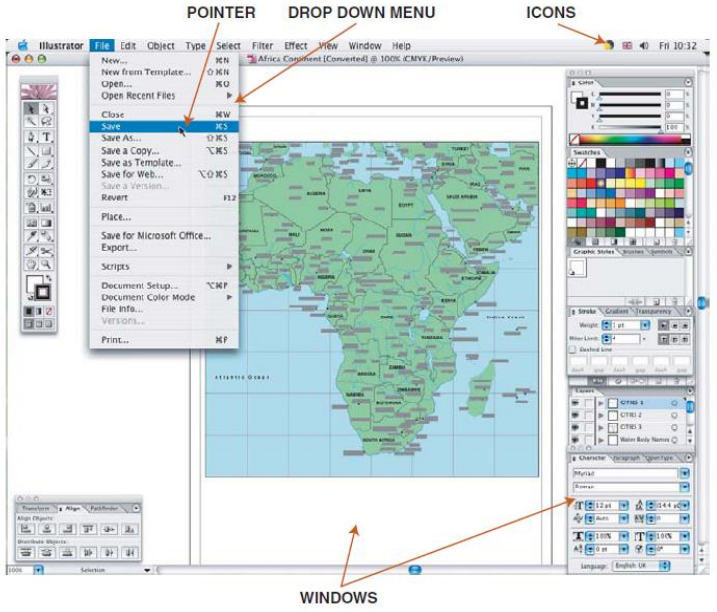


Figure 13.7 The WIMP (Windows, Icons, Menus, Pointers) interface to computing using Macintosh System 10

§ 3 Geovisualization and Transformation

§ 3.1 Overview

- GIS is a flexible medium for the cartographic transformation of maps

Table 13.2 Some examples of coordinate and cartographic transformations of spatial objects of different dimensionality (based on D. Martin 1996 *Geographic Information Systems: Socioeconomic Applications (Second edition)*. London, Routledge: 65)

Dimension	**0**	**1**	**2**	**3**
Conception	Population distribution	Coastline (see Box 4.6)	Agricultural field	Land surface
	Coordinate transformation of real world arising in GIS representation/measurement			
Measurement	Imposed areal aggregation, recorded as a sequence of digitized points	Sequence of digitized points	Digitized polygon boundary	Arrangement of spot heights
	Cartographic transformation to aid interpretation of representation			
Visualization	Cartogram or dasymetric map	Generalized line	Integral/natural area	Digital elevation model

§ 3 Geovisualization and Transformation

§ 3.2 Cartogram

- Cartograms are maps that lack planimetric correctness, and distort area or distance in the interests of some specific objective
- The usual objective is to reveal patterns that might not be readily apparent from a conventional map or, more generally, to promote legibility
- Cartograms are map transformations that distort area or distance in the interests of some specific objective.

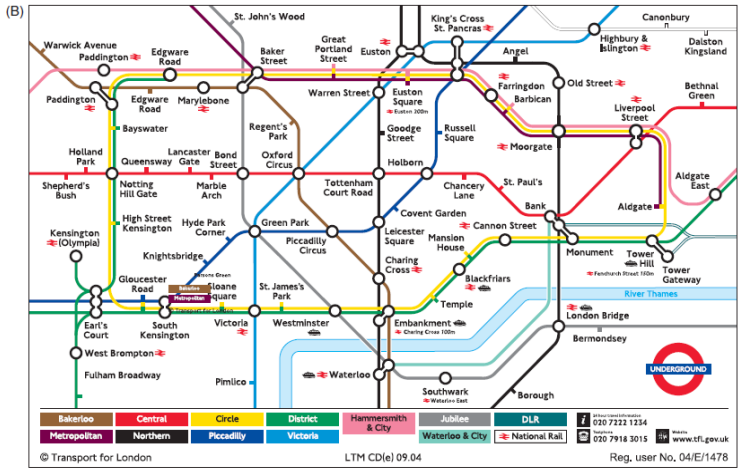


Figure 13.9 (A) A 1912 map of the London Underground and (B) its present day linear cartogram transformation

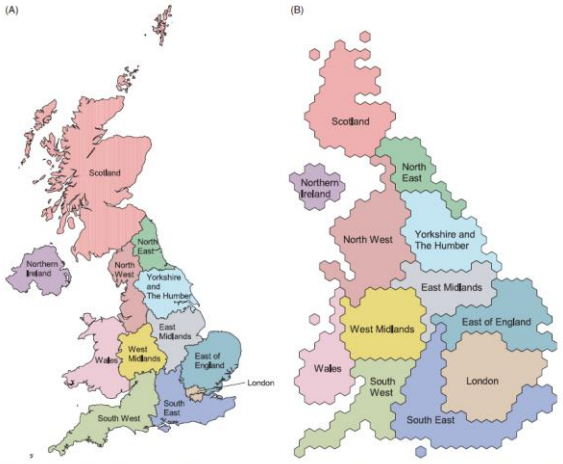


Figure 13.10 (A) A regional map of the UK and (B) its equal population cartogram transformation (Courtesy: Daniel Dorling and Bethan Thomas: from Dorling and Thomas (2004), page (vii)) (Reproduced by permission of The Policy Press)

§ 4 Immersive interaction and PPGIS

§ 4.1 Overview

- Faster processing hardware and more sophisticated computer graphics, including animation, have led to the development of a new field called ‘Visualization in Scientific Computing(ViSC).’
- ViSC provides greater flexibility, sophistication, and interaction in visualizing the world than the paper maps of the past
- requires dynamic and interactive *software* environments and *people* skills that are key to extracting meaning from a representation
- GIS should allow people to use software to manipulate and represent data in multiple ways, in order to create ‘what if’ scenarios or to pose questions that prompt the discovery of useful relations or patterns

§ 4 Immersive interaction and PPGIS(cont.)

§ 4.1 Overview(cont.)

- This is a core remit of PPGIS, where the geovisualization environment is used to support a process of knowledge construction and acquisition that is guided by the user's knowledge of the application
- PPGIS research entails usability evaluations of structured tasks, using a mixture of computer-based techniques and traditional qualitative research methods, in order to identify cognitive activities and user problems associated with GIS applications

§ 4 Immersive interaction and PPGIS(cont.)

§ 4.2 Geovisualization and VR system

- Geovisualization is enabling the creation of 3-D representations of natural and artificial (e.g., cityscapes) phenomena
- In parallel with the development of fine-scale 3-D models of cityscapes, there have been similarly impressive advances in whole-Earth global visualizations

Figure 13.17 (A) Raw LiDAR image of football (soccer) stadium, Southampton, England, and (B) LiDAR-derived bare earth DEM draped with aerial photograph of its wider area, overlaid with 3-D buildings. (Aerial photography reproduced with permission of Ordnance Survey © Ordnance Survey. All rights reserved. (Reproduced with permission from the Environment Agency of England and Wales. Courtesy: Sarah Smith.)

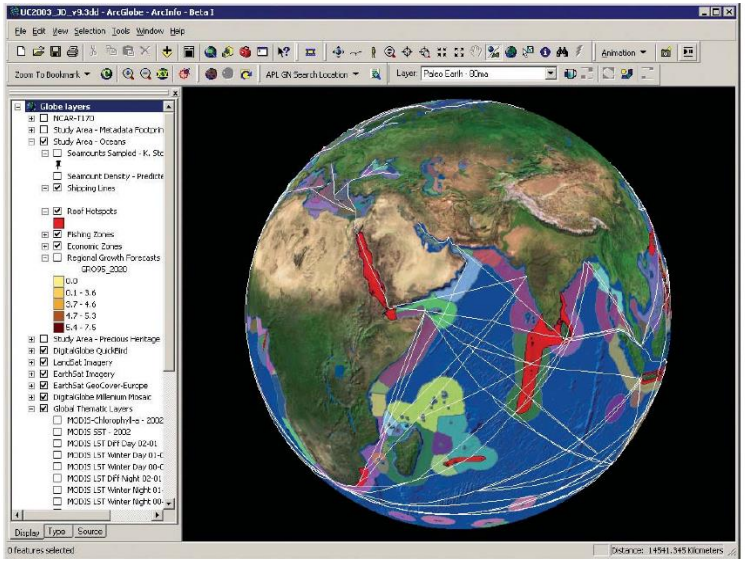


Figure 13.18 A whole-Earth visualization showing vector shipping lanes (white lines), reefs (red), and ocean fishing and economic zones, overlaid on top of raster topography (Courtesy: ESRI)

§ 4 Immersive interaction and PPGIS(cont.)

§ 4.2 hand-held computing and Geovisualization

- At the other end of the computer size spectrum, improved direct
- interaction with the real world has been made possible by the development of a range of hand-held, in-vehicle, and wearable computer devices
- Usually Augmented Reality