# UC Santa Barbara

## Core Curriculum-Geographic Information Systems (1990)

### Title

Unit 18 - Modes of User/GIS Interaction

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# UNIT 18 - MODES OF USER/GIS INTERACTION

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Compiled with assistance from Doug Banting, Ryerson Polytechnical Institute, Toronto

NOTES

This unit introduces the different ways users can interact with GIS. It also provides an introduction to the range of interfaces available and will help students recognize differences between different GISs.

# UNIT 18: MODES OF USER/GIS INTERACTION

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## A. MODES OF INTERACTION

### Product mode

- system generates information products - lists, maps - which are later used for decision-making
- user of products does not interact with the system directly
- e.g. student records system generates class lists, transcripts which are used by committees, faculty to make decisions about student progress
  - faculty need know nothing about student record system except some conceptual understanding of (a) what information is in it and (b) what its capabilities are
  - e.g. can you give me a set of mailing labels for all students who took at least one course in geography last year? - anticipates (a) that the necessary data is in the system and (b) that the system has the functionality to do this
- resource manager should have similar levels of understanding of the agency's GIS
  - what is stored in it (data layers)
  - what functions a GIS can perform
  - e.g. can you make me a map showing all lands visible from this proposed waste disposal site?
- market researcher should have similar understanding of capabilities of firm's GIS
  - e.g. report numbers of people age 25-34, income over $30,000, living within concentric bands 1/4 mile wide around this proposed restaurant location

### Query mode

- user interacts directly with system, perhaps through an operator, to obtain answers to queries

### Example queries by application

- common type of query in land records office - "what easements and zoning restrictions are on the property?"
  - GIS can handle different ways of identifying property, e.g. by pointing to map, street address, subdivision plan, adjacency to other property

GIS can answer queries like "what police precinct(s) cover(s) this property?" by overlay of precinct layer and check for overlap

- common queries for publicly accessible records in a municipal data base:
  - e.g. locations of water lines, sanitary and storm sewers, current, historical and proposed Official Plan designations, historical property designation, site plan details, state of approvals

- navigation - "how do I get there from here?"

Continuum

- query and product modes are two extremes on a continuum

- vendors position themselves differently on this continuum
  - e.g. vendors of navigation and utilities management systems provide products at the query end while vendors of resource management systems tend to focus at the product end

- choice of mode also depends on frequency of use and training
  - e.g. in a city records office, a clerk will operate the GIS to determine answers to specific queries while the general public will refer to updated maps printed at regular intervals from the GIS
  - e.g. travel agent learns commands to formulate queries for airline reservations while the traveler consults printed timetables (generated from same database) needing no technical knowledge of reservation system

B. TYPICAL QUERIES

1. Simple recall of data

  - given a way of identifying the object by unique attributes (name, ID number, street address, account number)
  - get list of attributes

- other queries require searching for objects satisfying requirements
  - there are several different types of search queries:

2. Where is object A?

- given a way of identifying the object by unique attributes (name, ID number, street address, account number)
  - show the location of the object on the screen along with its surroundings

- scale of the surroundings depends on the application
  - might show house in relation to neighborhood, then use an inset map to show neighborhood in relation to city

- common example of this query is address matching - finding the coordinates or location

of a house/customer/lot from its street address

- address matching is used extensively in market research, processing of census returns, dispatching emergency vehicles to fires
- in some instances address matching is the only required function of a GIS
- special case is the automobile navigation system which shows location of the vehicle on a constantly updated map on a small screen next to the driver

3. What is this object?

- inverse of (2)
- object is identified by pointing ("picked") with an interactive device - mouse, cursor, light pen
- system returns attributes of object
  - e.g. street address of lot, name of owner, price of house at last sale, production of oil well
- special case - given a grid of points, estimate the value of its attribute here
  - e.g. with a DEM, estimate the elevation at the point indicated

4. Summarize attributes of objects within distance x

- extension of (3) to multiple objects related by distance
- give me (summary of, total of) attributes of objects within distance x of this point (pointing to screen)
- common query in site selection
  - give me totals for potential customers within 1/4 mile rings of this proposed location, broken down by census information, e.g. income, age, sex, occupation
- statistics will be stored as attributes of point or area objects (reporting zones) and will be aggregated to respond to queries
- this query service is offered by many market research companies
  - client dials up with coordinates (lat/long) of proposed site, queries database
  - large chain (e.g. bank, supermarket, convenience store) will do this many thousands of times a year

5. Summarize attributes of objects within a region

- extension of (4) to user-defined polygons rather than circles centered on a point
- give me (summary of, total of) attributes of objects within this area (outlining polygon on screen)
  - e.g. tell me how much prime agricultural land is within this area (floodplain of proposed dam)

e.g. tell me how much prime timber was burnt by the fire which burned this (query) area

- common query in political, school districting
  - report numbers of students or voters in proposed district

6. What is the best route?

- what is the best (least cost, least impact, fastest) route between these two points?
- database model may be discrete (links and nodes of a network) or continuous (raster or grid)
- discrete case used to dispatch fire trucks, emergency vehicles, cabs etc.
  - requires constant updating of link attributes to include road construction, maintenance, congestion
- continuous case used to route transmission corridors, pipelines to minimize impact
  - used by aircraft flying N. Atlantic routes to minimize impact of jetstream if flying from East to West, maximize benefit of tailwind if flying the other way
  - military applications ("trafficability") in determining routes for e.g. tanks

7. Show all of the objects satisfying the criteria

- show all of the objects satisfying the following criteria (defined on their attributes)
  - e.g. show all oilwells producing over 1 m3 per day
- extension of (2) to many objects

8. Use of relationship between objects

- some queries require use of relationships between objects
- if relationships are not currently stored they must be computed
  - e.g. show all the links in the stream network downstream of this link - requires the "flows into" relationship between links
  - e.g. show all the oilwells in the same county as this one - requires the "is contained in" relationship between oilwells and counties
  - e.g. show the nearest road to this point - requires the "is nearest to" relationship between roads and the point
  - e.g. show the counties adjacent to this one - requires the "is adjacent to" relationship between counties

## C. CHARACTERISTICS OF QUERY MODE

- provide soft copy
- operate in real time - maximum time allowed for response is a few seconds

often reported verbally over phone

- response must be precisely what was required
  - e.g. phone call to information asking for number for "Bill Smith" does not want 20 possible numbers, only most likely

- GIS query system often replaces anecdotal memory of staff
  - traditional approach to address matching relied on personal knowledge of city - e.g. London cab drivers required to know every street in London as qualification for license
  - address match by traditional approach can take minutes per enquiry
  - GIS system provides answers which are more precise, more rapid and can handle many more transactions

User training

- query requires a high level of user expertise
  - user must make frequent use of system in order to justify and maintain the level of familiarity
  - use must involve a relatively small number of functions unless user is to commit large amounts of time to training
  - query mode works best when queries are repetitive, e.g. "onecall" operation to identify locations of underground pipes, cables prior to construction - query is always "what is near here"

- query requires a friendly interface
  - menus, icons may be preferred over commands which are tedious to type
  - on the other hand trained users may prefer cryptic commands to other methods of access, e.g. airline reservations systems are command-driven, have high level of functionality, speed

D. PRODUCT MODE

- product mode is necessary for more complex or recurring information products, often involving manipulation, analysis, and recombining stored data to derive new information

- produces hard copy which is useful for several months after production
  - e.g. phone book valid for 1 year
  - e.g. airline guide valid for 1 month
  - e.g. class list valid for 1 semester
  - e.g. map of current census boundaries good for 10 years

- products often need to be updated and reproduced on a regular basis
  - typical resource management agency may have 50-100 standard products to generate monthly or annually
  - some agencies may require generation of as many as 100 different map sheets to cover jurisdiction

- since there is no immediacy of demand, production can be treated as a batch processing operation according to a planned schedule
    - contrast this with query mode which places variable load on the system
        - to maintain minimum response time system must be configured for worst-case load, e.g. 10am

- due to the repetitive nature of the update of these products, their production can be pre-programmed through the use of macros
    - a macro is an ordered list of computer operations designed to generate a standard result
    - macros, initiated with a single command, will cause the execution of the long and complex set of required operations

Personnel requirements

- GIS Analyst
    - analyst required to translate user needs into products
        - identify necessary data layers
        - develop appropriate data collection strategies, plans
        - design sequences of GIS functions to generate products from layers
        - design products to meet needs of users
    - design of products requires personnel with ability to:
        - conceptualize the sequence of GIS processes required
        - construct algorithms for compiling the data
        - design the report format so that the information that is provided is worthwhile to the users
    - these people must have:
        - understanding of subject matter to interact effectively with decision-makers who need information
        - level of technical expertise to develop GIS operation sequences to produce specified product
        - clear understanding of limitations of technology and data

- GIS technicians
    - need to know technical aspects of the operation of the software and hardware
    - will use the macros to produce required products

- users
    - generally product mode requires little technical expertise on the part of ultimate users of the data since products will usually be in traditional form - e.g. maps and tables

E. USER INTERFACES

overhead - Types of user interfaces

- there are several types of user interfaces:

Command driven

- user types commands at generic prompt - e.g. C>
- commands usually cryptic
- user must absolutely follow system-defined syntax by using precise spelling and punctuation rules
    - can be frustrating for poor or slow typists
- may be very large number of many commands, e.g. near 1,000 in some GISs
    - online help may reduce need to learn all rules and syntax, especially for the infrequently used commands
- "toolbox" metaphor used to describe the collection of possible functions available at any time

Questions or prompts

- system asks user for responses in sequence to determine parameters for analysis and output
- limited range of operations
- common in programs with minimal or restricted functionality

Menu driven

- user picks options from menus by pointing or by typing single letters or numbers
- menus present the only options which are possible at that time
- consequences of choice may be listed beside each option
- with familiarity, complex menu systems become tedious to use
- may not provide the flexibility of command driven systems

Icons

- a form of menu system providing symbolic icons to represent options available
- user drives system by pointing to icons for some operations and using menus for others
- some users feel that symbolic systems can be more intuitive to learn and operate than verbal ones
    - e.g. measure of ease of use is whether "a child of 10 can do something useful with the system without any prior training"

## Windows

- GIS interfaces should take advantage of the nature of spatial data
  - there are two natural modes of access to spatial data - through maps and through attributes
- the more sophisticated systems now use multiple windows with different ones for textual and graphic images
- windows allow several views of the map at once
  - i.e. full area and zoomed in image

## Plain language interfaces

- efforts to construct plain language interfaces for GIS have not been successful to date
  - range, syntax of geographic queries is too large
  - stressing language ignores the importance of visual access through maps, pointing etc.

## REFERENCES

Burrough, P.A., 1986. Principles of Geographical Information Systems for Land Resources Assessment, Clarendon, Oxford. See pages 9-10 for a short review of different types of queries.

## EXAM AND DISCUSSION QUESTIONS

1. Describe the differences between query and product mode interaction with GIS. Which mode would you select in constructing a GIS for a state department of transportation?

2. Discuss the use of product and query modes in accessing (a) phone directory information, (b) airline flight information, (c) TV program guides.

3. How will geographical access to records most affect people's lives in the coming decade?

4. What do you anticipate will be the level of production of 1:100,000 quad sheets by the US Geological Survey in the year 2010 - higher, lower than today or zero?

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*Last Updated: August 30, 1997.*

# UNIT 18 IMAGES

**COMMAND ORIENTED** (OSU MAP for the PC )

ADD <firstmap> TO <secondmap> FOR <thirdmap>

ORIENT <inmap> [PRECISELY] [FOR <outmap>]

CONTOUR <inmap> [FROM <lowvalue>] [TO <highvalue>]
[/] [BY <increment>]

**PROMPTS** (IDRISI)

Enter the name of the original image: RIVERS

Enter the name of the window image: NEWRIVER

Remembering that column and row numbers start with zero ...

Enter the column number of the upper-left window corner: 0
Enter the row number of the upper-left window corner: 0

Enter the column number of the lower-right window corner: 100
Enter the row number of the lower-right window corner: 100

Enter a new title for the window image:

RIVERS IN STUDY AREA

**MENU ORIENTED** (MAP II)