# Chapter 9 Project management for spatial DB implementation

## 1. Introduction

implementation of spatial DB sys is a complex task

fail to meet user needs, delays in delivery, cost over-runs

spatial DB implementation from a management perspective is important - this is what this chapter deals w/

## 2. Principles of project management

### 2.1 Definition & objectives of project management

project - logical sequence of activities that must be completed within a specific time frame

project must have a well-defined goal w/ respect to the mission of an organization

three constraints of projects (or sub-projects) :

time - definitive milestones ex. specify component delivery schedule

cost - budgetary limits especially of human & technical resources

specification - deliverables of a project need to meet a specific level of functionality & quality

five project management processes :

initiating - planning - executing - monitoring - controlling process

nine knowledge areas that project managers to be competent :

project integration, scope, time, cost, quality, human resources, communications, risk, procurement managements

## 2.2 The project management life cycle (PMLC)

PMLC defines how a project is managed effectively & efficiently

cf. similar to the SDLC(sys development life cycle), DDLC(DB development life cycle)

five PMLC phases

initiation - planning - execution - monitoring & control - closeout & evaluation (Fig 9-1)

: there is a feed back loop, overlap of phases (Fig 9-2)

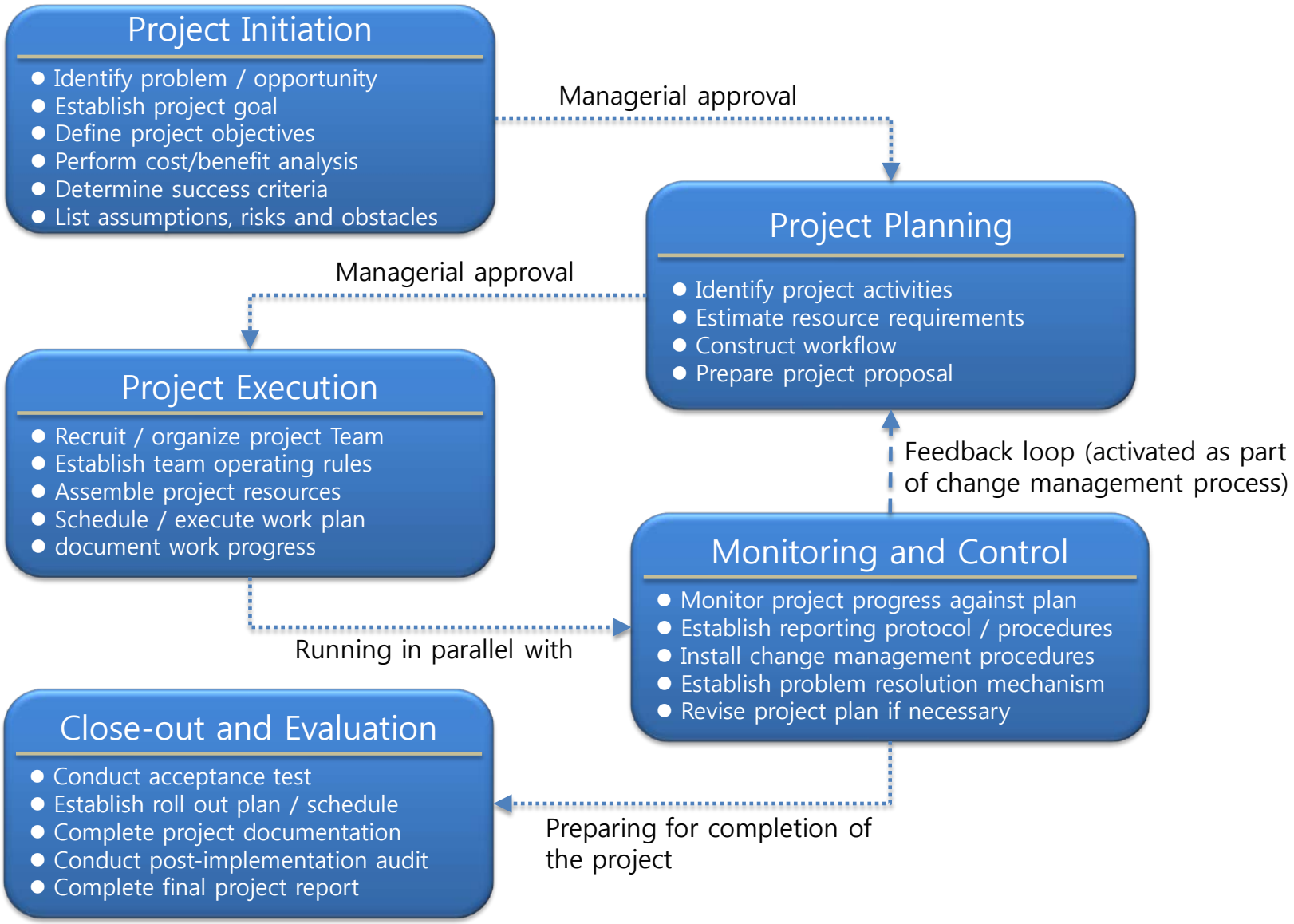





Fig 9-1 Phases of the project management life cycle & related activities

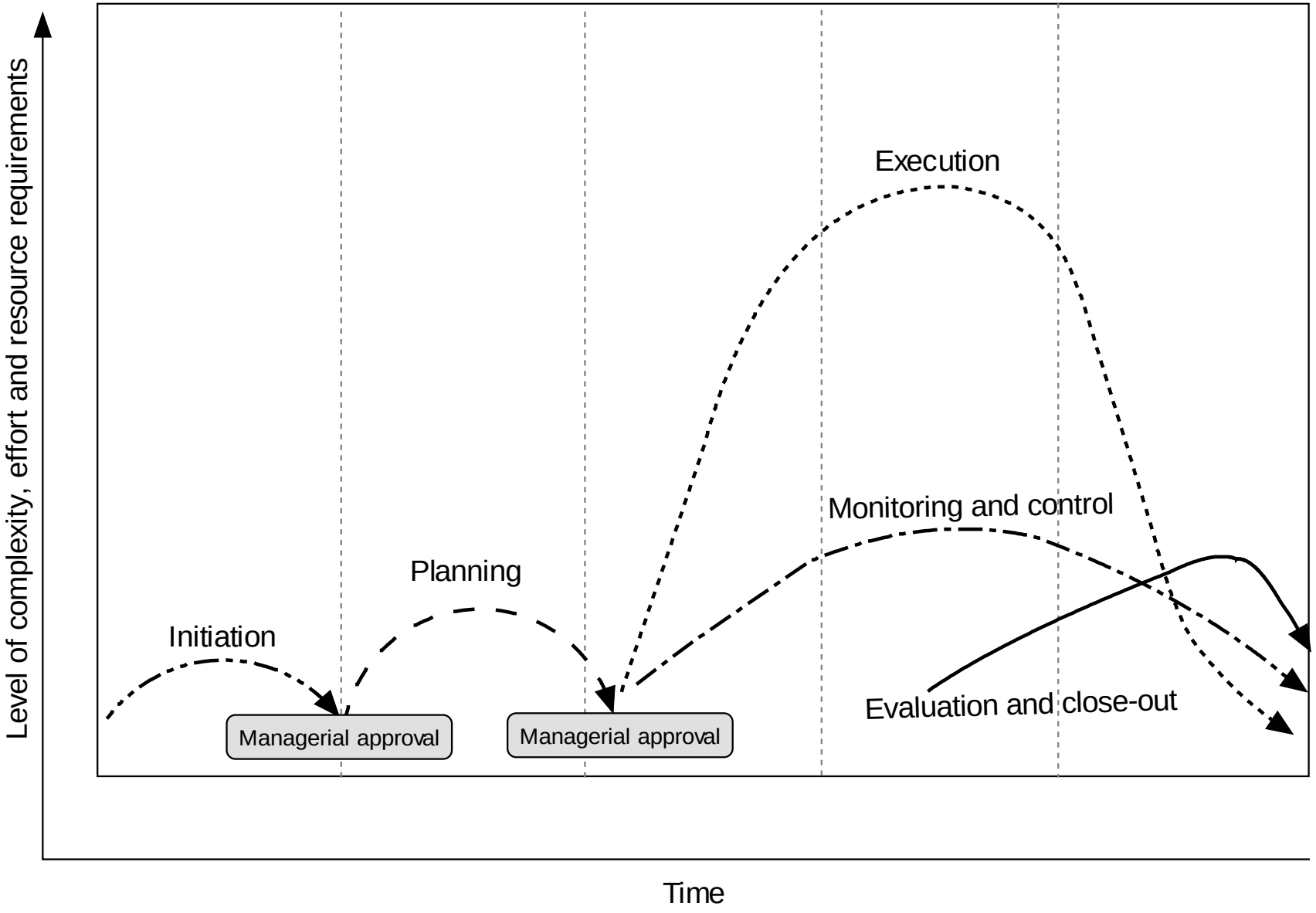





Fig 9-2 Relationship between phases of the PMLC, complexity, & resource requirements of project activities

## 2.3 Competencies & skills of project management

five core sets of competencies & skills for project managers (from NY State Proj Mgnt Guidebook):

- communication - good communication skills are a critical requirements - listen & talk
- leadership of a changing organization - change in org culture, institutional structure, business process
- managing politics & conflicts - need good networking, negotiation skills, mediation skills
- team leadership - motive members, provide necessary training, recognize their efforts & accomplishment appropriately, need delegation & empowerment, never ignore discipline
- building trust & credibility - of project sponsor, staffs, other stakeholders
- * technical competencies & skills are also important from other perspectives

three categories of competencies & skills (Fig 9-3)

- strategic - leadership of a changing organization, communication
- tactical - communication, managing politics & conflicts, team building, building trust & credibility
- technical - need thru out the entire course of the PMLC

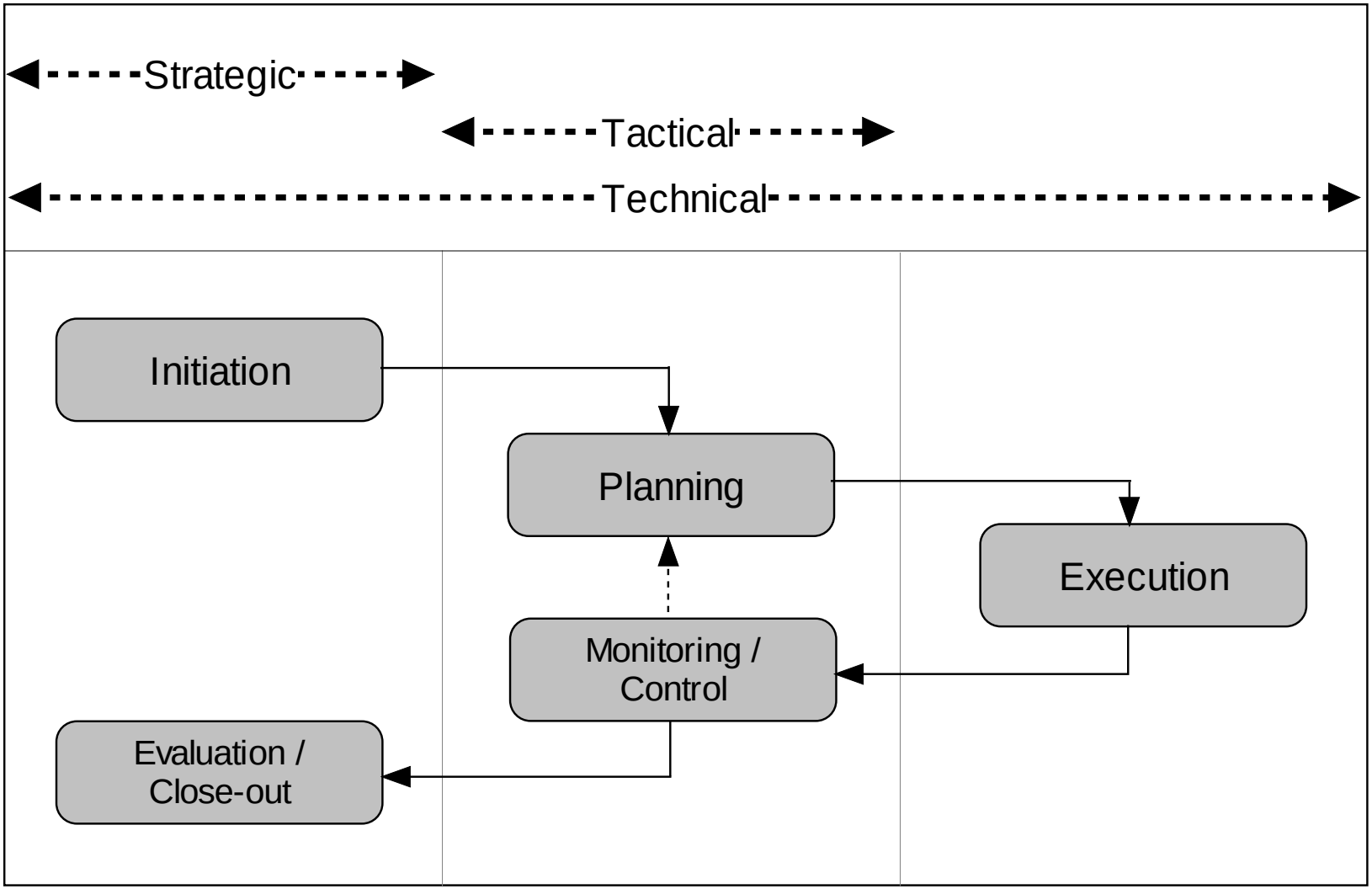



Fig 9-3 Competencies & skill requirements at different stages of the PMLC

## 3. Project initiation activities

### 3.1 Preliminary project organization

first task is to define the goal - define the scope (ex. what is included & excluded), constraints of time, cost, specification

goal statement should be :

specific, concise & clear, measurable, agreed upon, realistic

one of the most difficult challenges - document maintenance

project management SW can be used

### 3.2 Developing project activities

a top-down approach is recommended - uses a project activity hierarchy

start w/ the highest level activities, progress one by one to identify individual tasks

## Phase 1 - Initiate project

Activity 1A - Create preliminary project goal

Task 1A1: Develop project goal statements
Task 1A2: Create project org-chart
Task 1A3: Complete project business case form
Task 1A4: Create project folder
Task 1A5: Create project binder

Activity 1B - Create a list of activities

Activity 1C - Identify project resources

Task 1C1: Complete project resource requirements form
Task 1C2: Conduct cost-benefit analysis

## Phase 2 - Plan project

Activity 2A - Organise project team
Activity 2B - Meet with project team

Task 2B1: Confirm commitment of team members
Task 2B2: Seek approval from Human Resources Department
Task 2B3: Determine date, time and place of first meeting
Task 2B4: Prepare meeting ground rules and agenda

Activity 2C - Refine project plan

Task 2C1: .....
Task 2C2: .....

.....
.....

## Phase 3 - Execute project

Activity 3A - .....
Activity 3B - .....



Fig 9-4 Partial listing of a project activity hierarchy

## 3.3 Identifying project resources

project resources - financial, human, technical resources

to assist in the documentation, a resource requirement form is used (Fig 9-5)

useful to develop an organization chart (for human resources) (Fig 9-6)

| **Organisation Name**<br>Spatial Database Project - Resource Requirements | | | | | |
|---|---|---|---|---|---|
| ***Activity*** | ***Personnel*** | ***Facilities*** | ***Equipment*** | ***Materials*** | ***Other*** |
| | Person(s):<br>Time:<br>Cost: | | | | |
| | Person(s):<br>Time:<br>Cost: | | | | |
| | Person(s):<br>Time:<br>Cost: | | | | |
| | Person(s):<br>Time:<br>Cost: | | | | |
| | Person(s):<br>Time:<br>Cost: | | | | |

Fig 9-5 Examples of a resource requirements form

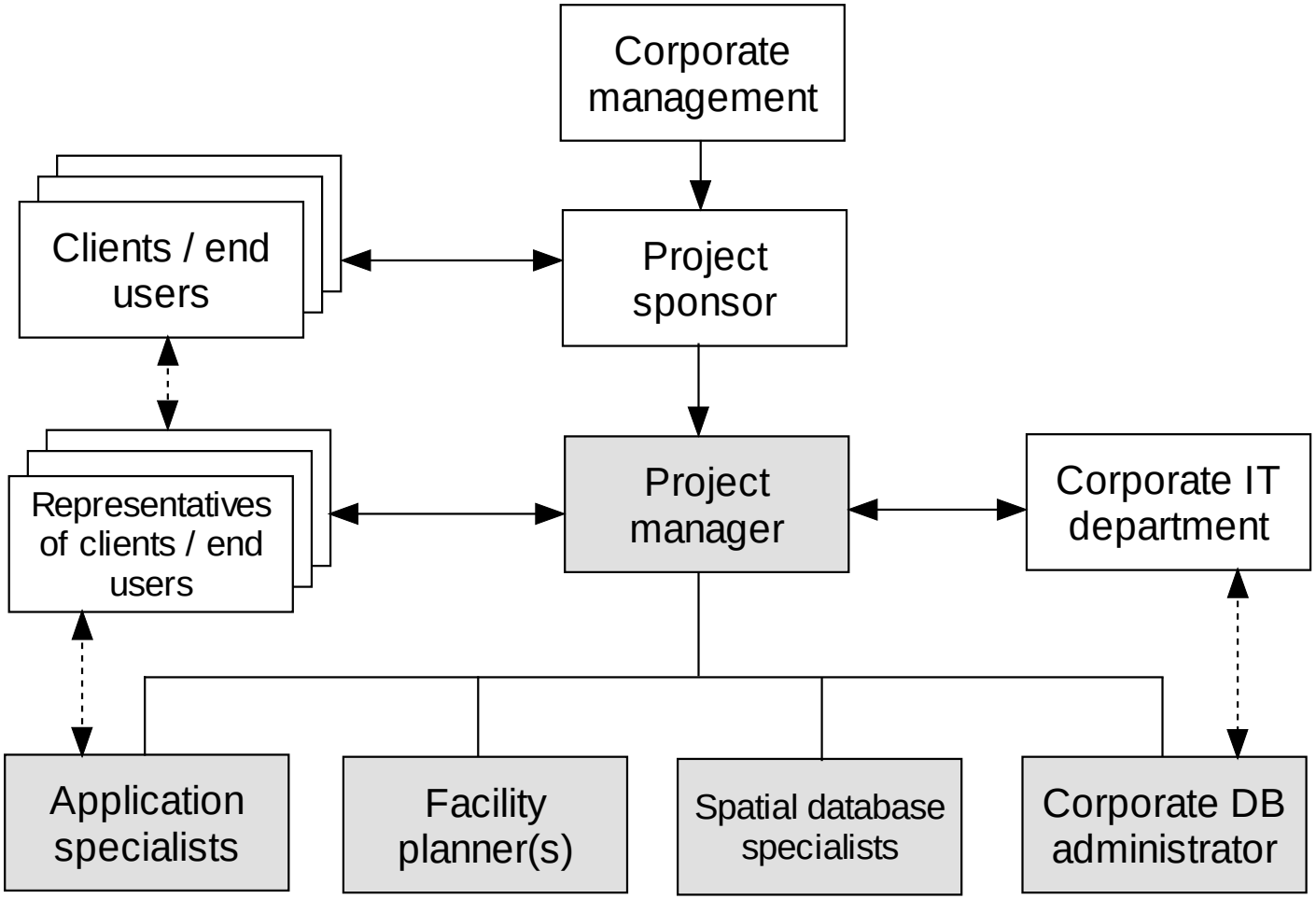



Fig 9-6 Example of an organizational chart of a typical spatial DB implementation project

## 3.4 Cost-benefit analysis

often imprecise as it do not account for non-monetarised subtleties & complexities

ex. intangible benefits

two steps of cost-benefit analysis :

assumptions - four sets of assumed parameters / variables

time frame - project life cycle, payback period, initial investment period, benefit accrual period

costs - for personnel, facilities, equipments, materials

benefits - from productivity gain, cost recovery, value-added services, economic spin-off

discount rates - differential weightings in the calculation of future costs & benefits

calculation - calculates annual benefits less annual costs

sum of flow of net benefit (SFNB) - all payments & income/benefits over the same payback period

net present value (NPV) - sum of future payments & income/benefits over the same payback period considering discount rate

*Table 9-1.* Value of potential benefits by percentage of productivity gain

| Productivity Gain (%) | FY 2003 (%) | FY 2004 (%) | FY 2005 (%) | FY 2006 (%) | FY 2007 (%) | FY 2008 (%) |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 284,704 | 284,641 |
| 3 | 0 | 0 | 0 | 0 | 854,112 | 862.624 |
| 5 | 0 | 0 | 0 | 0 | 1,423,968 | 1,438,207 |
| 10 | 0 | 0 | 0 | 0 | 2,847,935 | 2,876,414 |
| 15 | 0 | 0 | 0 | 0 | 4,271,903 | 4,314,622 |

| Productivity Gain (%) | FY 2009 (%) | FY 2010 (%) | FY 2011 (%) | FY 2012 (%) | FY 2013 (%) | Total (%) |
|---|---|---|---|---|---|---|
| 1 | 290,518 | 293,423 | 296,357 | 299,321 | 305,607 | **2,057,660** |
| 3 | 871,554 | 880,269 | 889,072 | 897,962 | 916,820 | **6,172,981** |
| 5 | 1,452,589 | 1,467,115 | 1,481,786 | 1,496,604 | 1,528,033 | **10,288,302** |
| 10 | 2,905,178 | 2,934,230 | 2,963,573 | 2,993,208 | 3,056,066 | **20,567,605** |
| 15 | 4,357,768 | 4,401,345 | 4,445,359 | 4,489,812 | 4,584,099 | **30,864,907** |

*Table 9-2.* Total capital investment and operating costs by year

| FY 2003 ($) | FY 2004 ($) | FY 2005 ($) | FY 2006 ($) | FY 2007 ($) | FY 2008 ($) |
|---|---|---|---|---|---|
| 10,000 | 618,000 | 932,000 | 583,654 | 182,214 | 125,880 |

| FY 2009 ($) | FY 2010 ($) | FY 2011 ($) | FY 2012 ($) | FY 2013 ($) | Total ($) |
|---|---|---|---|---|---|
| 309,656 | 133,546 | 137,553 | 141,679 | 145,929 | **3,320,911** |

*Table 9-3.* Sum of flow of net benefits by year based on percentage of productivity gain

| Productivity Gain (%) | FY 2003 (%) | FY 2004 (%) | FY 2005 (%) | FY 2006 (%) | FY 2007 (%) | FY 2008 (%) |
|---|---|---|---|---|---|---|
| 1 | -10,000 | -618,000 | -932,800 | -583,654 | 102,490 | 161,761 |
| 3 | -10,000 | -618,000 | -932,800 | -583,654 | 672,167 | 737,044 |
| 5 | -10,000 | -618,000 | -932,800 | -583,654 | 1,241,754 | 1,312,327 |
| 10 | -10,000 | -618,000 | -932,800 | -583,654 | 2,665,721 | 2,750,534 |
| 15 | -10,000 | -618,000 | -932,800 | -583,654 | 4,089,689 | 4,188,742 |
| **Productivity Gain (%)** | **FY 2009 (%)** | **FY 2010 (%)** | **FY 2011 (%)** | **FY 2012 (%)** | **FY 2013 (%)** | **Total (%)** |
| 1 | -19,139 | 159,877 | 158,805 | 157,642 | 159,677 | **-1,263,251** |
| 3 | 561,897 | 746,723 | 751,519 | 756,283 | 770,890 | **2,852,070** |
| 5 | 1,142,933 | 1,333,569 | 1,344,234 | 1,354,925 | 1,382,103 | **6,967,391** |
| 10 | 2,592,522 | 2,800,684 | 2,826,020 | 2,851,529 | 2,910,136 | **17,255,693** |
| 15 | 4,048,111 | 4,267,799 | 4,307,806 | 4,348,133 | 4,438,169 | **27,543,996** |

*Table 9-4.* Discounted net present value (NPV) of costs and benefits and pay period based on productivity gain

| Productivity Gain (%) | Net Present Value ($) | Payback Period (Years) |
|---|---|---|
| 1 | -1,321,386 | 9 |
| 2 | 235,859 | 6.75 |
| 3 | 1,793,103 | 5.75 |
| 4 | 3,350,347 | 5.25 |
| 5 | 4,907,591 | 5 |
| 6 | 6,464,836 | 4.75 |
| 7 | 8,022,080 | 4.75 |
| 8 | 9,579,324 | 4.5 |
| 9 | 11,136,568 | 4.25 |
| 10 | 12,693,813 | 4.25 |
| 11 | 14,251,057 | 4.25 |
| 12 | 15,808,301 | 4.25 |
| 13 | 17,385,545 | 4.25 |
| 14 | 18,922,790 | 4.25 |
| 15 | 20,480,034 | 4.25 |

(Source for all tables: GeoAnalytics, 2003)

## 3.5 Writing a project proposal

project proposal - project overview statement / project definition form

two forms to be useful :

PBC (project business case) form - helps senior managers understand the justifications of project

PS (proposed solution) form - provides clear description of the proposed solutions

**Name of Organisation**
**Project Business Case**

**Project Identification**

**Project name:** _____ **Date:** _____

**Division/Department/Unit:** _____

**Project sponsor:** _____ **Project manager:** _____

**Business needs / problems and project goal statements**

**Solutions** *(Summarised from and cross-referenced with Proposed Solutions)*

**Consistency with orgamisational mission, legislated and regulatory requirements**

**Resource requirements** *(Summarised from Resource Requirements Form and org-chart)*

**Anticipated benefits and opportunities** *(Both quantitative and qualitative)*

**Cost estimate** *(Abstracted from and cross-referenced with Proposed Solutions)*

**Cost/Benefit analysis** *(Summarised results only)*

**Risk and organisational impact**

**Sources of funding** *(Include both internal and external funding where applicable)*



Fig 9-7 Example of a project business case form

**Name of Organisation**
**Proposed Solutions**

**Project Identification**

**Project name:** _____ **Date:** _____
**Division/Department/Unit:** _____
**Project sponsor:** _____ **Project manager:** _____

**Summary of business needs / problems** *(From Business Case)*

**Proposed solutions / Project approaches**

| Solution / Approach / Alternative | Why chosen / not chosen |
|---|---|
| | |
| | |
| | |

**Budget / Estimate costs**

| Item | Initial (Development) | Annual (Recurring) | Remarks |
|---|---|---|---|
| Hardware | | | |
| Software licences | | | |
| Supplies | | | |
| Data | | | |
| Consulting services | | | |
| Other | | | |
| Total | | | |

**Personnel / Estimate resources**

| Item | Initial (Development) | Annual (Recurring) | Remarks |
|---|---|---|---|
| Design / development | ------- hours | ------- hours | |
| QA / QC / Testing | ------- hours | ------- hours | |
| Training | ------- hours | ------- hours | |
| Legal services | ------- hours | ------- hours | |
| Outsourcing | ------- hours | ------- hours | |
| Total | ------- hours | ------- hours | |



Fig 9-8 Example of a proposed solutions form

## 4. Project planning processes - turning ideas into realities

### 4.1 Recruiting & organizing the project team

project team - includes project manager & members

project manager - key person, chief executive officer

team members - be co opted from internal staff / hired externally

helpful to divide the team into small working groups, each headed by an experienced technical lead

## 4.2 Refining the project plan

refining - identify the actions, costs, start & end dates, order of tasks, project team responsible for tasks

four basic aspects of work :

project tasks - identify the details of all tasks, sort into a logical order for execution

resources - quantify the resources required for each task

project schedule & task precedence - determine the most efficient order for the tasks

precedent relationship between tasks - dependent & independent tasks

deliverables - Gantt chart, project network diagram

project member’s role & responsibility - Responsibility Chart is helpful

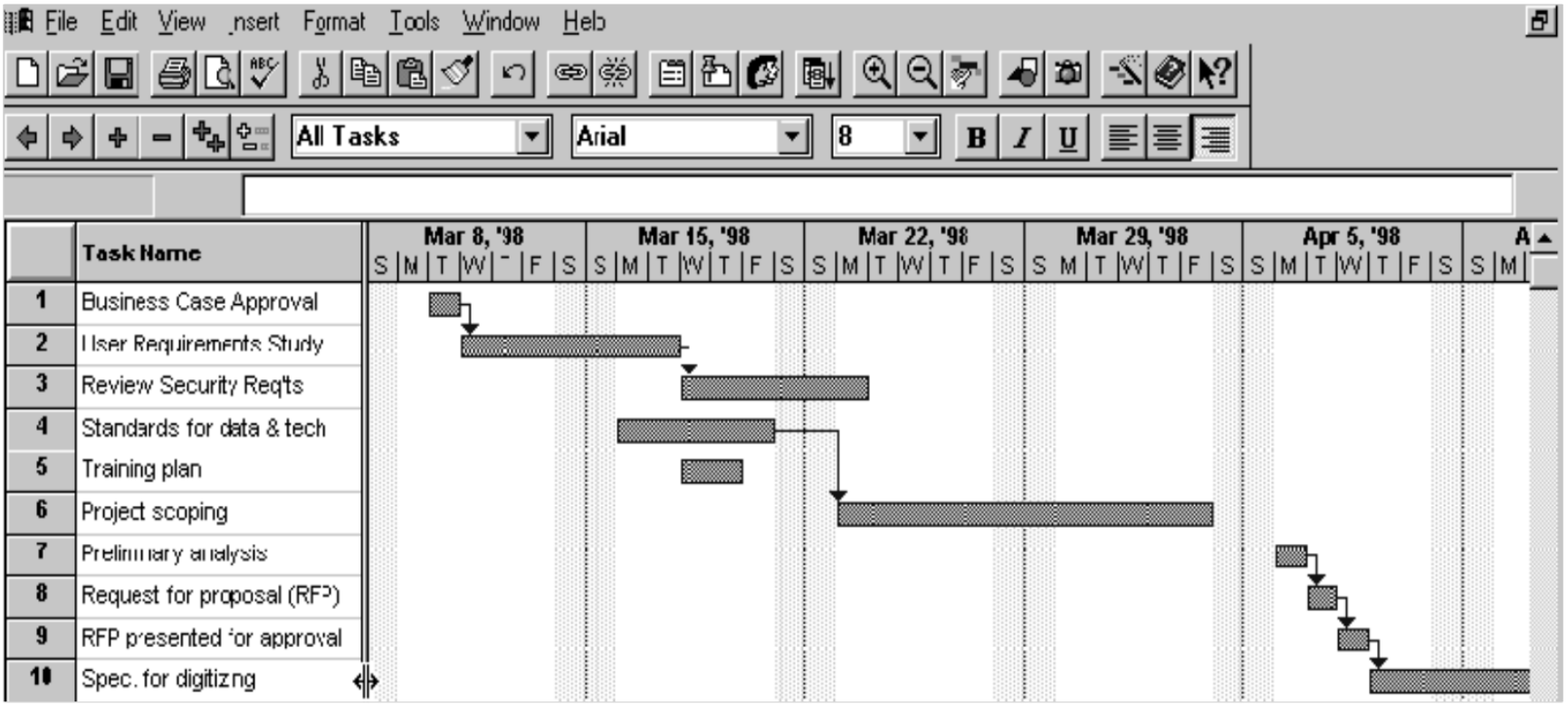



Fig 9-9 Example of a Gantt chart

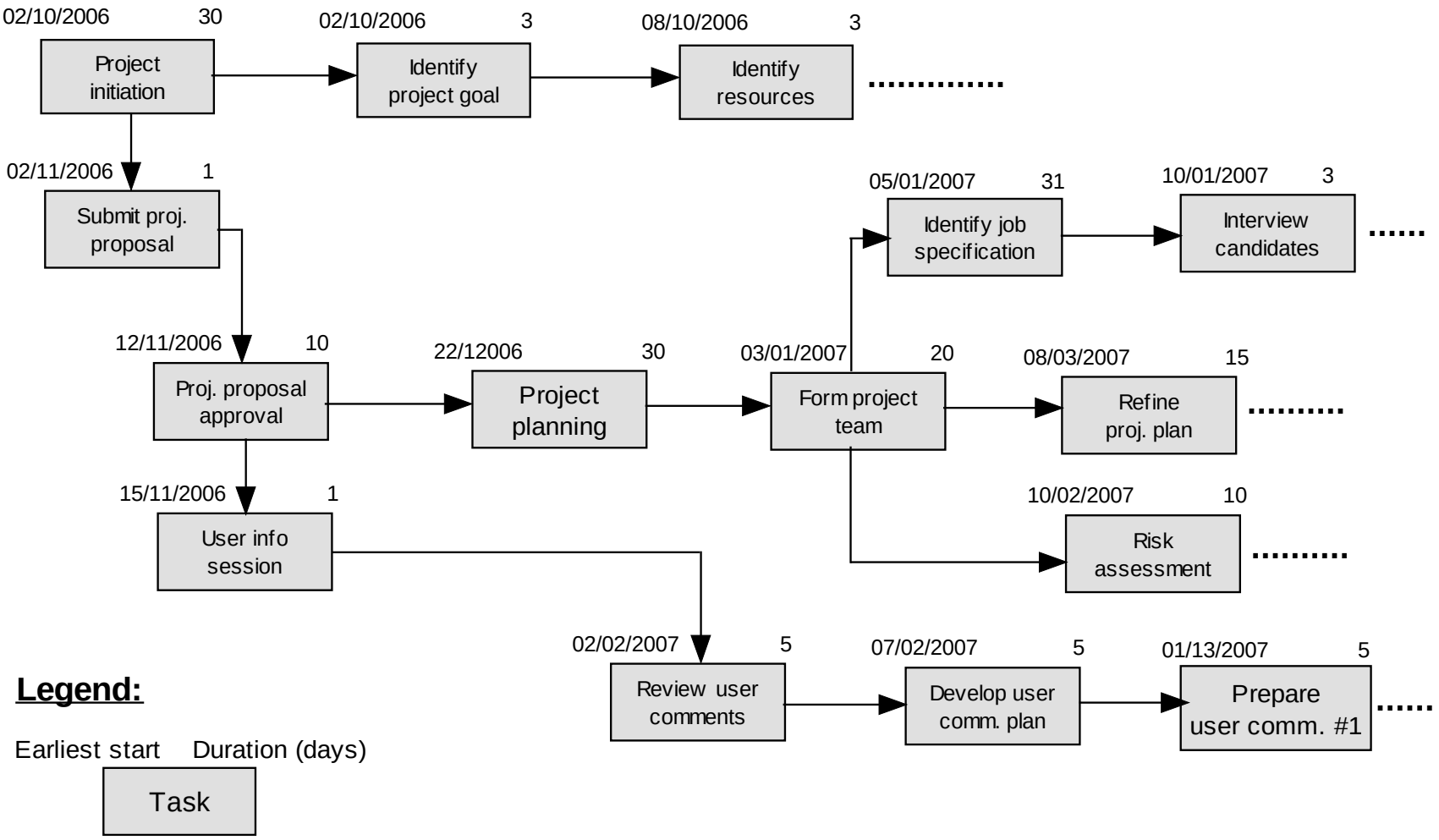



Fig 9-10 Example of a project network diagram

## 4.3 Potential risk & opportunity analysis

possibility of unexpected problems & benefits occurring during the PLC is real

common risks & preventive measures (Table 9-5)

possibility of benefits from the project

ex. value-added sales of the data to other users, offer consulting services to other orgs

*Table 9-5.* Common risks and preventative measures in spatial database implementation projects

| ***Possible Risks*** | ***Preventative Measures*** |
|---|---|
| **Loss of project personnel (due to resignation, reassignment of duty and/or long term absence such as illness, maternity leave, etc.)** | ○ Always have a back-up person for all critical areas, who can quickly be reassigned with minimum delay or productivity loss.<br>○ Ensure detailed and up-to-date documentation of work done by all project team members. |
| **Late delivery and delayed availability of materials** | ○ Adjust project schedule by launching independent project tasks when dependent tasks are being put on hold.<br>○ Keep a record of alternative source materials and services. |
| **Processing errors** | ○ Establish stringent backup policies and set up properly managed back-up facilities to ensure all completed work and work in progress are properly backed up. |
| **Data errors** | ○ Avoid the assumption of "clean" data.<br>○ Exercise stringent quality assurance and quality control when evaluating, acquiring, storing and archiving data.<br>○ Keep an up-to-date record of metadata to enable the tracking of errors if and when they occur. |

## 5. Project execution activities & methods

### 5.1 Request for a proposal (RFP)

three common approaches to outsourcing :

sole source - entire contract for a project is awarded to a single contractor

invitation to tender (ITT) - vendors are openly invited to bid for the contract

suitable when the supply of materials & type of services are well-defined

RFP - org knows what it wants but prefers to seek solutions from the consulting community

*Table 9-6.* Comparison of approaches to procurement

| *Approach* | *Flexibility* | *Selection Time* | *Rigour* |
|---|---|---|---|
| Sole Source | Low | Short | Low |
| Invitation to Tender | Low | Moderate | Moderate |
| Request for a Proposal | High | High | High |

RFP covers all / a substantial part of the project execution activities (Fig 9-11)

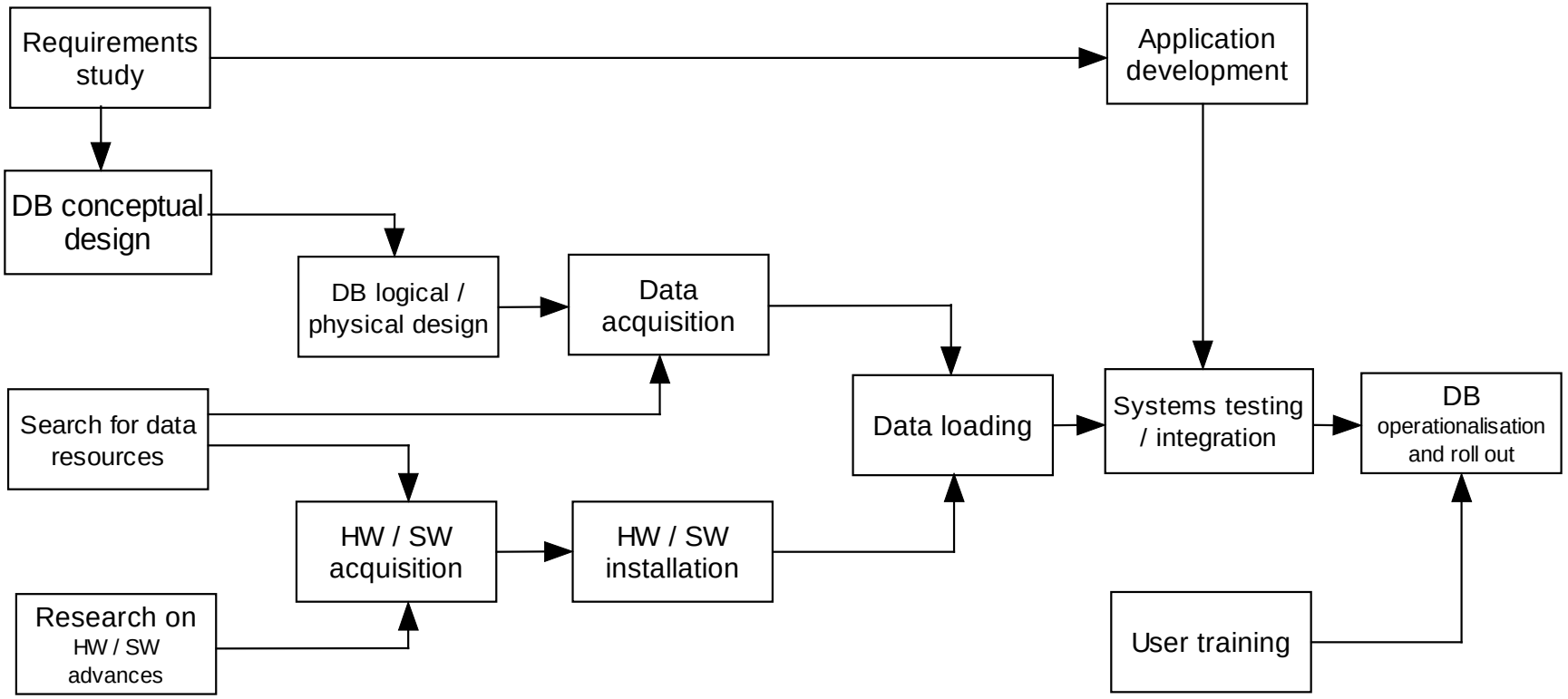



Fig 9-11 Major activities & workflow of the project execution phase

workflow of typical RFP exercise (Fig 9-12)

contents of the RFP packages :

- background of the project, including business mission & mandate of the orgs
- scope of the project
- objectives + all mandatory, desirable, optional outcomes including performance standards
- specification of the orgs HW & SW, standards for DB & services, resource sharing, partnership w/ orgs
- request for respondent's info
- descriptions of proposal formats, proposed solutions, technology requirements, quality control, price
- specification of method of submission
- supplementary info about conflict resolution, ownership of intellectual property, safety policies
- description of selection criteria & procedure
- request for certification of insurance & redemption coverage
- requirement for the signature of the principal officer
- a sample of the contract to be signed
- a glossary of terms pertaining to the project

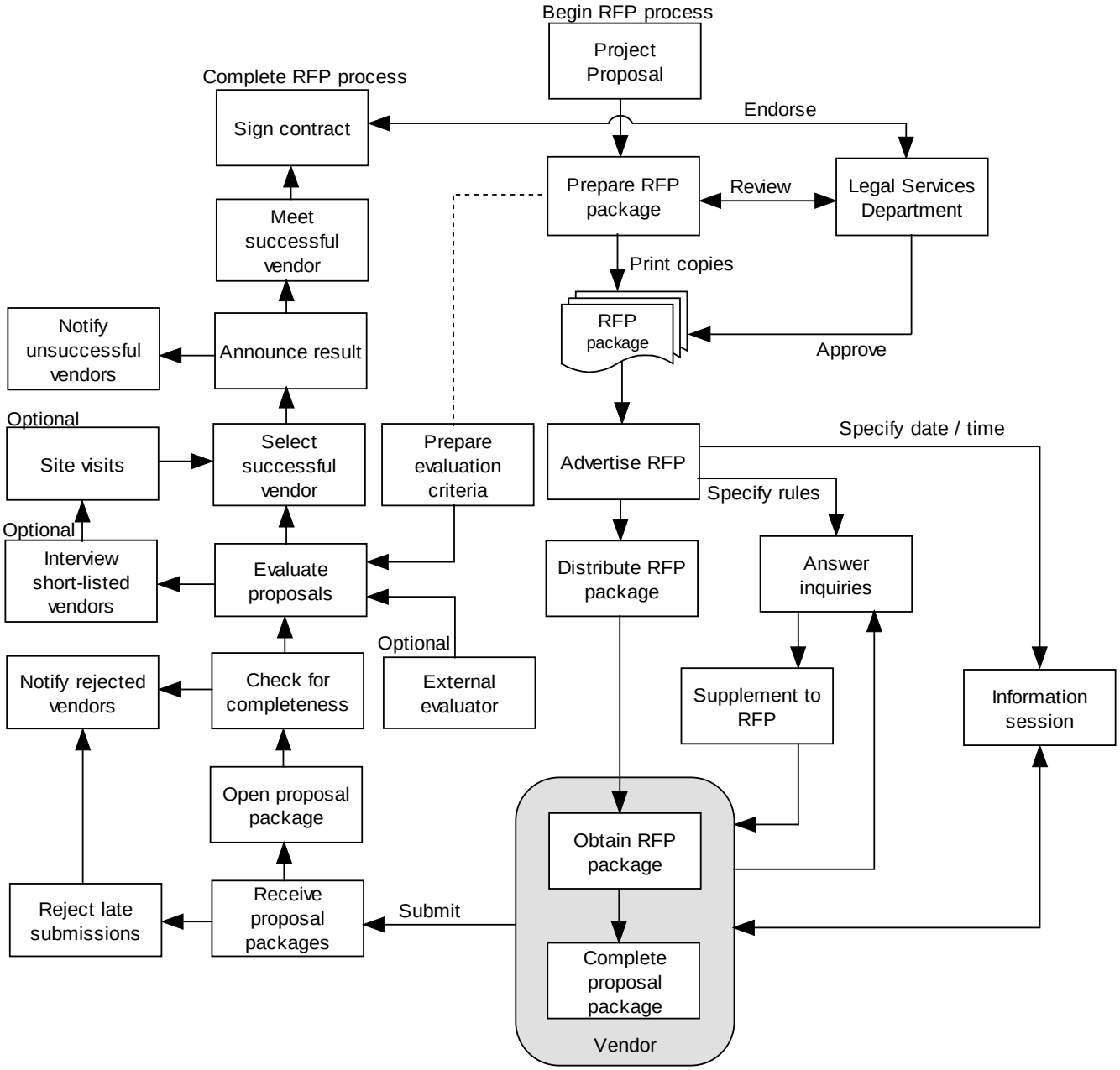





Fig 9-12 Workflow of a request for a proposal (RFP) exercise

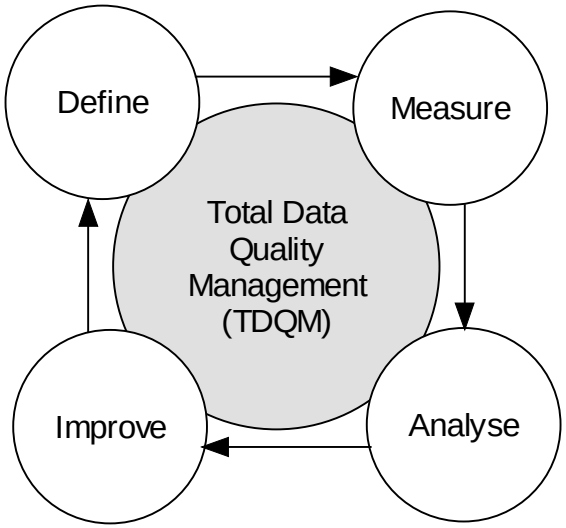
## 5.2 Spatial data acquisition & evaluation

data acquisition is the most challenging & expensive part

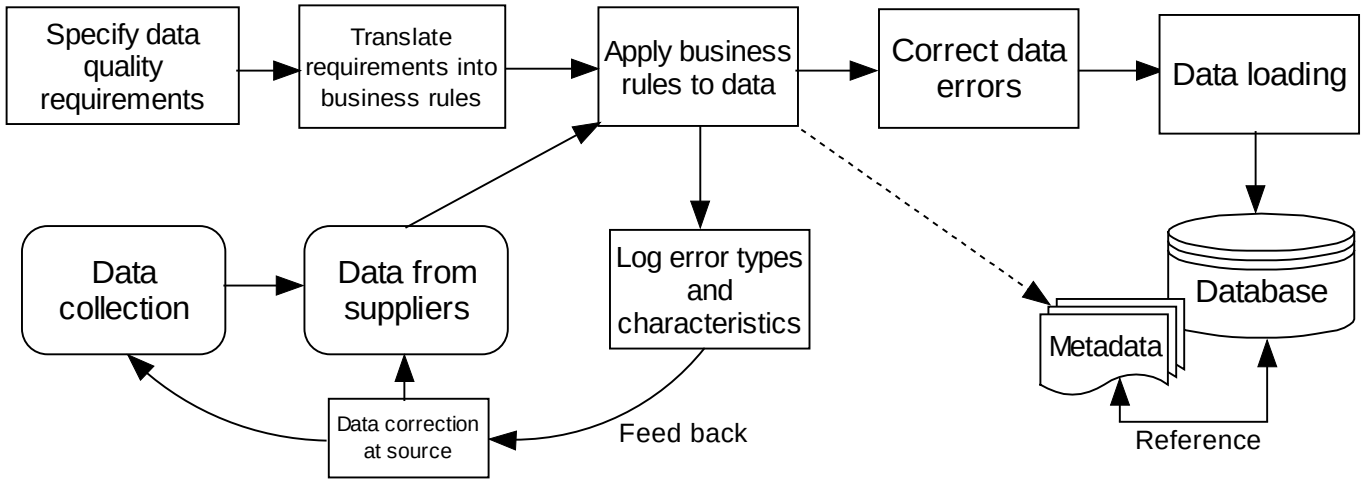
- but, spatial data are much more readily available now than ever before
- so, focus has moved from acquisition to quality / usability

preventative approach to data quality uses a four-tier Total Data Quality Management (TDQM) model

- to define, measure, analyze, improve data quality




(a) The conceptual TDQM model




(b) Workflow of applying TDQM in practice



Fig 9-13 The concept & application of total data quality management (TDQM)

## 5.3 Technology acquisition & evaluation

technology refers to HW, SW, local & wide area network

technology evaluation plan - complex task

review of user requirement → identify the key features → broken down into further detail → record in a evaluation manual (Fig 9-14)

potential vendors are required to supply in detail specific info of their products to be evaluated

| 7.1 Database implementation<br>7.`1 Spatial data structure and organisation | | |
|---|---|---|
| *Ref #* | *Requirement* | *Comments / Observations* |
| 7001 | **MUST** represent point, line, area and surface spatial entities and topological relationships using vector data models<br>● Describe the specific data models in each case<br>● Describe the data structures used to implement the models<br>● Describe how these entities can be used to construct higher order entities, i.e. user-defined objects | |
| 7002 | **MUST** represent areas and surfaces using a grid data model<br>● Describe the data models and the data structure used to implement them | |
| 7003 | **MUST** support appended images for point, line and area entities<br>● Describe how images are retrieved through attribute data queries and through selection of spatial entities<br>● Describe data format used and access/retrieval methods | |
| 7004 | **SHOULD** support full UTM Grid Reference values<br>● Identify the maximum and minimum coordinate values the system can handle, and the internal storage format and data type | |
| 7005 | **SHOULD** support storage of elevation values with each planimetric coordinate pair used to represent point, line and area entities<br>● Describe format used. | |
| 7006 | **MUST** support data transformation from vector-to-grid and grid-to-vector for area, line and point entities<br>● Describe the process used and any limitations on data set size. | |



Fig 9-14 Example of a page of a software evaluation manual

## 5.4 Application development strategies & techniques

application development - includes design, programming, testing, integration of SW modules
for user interface, DB connectivity, info retrieval, analysis, reporting, displays

predominantly using the method of SW engineering

ex. rapid prototyping (Fig 9-15) - provide users w/ a working prototype to show end products
- many benefits : improved communication, early detection & correction of missing functionality, reduction of risks, educate users

two strategies to prototyping :

throw-away prototyping - develop a practical prototype → a fully functional application
suitable when the application is new to the users, requirement are hard to understand

evolutionary prototyping - deliver a working application progressively,
suitable when the specification can not be determined in advance

cf. variant is incremental prototyping - applications are developed & delivered incrementally

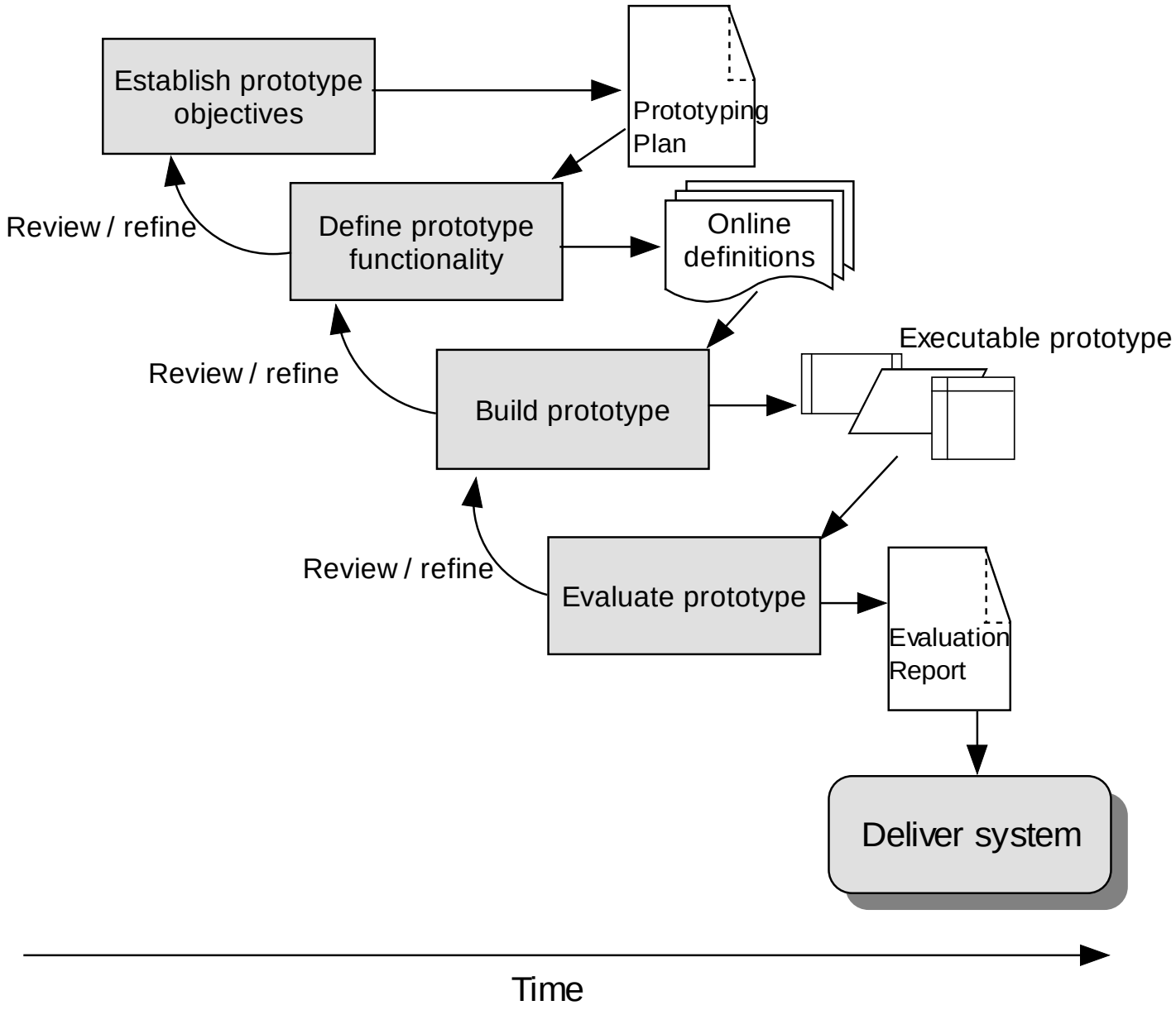
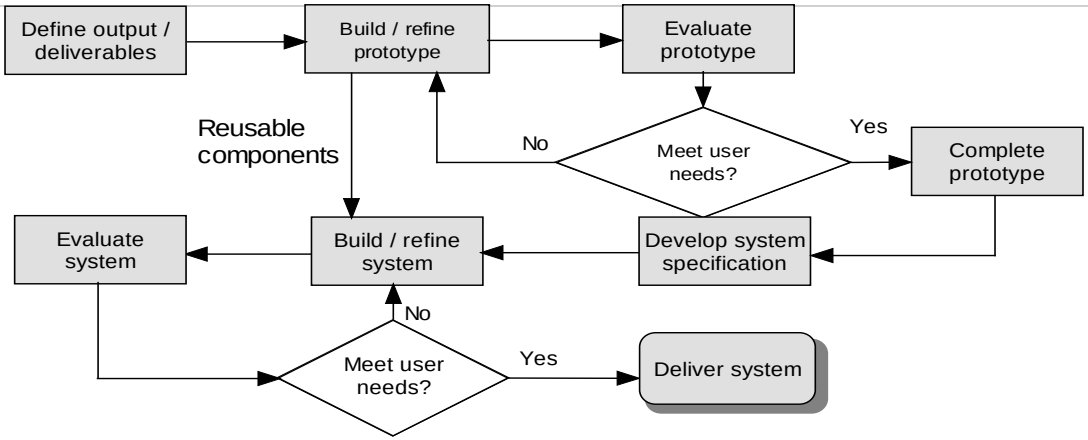
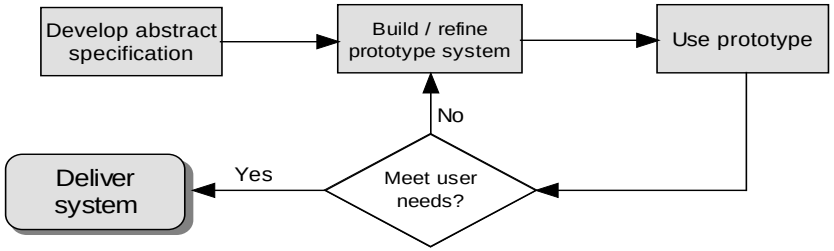




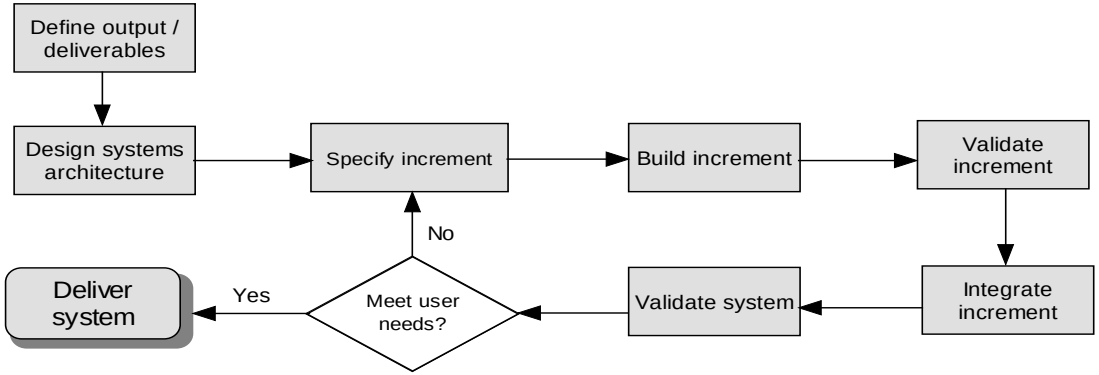

Fig 9-15 Workflow & processes of application development by (rapid) prototyping




(a) Throw-away prototyping




(b) Evolutionary prototyping




(c) Incremental prototyping



Fig 9-16 Types of prototyping

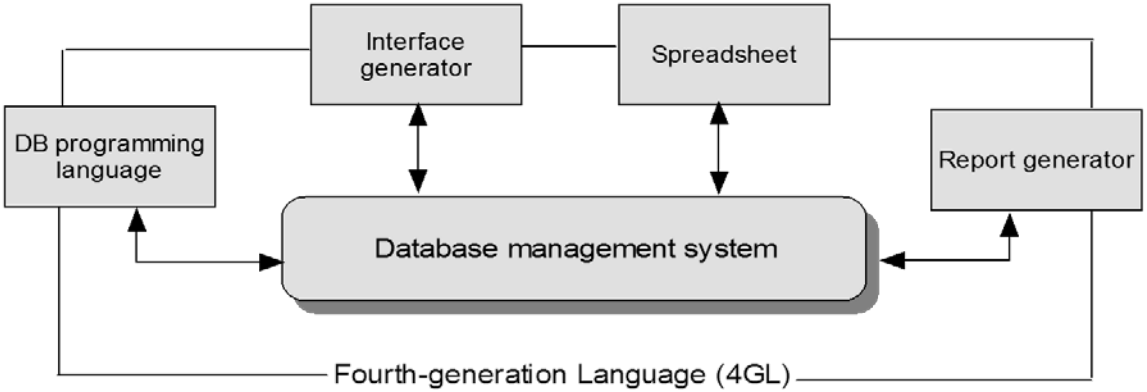
## 5.4 Application development strategies & techniques

techniques used for sys programming can classified into three :

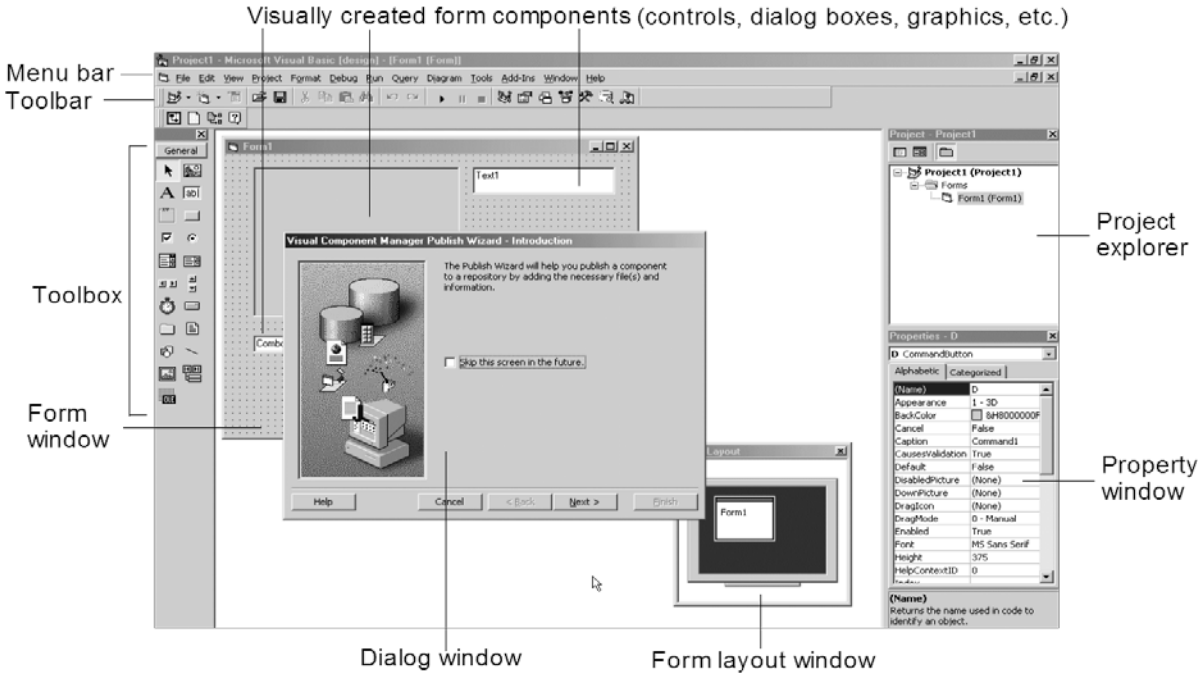
high-level language programming

DB programming - use domain specific language for business applications ex. SQL, interface generator, spreadsheet, report generator

visual programming - Visual Basic, Visual C++




(a) The Fourth-generation Language programming environment




(b) The visual programming environment of Visual Basic



Fig 9-17 Methods of prototyping by 4GL & visual programming

## 6. Project monitoring & control

### 6.1 Project documentation & record keeping

project monitoring starts w/ documentation & record keeping

PM monitors the progress of the project by a reporting sys using two types of reports :

- regular / periodic progress reports - by project staffs
- cumulative reports - by PM, show the trends in project progress

## 6.2 Contract management & control

disagreements between the project team & the contractor can occur

rules & protocols of communication specified in RFP is used

to keep track of communications, a *pro forma* problem reporting form is useful (Fig 9-18)

change management is the one important

unforeseen events to necessitate a change in the plan & the specifications

ex. advances in technology, additional user requirements, changing business practices, unexpected difficulties in coding programs

changes in project plans & specifications have five categories (Table 9-7)

change management process (Fig 9-19)

**Problem Report Form**

**Problem #** [ ] Date: _____ Time: _____
Reported by:

**Description of problem**

New problem? [yes/no]
Data-related? [yes/no]
Priority? [Severe/Critical/annoyance]

Name of system components/functions where the problem occurs:

_____

Error messages:

_____

_____

_____

**Notify contractor:**

Date/Time: _____
By [Fax/e-mail] _____
Acknowledgement date/time: _____

**Problem Fixing status**

Clarify [y/n] _____ Date/Time _____

In progress [y/n] _____ Date/Time _____

Fixed _____ Date/Time _____

Distributed _____ Date/Time _____

**Acceptance test**

Performed by _____ Date/Time _____
Description of solution:

_____

_____

_____

**Reports received from contractor (MUST be filed with is Problem Report Form)**

1. _____ Date/Time _____
2. _____ Date/Time _____
3. _____ Date/Time _____
4. _____ Date/Time _____
5. _____ Date/Time _____

**Additional information**

Problem/error satisfactory resolved. Signed (Project Manager / Date)

_____

Problem/error not resolved. Possible further course of action/mediation:

_____

_____



Fig 9-18 Example of an error report form

*Table 9-7.* Categories of change in project management

| ***Categories*** | ***Characteristics*** |
|---|---|
| **1** | Can be accommodated within the project resources and timelines. |
| **2** | Can be accommodated but will require an extension of the deliverables schedule. |
| **3** | Can be accommodated but within the current deliverable schedule but additional resources will be needed. |
| **4** | Can be accommodated by additional resources and an extension of the deliverable schedule will be required. |
| **5** | Cannot be accommodated without a significant change to the project. |

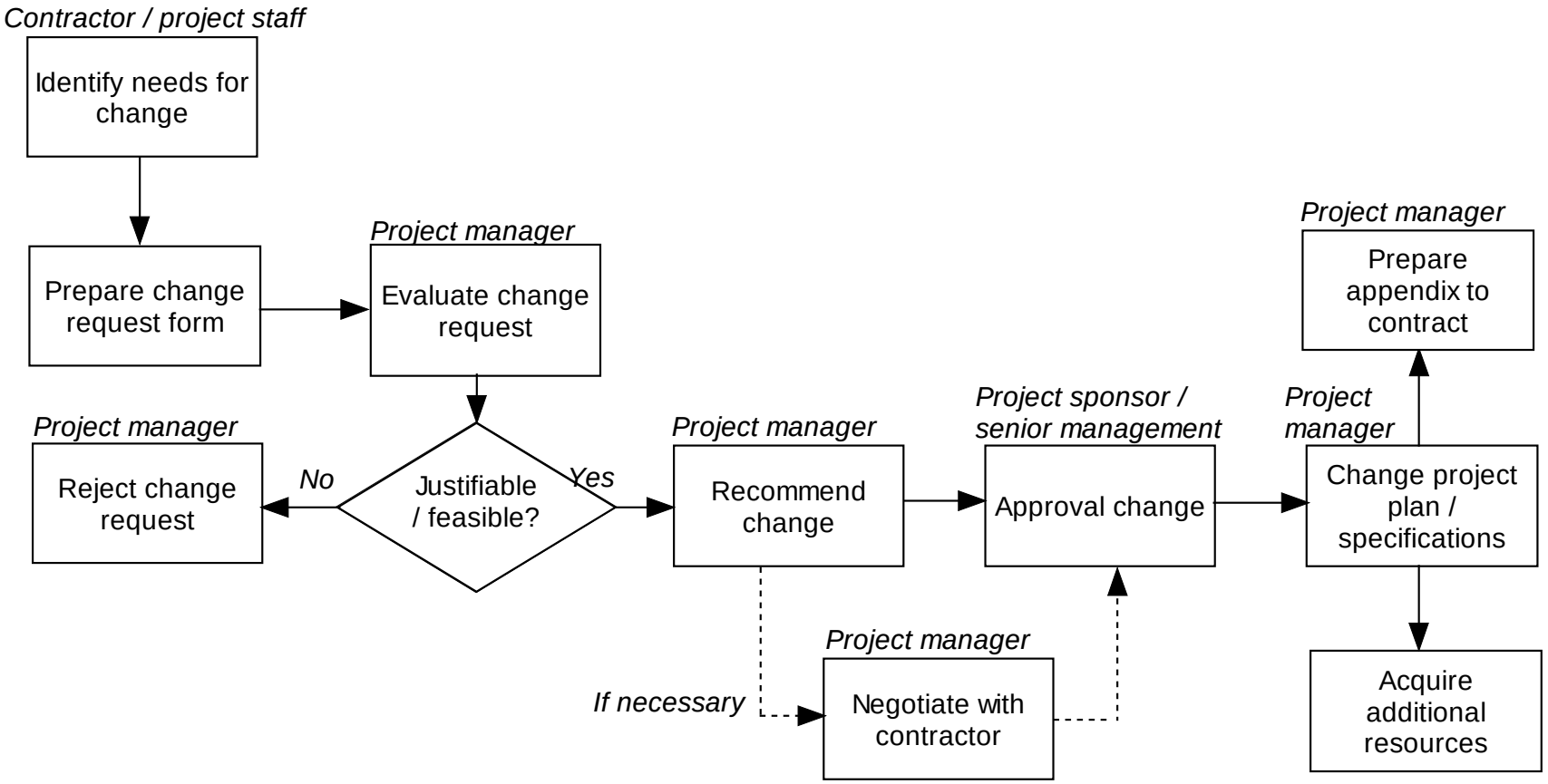



Fig 9-19 The change management process

## 6.3 Quality assurance (QA) & quality control (QC)

QA/QC are preventive measures applied thru out the entire production

relationship between QA & QC can be understood from the different levels (Fig 9-20)
organization level, project level, technical level

QA - umbrella activities to provide the support infra for the technical application of QC measures
includes corporate info quality & standards, competencies of staff, performance standards
ISO9000 by ISO defines a quality assurance program - ISO9000 certification

QC - done by conducting a series of SW tests
unit tests, integration tests, system tests

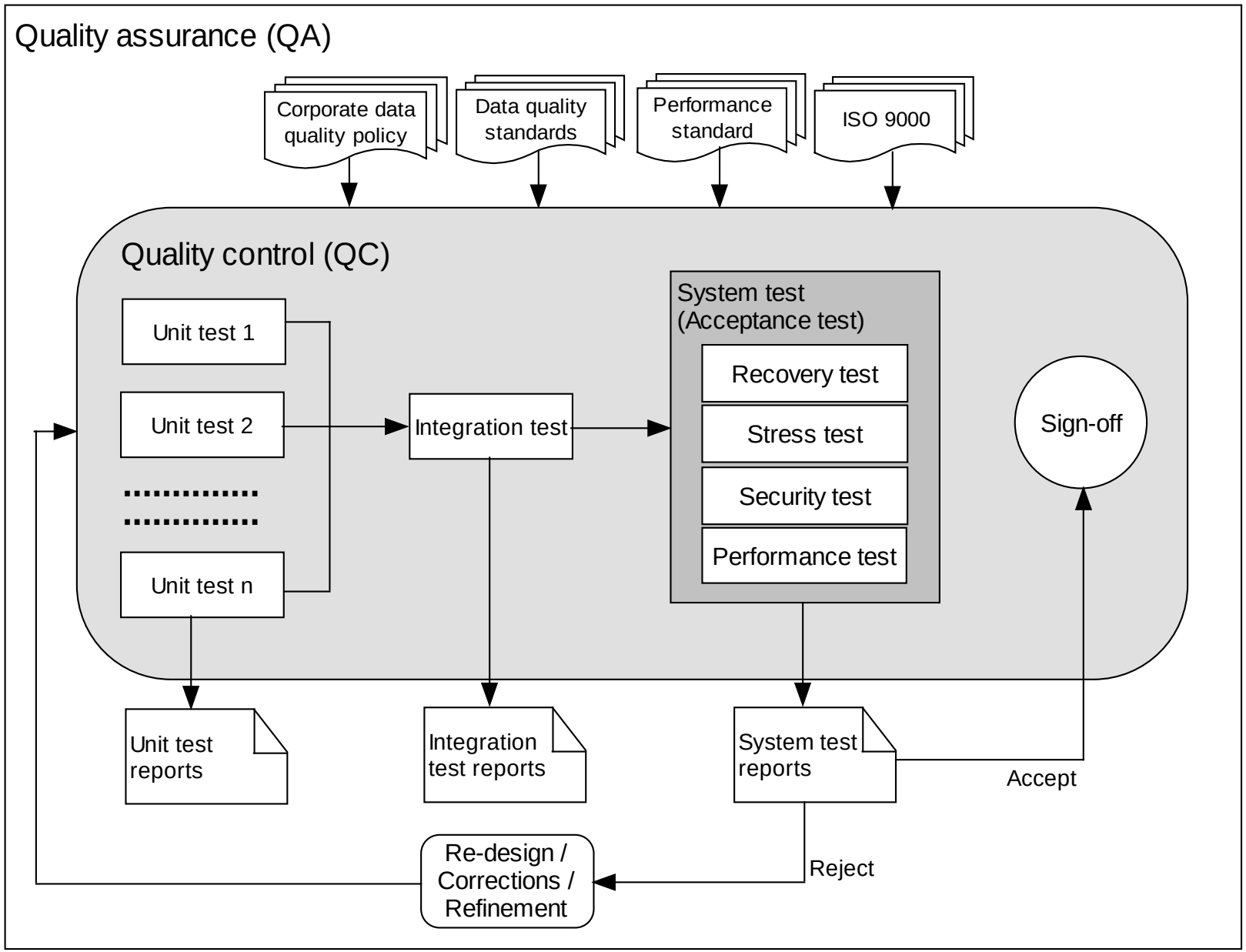





Fig 9-20 A conceptual framework of QA/QC in spatial DB implementation

## 7. Project closing & post-implementation evaluation

### 7.1 Technology roll-out activities

typical technology roll-out activities :

site preparation for the implementation of the DB sys

HW & SW installation & testing

development of user education & training program

development of user support facilities ex. help desk

development of an on-going error /problem reporting & response sys

### 7.2 Post-implementation evaluation

to summarize the experiences gained so that the same mistakes will not be repeated