Requirements analysis for GIS applications

- May need to cover requirements for:
  - database design
  - user interface design
  - functional requirements
  - hardware and software requirements

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Information Systems Design Process

- Requirements analysis – specifies what the system is required to do based on user/stakeholder input
- Design – specifies how the system will address the requirements
- Implementation – translates design specifications into a working system

Requirements analysis is critical to the success of a project.

Requirements Analysis

Requirements analysis can be applied at several different levels

- Overall system design
- GIS application design
- Database design

Determines data, information, system components, data processing and analysis functions required by an organization, enterprise, individual user.
**Requirements Analysis**

Includes three primary activities:

- **Eliciting requirements**: communicating with stakeholders to determine their requirements.
- **Analyzing requirements**: determining whether the stated requirements are clear, complete, unambiguous, and consistent and resolving any problems.
- **Recording requirements**: documenting requirements in various forms, such as natural-language documents, use cases, user stories, or process specifications.

**Requirements Analysis Techniques**

Techniques for eliciting and checking requirements from users

- Holding interviews or focus groups (or requirements workshops) and creating requirements lists.
- More recent techniques include prototyping, and use cases

**Requirements analysis components**

- Organizations' goals and objectives
- Current practices, problems encountered, and redundancies
- Organizational issues - management structure, resources, staff training
- Applications
- Data requirements
- Conceptual data base design
- Hardware and software
- System integration
- Cost of implementation - applications development, data conversion, hardware, software, resources, training, update and maintenance
- The Strategic Implementation Plan over a period of 3-5 years

**Requirements Analysis for GIS application design**

**Identification of users:**

Who will use the system? - system users, end product users. What are their needs? what is their level of expertise?

**What are required products/outputs:**


**Evaluation of work flow:**

what do the users need to do? what are they required to do? routine tasks? one off tasks? as yet undefined tasks?

types of data used, formats of data, data accuracy requirements, data display requirements
Steps in Database Design

1. Requirements analysis
2. Conceptual design
3. Implementation design
4. Physical design

- Data is the core of GIS and the quality of the system/application depends on quality of the data
- Database design is a fundamental component of GIS application design

Conceptual design

- Synthesis of information from requirements analysis according to semantic rules
- Outcome is a conceptual model
- The conceptual model describes entities, attributes and relations among entities independent of implementation details

Implementation Design

- Transforms the conceptual data model into an internal model - schema that can be processed by a particular Database management System (DBMS)

Physical Design

- Involves design of internal storage structures, record formats, access methods, record blocking

Steps in requirements analysis for database design

1. Identify scope of the design effort
2. Establish metadata collection standards - who to interview, what to collect - how to structure interview
3. Identify user views
   - user view: subset of data used by a person in a specific context
   - can be identified by reviewing tasks, documents
4. Build a data dictionary
   - define and describe each item in detail: name, description, type, length, range and relationships
Steps in requirements analysis for database design

5. Identify data volumes and usage patterns how much data is used, how frequently, how frequently does data change

6. Identify operational requirements

Establish Data Collection Standards

- Formalize the interview process
- Ideally use a structured interview process with standardized data collection forms

Survey form example

**Organization Unit Profile**

Organization: 
Director: 
Location: 
Interviewer: 
Date: 
Describe the overall mission of your department
Provide an organizational chart including job descriptions

**Task List**

List tasks performed by a department and give estimates of how often this task is performed (routine/non-routine, daily, monthly, yearly)

<table>
<thead>
<tr>
<th>Task</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>Task #_____</td>
<td>Data Requirements</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------</td>
</tr>
<tr>
<td><strong>Data Sources:</strong></td>
<td></td>
</tr>
<tr>
<td>What data is used by the organization in the performance of this task?</td>
<td></td>
</tr>
<tr>
<td>What is the source of this data (in house, other department, outside)?</td>
<td></td>
</tr>
<tr>
<td>If in-house collection, describe collection method, including estimate of frequency of collection. Provide any data forms, if applicable.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task #_____</th>
<th>Data Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Descriptions/contents</strong></td>
<td></td>
</tr>
<tr>
<td>Describe the spatial reference of the data – (does it have one, need one)?</td>
<td></td>
</tr>
<tr>
<td>Describe the scale, resolution, accuracy and/or reliability of the data</td>
<td></td>
</tr>
<tr>
<td>What is the areal coverage of the data available/required? temporal coverage available/required?</td>
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</table>

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<thead>
<tr>
<th>Task #_____</th>
<th>Data Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Storage</strong></td>
<td></td>
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<tr>
<td>What is physical format of the data?</td>
<td></td>
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<tr>
<td>What volume of data needs to be maintained?</td>
<td></td>
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<tr>
<td>How long is data maintained?</td>
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<tr>
<td>What archiving procedure is used if any?</td>
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</tbody>
</table>

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<tr>
<th>Task #_____</th>
<th>Data Operations</th>
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</thead>
<tbody>
<tr>
<td>Describe the operations/processing required for a task including frequency</td>
<td></td>
</tr>
<tr>
<td>List personnel involved in this task including amount of time each person spends on the task and their level of training</td>
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</tr>
<tr>
<td>List the tools used in this task (hardware and software) and give their locations</td>
<td></td>
</tr>
<tr>
<td>List any maps used or produced in this task</td>
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</tr>
<tr>
<td>Rate the current efficiency of this task: [very efficient, efficient, poor]</td>
<td></td>
</tr>
</tbody>
</table>
Task #____ Information Products

Describe any products associated with this task

What is the intended purpose of this product?
Who are the intended users [internal use, public access]?
What is the overall importance of this information?
Describe the spatial reference of this information.
Describe the accuracy, resolution and or reliability.
Are there required formats for the product?

Use Cases

A use case is a technique for documenting the potential requirements of a new system or software change.

A use case provides one or more scenarios that convey how the system should interact with the end user or another system to achieve a specific business goal.

Break down requirements into user functions.

Use Cases

A use case describes a sequence of interactions between a user and an application without specifying the user interface.

Each use case captures:
- The actor (who is using the application?)
- The interaction (what does the user want to do?)
- The goal (what is the user's goal?)

Use Cases

Example use case diagrams
**Functional requirements**

Show how the use cases are to be satisfied.

Functional requirements define the internal workings of the software: the calculations, technical details, data manipulation and processing, and other specific functionality.

They are supported by non-functional requirements, which impose constraints on the design or implementation (such as performance requirements, security, quality standards, or design constraints).

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**Identify User Views**

Subset of the data required by a particular user to make a decision or carry out some action.

Extracted by reviewing user tasks, use cases, and types of decisions. Forms, reports, graphs, maps can be useful information for defining views.

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**Build a Data Dictionary**

Each data item identified in a view should be defined in detail.

Identify and document each item’s attributes: name, description, type, length, allowable range.

**View Integration**

Consolidate terms and eliminate redundancies.

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**User View**

City of Seattle Maps
### Data Dictionary – Feature Table

<table>
<thead>
<tr>
<th>Author</th>
<th>Data</th>
<th>Entity</th>
<th>Description</th>
<th>Method</th>
<th>Address</th>
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<td></td>
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**Data Dictionary**

**Feature Definition**

**PUBLIC LAND SURVEY SYSTEM**

- **DEGREE DESIGNATION:**
  - **Standard Survey:**
    - **CORNER NUMBER:**
      - **X:**
      - **Y:**
      - **Z:**
    - **DESCRIPTION:**
      - **GROUND MEASUREMENT:**
        - **LINE TYPE:**
          - **DEGREE LENGTH:**
            - **LINE:**
              - **DEGREE LENGTH:**
                - **POLYGON:**
                  - **SURVEY:**
                    - **COORDINATE:**
                      - **X:**
                      - **Y:**
                      - **Z:**
                    - **LAND:**
                      - **COORDINATE:**
                        - **X:**
                        - **Y:**
                        - **Z:**

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                    - **LAND:**
                      - **COORDINATE:**
                        - **X:**
                        - **Y:**
                        - **Z:**

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**Example:**

- **Feature:**
  - **Description:**
    - **Area:**
      - **Boundary:**
        - **Measurement:**
          - **Location:**
            - **Property:**
              - **Address:**
                - **Survey:**
                  - **Datum:**
                    - **Datum Name:**
                      - **Datum Code:**

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**Example:**

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Requirements analysis provides an initial understanding of the level of effort and realistic schedule required to implement a system or application envisioned by users.

A requirements analysis report forms a framework for a common understanding between the client and a developer in terms of breadth and scope of the envisioned system or application.

Issues arising from requirements analysis:

- Technical personnel and end users typically have different vocabularies. They can believe they are in perfect agreement until the finished product is supplied.
- Engineers and developers may try to make the requirements fit an existing system or model, rather than develop a system specific to the needs of the client.
- Analysis may be carried out by engineers or programmers, rather than personnel with the people skills and the domain knowledge to understand a client’s needs properly.
- Requirements can be a moving target

Listen carefully, think creatively, be patient