How to Pick a GIS

GIS Software
Chapter 8 in Longley, Goodchild, Maguire, and Rhind, 2001
How to Pick a GIS

- Evolution of GIS software
- Architecture of GIS software
- Types of software
- Example products
- The GIS market
A functional definition of GIS

- A GIS is often defined not for what it is but for what it can do.
- If the GIS does not match the requirements for a problem, no GIS solution will be forthcoming.
- A GIS may have overcapacity.
Ken Dueker’s definition of GIS (Reprise)

“ A special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines or areas. A GIS manipulates data about these points, lines and areas to retrieve data for ad hoc queries and analyses.”
GIS Software

- The geoprocessing engines of GIS
- Major functions
  - Collect, store, manage, query, analyze and present
- Key terms
  - Program – collections of instructions to manipulate data
  - Package – integrated collection of programs
  - Component – self-contained, reusable software building blocks
Evolution of GIS Software

- **Sub-routine libraries (60s/70s)**
  - Libraries of small programs (sub-routines)
  - Required advanced programming skills

- **Tool box with CLI (70s/80s)**
  - Basic package with Command Line Interface
  - Required advanced technical skills

- **Task-oriented system (90s/00s)**
  - Graphical User Interface (GUI)
  - Customization capabilities to create specific-purpose applications
Project and Departmental GIS
Enterprise GIS
Three-tier Architecture

- Presentation
  - User Interface
- Business Logic
  - Tools
- Data Server
  - Data Management
The “critical six” functional capabilities extracted from Deuker’s definition:

- Data capture
- Storage
- Management
- Retrieval
- Analysis
- Display
Data capture functions

- Digitizing
- Scanning
- Mosaicing (edge matching)
- Editing
- Generalization
- Topological cleaning
Steps in Mosaicing

Figure 8.1 Steps in mosaicing. Left: Two maps show one feature, but there is a gap. Center: Map edge is merged; nodes are snapped to “zip” feature. Right: Mosaiced map with continuous feature and dissolved map edge.
Figure 8.4 Line generalization alternatives. The line (left) can be resampled by retaining every $n$th point (center), or by repeatedly selecting the most distant point from a line between end nodes (right) and redviding the line until a minimum distance is reached, the Douglas–Peucker method.
Storage Functions

- Compression
- Metadata handling
- Control via macros or languages
  - Customization
- Format support
  - Maintenance
  - Update
Compression

- By data structure
  - quad trees
  - run length encoding
- By data format
  - compressed TIF
  - jpeg
- By physical compression
  - digit handling
Data Management Functions

- Physical model support
- DBMS
  - Query
- Address matching
- Masking
- Cookie cutting
  - Clip to study area
Cookie cutting
Data Retrieval and Analysis Functions

- Locating entities / finding records
- Selecting by attributes
- Selecting by Location
  - Buffering
  - Map overlay
  - Map algebra
Map Algebra

\[
\begin{array}{cccc}
1 & 1 & 0 & 0 \\
1 & 1 & 1 & 0 \\
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\end{array}
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Data Analysis Functions

- Buffering
- Map overlay
- Map algebra
- Interpolation - creating surfaces
- Optimal path selection
- Geometric tests - spatial relationships
- Slope calculation
Interpolation
Data Display Functions

- Desktop mapping
- Interactive modification of cartographic elements
- Graphic file export
Functional Capabilities are By-products of Data Structure

- Raster systems work best in forestry, photogrammetry, remote sensing, terrain analysis, and hydrology.

- Vector systems work best for land parcels, census data, precise positional data (GPS, fieldwork), and networks.
Vector

- Precision intact
- Used when individual coordinates are important
- More concise spatial description
- Assumes feature model of landscape
- Easy to transform data e.g. map projections
**Raster**

- Better for field data
- Used by most imaging systems
- Can be compressed
- Easy to display and analyze
- Many common formats
- However, most systems now use both
- Raster layer often backdrop-onscreen editing
The “Big Eight”

- Form the bulk of operational GIS in professional and educational environments.
- There are some significant differences between these “big eight” systems.
Professional GIS

**Full featured**
- Automation
- Manipulation
- Data access
- Query
- Spatial Analysis

**Visualization**
- Mapping
- Advanced editing
- Customization
- $10,000
Arc/Info

ESRI
Redlands, CA
Arc/Info
Market leader
workstation (mostly)
remarkable functionality
many formats supported
ArcEdit
ArcGRID
ArcPlot
INFO

The ArcInfo 8 system is today’s premier GIS software. All—relational, open, extensible, and the core of an enterprise GIS solution, ArcInfo 8 is a system used by corporations for tasks such as planning sales territories, analyzing competition, and routing delivery vehicles. Uses of ArcInfo 8 in governments include land records management, real—time emergency vehicle tracking, and park design.

Business, governments, utilities, educators, and others rely on ArcInfo 8 to improve operational efficiency, increase profitability, and tap the true potential of their databases for better decision making.
ArcInfo 8
Desktop GIS

Data exploitation
- Data access
- Query
- Spatial Analysis
- Simple editing

Visualization
- Mapping
- Customization
- $1500
ArcView

Versions 1-3, 3.1
PC Windows
Avenue
Web links
Map Objects
Extensions
MapInfo

Based in Troy, NY
Mapping functions
Limited GIS functionality
Uses Visual Basic
Many applications
Favored for 911, field
MapInfo
AutoCAD MAP

Windows all versions
SQL DBF Access
Extension to AutoCAD
Menu-based
Massive installed base
Added grid, projection
& topology support
DB links good.
3D links good
GRASS

First UNIX GIS
Developed by Army Corps of Engineers
UNIX functionality
Many unique functions
Free until recently
Many data sets
Baylor University now supports
IDRISI

Developed at Clark University, Worcester MA
Original in PASCAL, with open code
Development uses a specialty Windows/DOS Spatial analysis/stats extensions
Maptitude

Caliper Corporation
Consultancy
TRANSCAD and GIS+
Many network solutions
Windows
Import/Export
Address matching
Microstation MGE

CAD software with GIS extensions
Intergraph Corp, Huntsville AL
Uses Windows NT
Many parcel applications
Web extensions, server tools etc.
Hand-held

Field-based GIS

- Lightweight hardware
- Extension of desktop
- Limited capabilities
- Data collection
- Mobile mapping
- $500
Autodesk OnSite & ArcPad
Component GIS

Do it yourself GIS

- Software building blocks
- Embeddable
- Highly customizable
- Highly interoperable
- Lightweight, low cost deployments
- $5000 for 50 ($100 each)
Internet GIS

Distributed GIS

- Centralized service
- Simple, low cost
- Easy to use
- Map focused, some other services
- Read-only
- $7500 per server (10-30 users)
MapGuide

Local Government Application
with Oracle Spatial

Water service affected:

Parcel Information:
- APN: 941 0171 031 00
- Address: 7867 Gardella Dr
- Owner: Loren & Bonnie Sharp
- Acres: 0.17
- Assessed Value: $77,993 00
- Landuse: RES, SINGLE FAMILY RESIDENCE
- Tax Rate Area: 26001
- Year built: 1980

Map Tools:
- zoom scale
- buffer
- select within
- clear selection
- measure
- copy as url
- clear buffer
- search by APN
- parcel search
- redline circle
- redline text
- clear redline
GIS Viewers

Free GIS

- Lightweight
- Low cost
- Read only
- Mini-desktop GIS
- No customization
- $0!
A variety of issues should be considered in system selection:

- cost
- upgrades
- LAN configuration support
- training needs
- ease of installation
- maintenance
- documentation and manuals
- help-line and vendor support
- means of making patches
- workforce
GIS Market

Type of Software System

- Professional
- Desktop
- Hand-held
- Component
- Viewer
- Internet

Users

0 1,000,000 2,000,000 3,000,000
Summary

- GIS software is developing fast
- Consistent GIS architecture
- Major development areas
  - Internet
  - Hand-held
- Increasingly standards-based
- Very wide ranging
- Rationalization of vendors
GIS Case Study
GIS IN ACTION

September 11, 2001
The World Trade Center
Towers, NYC
GIS World Trade Center operations at Pier 92

- GIS support for firefighters, rescue workers, utility crews
- 24 hours a day / 7 days a week support for 2+ months
- 50+ GIS professionals
Data

- NYCMap
  - Orthophotography
  - Planimetric maps
- Thermal imagery
- LIDAR imagery
- GPS data
NYCMap

30 cm resolution orthophotography

Planimetric map - absolute spatial accuracy of half a meter
Thermal imaging

Thermal remote sensing data collected at the WTC on September 16.

Source: Roger Clark, USGS, Open File report 01-0429
Problems

- Maintaining building status database
- Unique identifiers for the buildings?
- Data consistency
- Data integrity
- TIME!
Lessons learned

- NYC GIS infrastructure was critical
- Cities should connect their spatial data to its attributes!
- Need for cartographic standards
- Need mobile access to GIS
- Version management for multi-user environment