

GIS APPLICATIONS

LECTURE 5

DECISION MAKING WITH GIS AND DECISION SUPPORT SYSTEMS- DSS

- A spatially based computer application or data that assists a researcher or manager in making decisions- UMESC-Midwest USGS
- There is no one DSS; they are as diverse as the problems they help solve.
- This diversity –
- DSSs are built in a variety of ways
- DSSs are built with appropriate methods and tools for the individual application
- The skills of potential DSS users may vary widely





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Providing the scientific information needed by managers, decision makers, and the public to protect, enhance, and restore the ecosystems in the Upper Mississippi River Basin, the Midwest, and worldwide.

CLIMATE CHANGE
By 2095, Wisconsin winters are predicted to be similar to Iowa and Wisconsin summers may be more like Arkansas!

Source: Union of Concerned Scientists

Climate Change [link to information](#) [show all topics](#)

A changing climate has potential impacts on species like mussels and amphibians, as well as the quality of water and habitats.

2/11

Can't see Flash? Install [Flash Player](#) or use the [HTML version](#).

Impact of UMESC Science



Search the UMESC web site

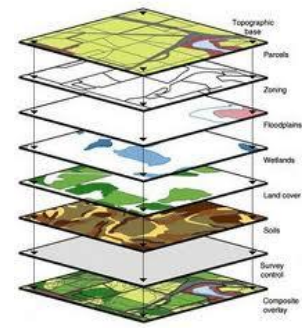
All documents and web pages ▾

UMESC Science

Select a Science Topic ▾

Select a State ▾ Select a River ▾

DECISION SUPPORT SYSTEMS- GIS



- Some small, highly trained user groups - powerful modeling tool with extensive functionality at the expense of ease of use.
- Other user groups less familiar with (GIS) and spatial data may want an extremely easy to use application for
 - a wide public or otherwise
 - nontechnical audience.



DECISION SUPPORT SYSTEMS- GIS

- The GIS tools fall into one of two categories:
 - general purpose or
 - specific purpose
- General-purpose GIS tools are programs such as ARC/INFO and ArcView
- specific-purpose GIS tools were written primarily using a macro language such as Avenue
- (ArcView's macro language) or AML (ARC/INFO's macro language)



DECISION SUPPORT SYSTEMS- GIS

- The GIS programmers now have a far richer set of tools for application development.
- Programming libraries with classes(object oriented programming) for interactive mapping and spatial analysis functions have made it possible to develop specific-purpose GIS tools using industry-standard programming languages that can be compiled and run without a host program (stand-alone).



DECISION SUPPORT SYSTEMS- GIS

- Internet development tools –
- develop fairly complex GIS-based programs that users can use through the www.
- Think Internet GIS-
- Google maps, mapquest etc are all GISs!



KNOWLEDGE-BASED TECHNIQUES

- Many geographical problems are
- ill-structured and
- an ill-structured problem "lacks a solution algorithm and often even clear goal achievement criteria"



KNOWLEDGE-BASED TECHNIQUES

- Many geographical problems are
- ill-structured and
- an ill-structured problem "lacks a solution algorithm and often even clear goal achievement criteria"
- In many geographical problems
 - the goals are poorly defined and
 - data may be incomplete, or
 - lack sufficient spatial resolution



KNOWLEDGE-BASED TECHNIQUES

- Complex problem- large volume of knowledge may be relevant to the problem
- *[Knowledge can be considered as information to which value has been added by interpretation based on a particular context, experience, and purpose]*



Wisdom



Knowledge



Evidence



Information



Data



KNOWLEDGE-BASED TECHNIQUES

- Complex problem- large volume of knowledge include:
 - past experience with similar cases
 - precise knowledge in certain narrowly defined parts of the problem
- KBGISs
- Knowledge representations(We need data structures in which knowledge can be stored.)
 - Trees
 - Semantic networks
- Learn from the user and find the optimum steps required to carry out a task by the system.
- It is software!- Expert system "shells"



KNOWLEDGE-BASED TECHNIQUES

- Expert system shells- provide a framework for organizing and representing knowledge
- Inference
- Inference is defined as the creation of new knowledge.
- Deductive inference:
 - Creates new knowledge from existing facts through logical implication e.g. if $A=B$ and $B=C$, then the system can deduce that $A=C$
- Inductive inference:
 - Produces new generalizations ("laws") which are consistent with existing facts



KNOWLEDGE-BASED TECHNIQUES- ISSUES

- Issues
- Knowledge based systems have been only moderately successful in areas where problems are relatively straightforward. E.g. medical diagnosis. Several factors may impede greater use:
- high cost of developing system - building the knowledge base
- uniqueness of every application
- dynamic nature of knowledge - knowledge base is not static
- inadequacy of alternatives for knowledge representation - few examples fit precisely within any one form, e.g. production rules

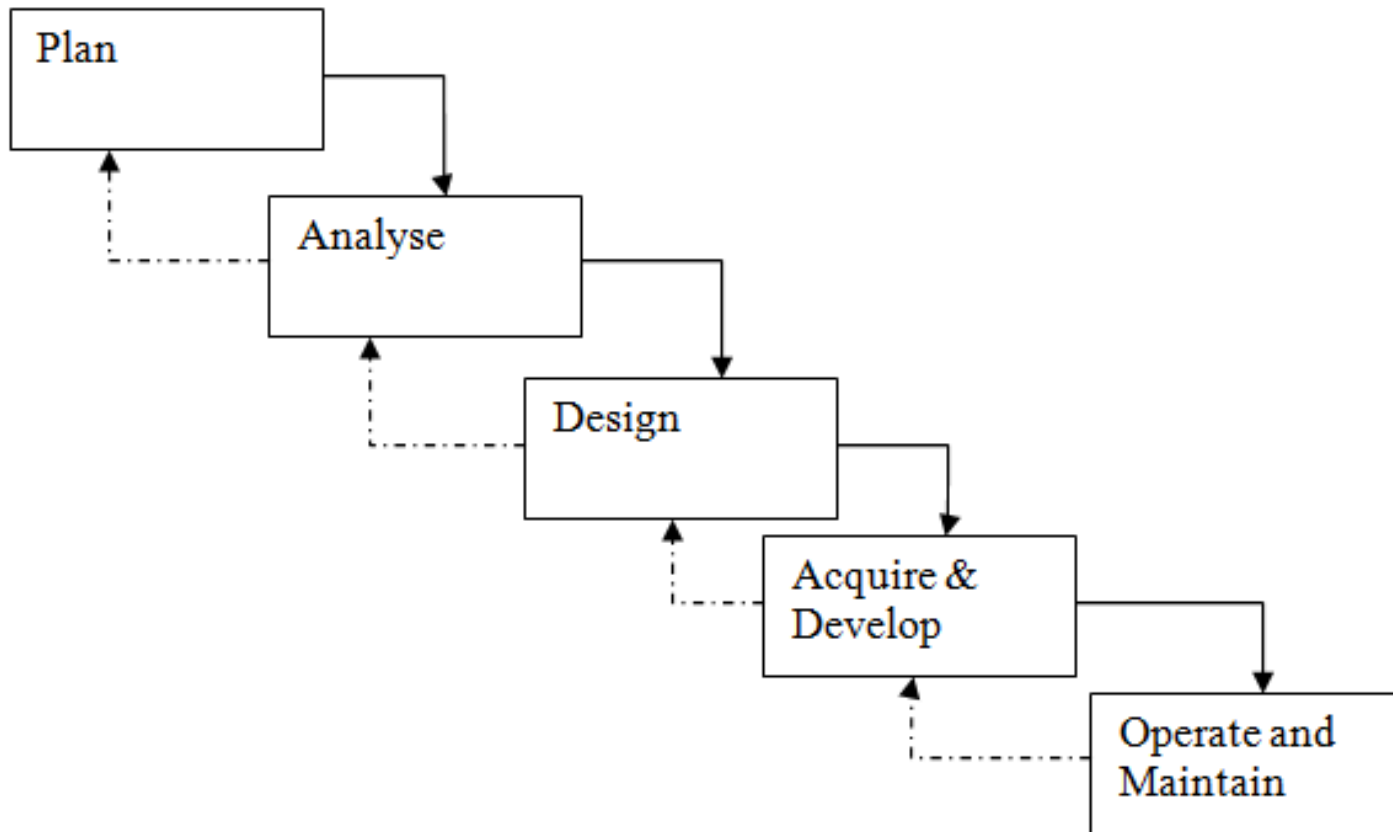


KNOWLEDGE-BASED TECHNIQUES- ISSUES

- unwillingness to trust the decisions of a machine (no "bedside manner")
- response time deteriorates rapidly as knowledge base grows
- most knowledge is "fuzzy" or uncertain - system must return many possible answers to a problem - few problems have a precise, single answer - technical difficulties of representing and processing fuzzy knowledge
- poor design of user interface - not "user friendly"
- user often wants the reasoning behind a decision, not just the decision itself
- some of the most successful applications have been for instruction



GIS IMPLEMENTATION PROCESS



GIS

IMPLEMENTATION PROCESS

- Planning—defining the scope of the GIS and developing a general plan;
- analysis—determining users' specific GIS requirements;
- Design integrating all requirements and developing GIS specifications;
- acquisition and development—acquiring software, hardware, and data, and putting them together in a system tailored to the organization; and
- operations and maintenance—using the GIS and maintaining the system.



GIS

IMPLEMENTATION PROCESS-PLANNING

- **Planning—defining the scope of the GIS and developing a general plan;**
- Will it be a one-time project or an ongoing program?
- Will it be used for all the organization's spatial data handling or for only a specific subset of
- functions, such as mapping?
- Will most people in the organization use it or will users be limited in number or job function?
- Will this GIS activity be part of a larger GIS effort?
- Will spatial data and technology be integrated with the organization's other data and systems?
- Will GIS change the way the organization does business or will its impacts be limited?



GIS

IMPLEMENTATION PROCESS-PLANNING

- Consider several perspectives.
 - *Users and stakeholders.* Ensure that the end-users and beneficiaries are adequately involved
 - *Management and policy makers.* Large enterprise GISs often require the involvement of top management- support and vision
 - *Required skills.* What skills will be needed to carry out GIS implementation?- contractors/consultants
 - *Project management and leadership.* For GIS efforts of even modest size, it is usually necessary to form a team and assign a leader- educate



GIS

IMPLEMENTATION PROCESS-PLANNING

- Develop resource and benefit estimates. The scope of the GIS determines initial estimates.-no of users/web=\$100,\$1000, \$10000,,,,,\$\$\$
- Conduct Strategic Planning.
 - Planning a large complex GIS may take months. For these types of projects a formal GIS strategic planning approach is required.



GIS

IMPLEMENTATION PROCESS-ANALYSIS

- Analysis—determining users' specific GIS requirements;
 - Analysis process. Identify all the work processes that involve spatial data and will use GIS.
 - It is important to identify as many of the future users of the GIS as possible
 - A business process analysis approach is very useful in analyzing GIS requirements—each current and planned work process and identifies the steps and the data involved
 - Specific data, sources, characteristics, and flows and links to other work processes and systems are identified
 - Note changes!



GIS

IMPLEMENTATION PROCESS-ANALYSIS

- Performing the analysis.
 - The requirements analysis is accomplished through user interviews and work sessions.
 - The GIS implementor or analyst must work with each individual user or group to perform the business process analysis.
 - RESULTS;
- □□ A description and diagram of each future GIS work process and its functional and data needs. Many of these future work processes will become applications.
- □□ Any constraints, opportunities, or problems associated with individual work processes, user groups, or the organization a whole.
- □□ The expected benefits and costs of the GIS.



GIS IMPLEMENTATION PROCESS-DESIGN

- Design—integrating all requirements and developing GIS specifications;
 - combine the organization's overall goals for GIS and the specific needs of the diverse users and applications, while developing an integrated and effective design
 - >> . Database design



GIS IMPLEMENTATION PROCESS-DESIGN

- Data characteristics are defined to suit the combined users' requirements. Each data entity
- is described in terms of data type, format, accuracy or resolution, attributes, amount, source, and maintenance responsibility and standards.
- Data relationships are identified and described through a data model.
- Data access and handling requirements are described, ensuring that each user and application will have access to needed data in required form.



GIS IMPLEMENTATION PROCESS-DESIGN

- Data security needs are identified.
- Temporal aspects are identified to support applications and data management functions such as time series analysis, planning scenarios, backup, archive, and retrieval.
- Metadata are identified at the appropriate level and in terms of how they will be used.
- The landbase or basemap is defined,



GIS

IMPLEMENTATION PROCESS-DESIGN

- Software and applications.
- The required functions of the GIS software and applications are derived from the users' operational need and the database support requirements.
- *Applications support.* What functions will the applications perform and what basic GIS software tools will be needed to support applications development?
- *Data support.* What functions and features are needed to support the database design in creation, operation, use, and maintenance activities?
- *Data access.* What types of data access tools will be needed by users?
- *Data integration.* What are the data and systems integration requirements?
- *Performance.* What are the performance requirements for applications and for other aspects of system operation?



GIS IMPLEMENTATION PROCESS-DESIGN

- Design results.
- The design activity results in several important products:
 - database design, including data descriptions, data model, and metadata specifications;
 - applications descriptions;
 - correlations among data, application, and users;
 - general architecture for the GIS system and its integration with other systems and databases;
 - management and organization components
 - cost/benefit analysis and budget; and
 - an implementation plan



GIS

IMPLEMENTATION PROCESS-ACQUISITION AND DEVELOPMENT

- Acquisition and development—acquiring software, hardware, and data, and putting them together in a system tailored to the organization; and
- To many, the task of GIS procurement—understanding and choosing among the many alternatives—is daunting. However, if the work done in the requirements analysis and design tasks is thorough, then selecting, procuring, and developing GIS components should not be difficult.



GIS

IMPLEMENTATION PROCESS- ACQUISITION AND DEVELOPMENT

- Main GIS components to be acquired -GIS software and hardware, applications, data, and systems integration.
- Procuring GIS products and services. Depending on the organization and the GIS, any of a variety of methods may be employed for the acquisition of system components.
- Many public sector organizations must follow formal RFP(Request for Proposals) procedures.
- A large, formal selection process usually involves evaluating written responses to the RFP specifications, and then meeting with shortlisted vendors to conduct a more detailed evaluation.



GIS

IMPLEMENTATION PROCESS-OPERATIONS AND MAINTENANCE

- operations and maintenance—using the GIS and maintaining the system.
- The combined costs for the development and operation of the GIS include the following components:
 - □□ hardware purchase, upgrade, and maintenance;
 - □□ software purchase, development, enhancement, and upgrade;
 - □□ software support;
 - □□ systems integration;
 - □□ database design and development;
 - □□ data purchase, license, conversion, collection, and creation;



GIS

IMPLEMENTATION PROCESS-OPERATIONS AND MAINTENANCE- COSTS

- □□ data maintenance and enhancement;
- □□ data preparation;
- □□ quality control and assurance;
- □□ training—initial and ongoing;
- □□ on the job learning;
- □□ recruiting and hiring;
- □□ system maintenance and enhancement;
- □□ staff;
- □□ consulting and services; and
- □□ management time.



GIS

IMPLEMENTATION PROCESS-OPERATIONS AND MAINTENANCE

- operations and maintenance—using the GIS and maintaining the system.
- careful management. The organization must be able to continue its work without interruption
- Project Management
Skills/Management/Cost/Benefit analysis



OTHER GIS APPLICATION AREAS

- **URBAN PLANNING;**
www.esri.com/library/brochures/pdfs/gis-sols-for-urban-planning.pdf
- **LAND USE AND AGRICULTURE;**
www.esri.com/library/bestpractices/gis-for-agriculture.pdf
- **NATURAL RESOURCE MANAGEMENT;**
<http://www.gis.com/content/natural-resources>
- **ENVIRONMENTAL AND ECOLOGICAL MODELLING AND MONITORING;** <http://geospatialworld.net>
- **DEFENCE AND EMERGENCY SERVICE NEEDS;**
- **AND HEALTH PLANNING.**



OTHER GIS APPLICATION AREAS

- **MARKETING AND DEMOGRAPHIC STUDIES;**
- To analyze market opportunities for your downtown, you need to examine data and ask questions like the above about residents of your trade area(s). This data must include the absolute number of residents, as well as their household characteristics. Current and projected demographic, lifestyle and consumer spending data about your trade area from secondary sources can provide this information.
- Demographic and lifestyle data about your trade area can give you a starting point for an in-depth analysis of specific business and real estate development opportunities.
- <http://fyi.uwex.edu/downtown-market-analysis/understanding-the-market/demographics-and-lifestyle-analysis/>



