DESIGN OF THE CAPITAL AREA DEVELOPMENT INFORMATION SYSTEM (CADIS) BAGHDAD, IRAQ

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ABSTRACT

Environmental Systems Research Institute (ESRI) of Redlands, California, U.S.A., under contract to PASCO International, and under the direction of the Japanese Consortium of Consulting Firms, has been participating in the Baghdad 2001 Project which will produce a long-term development plan for the City of Baghdad and its regional environs. ESRI's work has been the development for Amanat Al Assima (AAA) of a conceptual design and implementation plan for an automated geographic information system (GIS). ESRI's work included assessment of GIS user needs, evaluation of existing data, designing a new data base, designing an information system and developing an implementation plan. Based on these efforts a new data base (including the cartographic layers and related tabular items) and 22 "applications modules" (each a set of software procedures which use, manage and update a commonly stored data set) were designed to satisfy the information needs of all the user groups. This new system, the Capital Area Development Information System (CADIS), is now under development.

INTRODUCTION

In the past decade the City of Baghdad has experienced an exponential growth in its population; currently this growth rate exceeds five percent per year. It is anticipated that the population of Baghdad will reach 7.65 million by the year 2000-- nearly double the present population.

This rapid growth is placing a tremendous burden on agencies involved in the planning and implementation of municipal infrastructure and community services. To meet the challenge of spiraling growth as well as to be able to conduct day-to-day management activities, planners and managers need comprehensive and up-to-date information about the City, its operations, and its population; and they need tools to effectively store, use and manage this information.

The Amanat Al Assima-- the "Keeper of the City"-- is the central government agency responsible for municipal functions within the City of Baghdad. To facilitate the management of growth to the year 2001 and beyond the Amanat Al Assima (AAA) has undertaken the development of a comprehensive masterplan for Baghdad. This development is being carried out at three levels: a study for the Regional Framework, the Structure Plan of Greater Baghdad, and the Comprehensive Development Plan of the City of Baghdad.

In scope and content this study, called the "Integrated Capital Development Project: BAGHDAD 2001", is one of the most comprehensive and intensive studies of this type ever attempted.

One element of the Integrated Capital Development Program (ICDP) is the development of a Capital Area Development Information System (CADIS), a computerized geographic information system to support current metropolitan planning efforts and, ultimately, municipal operations of the various agencies within AAA.

This paper reports the results of a several month effort to:

-- define the data and applications needs of the various departments within AAA and the ICDP planning team;
--to develop specifications for hardware and software for a Geographic Information System (GIS);
--to design a conceptal structure for an AAA geographic data base, and, finally;
--to develop an implementation plan to guide the development of CADIS.

STUDY METHODS

This study effort involved the application of a comprehensive method for the design, development and implementation planning of a municipal Geographic Information System (GIS).

The method involved a five-step, rational process of defining how geographic information is used by AAA and then a translation of this knowledge into detailed specifications and an implementation plan for CADIS.

The five steps were:

1. Conduct User Needs Assessment
2. Evaluate Existing Data
3. Define CADIS Conceptual System Design
4. Develop System Component Specifications
5. Develop Implementation Plan

USER NEEDS ASSESSMENT

The design of CADIS was based on first gaining an understanding of how municipal operations and planning are carried out in Baghdad at present, and, secondly, translating these needs to specifications for the basic components of a GIS system and alternatives for how it might function. To understand the current systems, the CADIS design team spent three weeks in February, 1985, in Baghdad conducting interviews with various agencies within Amanat Al Assima and several other ministries involved either directly or indirectly in municipal operations.

The report on each interview was divided into four sections:

--A brief description of the basic organization and responsibilities of the agency.
--A description of the general tasks carried out by the agency and systems (i.e., procedures and/or equipment) used to carry out these tasks.
--An inventory and descriptions of geographic data used and/or generated by the organizations.
--A short narrative of general observations and GIS potential within the agency, whether stated directly by the interviewees or perceived by the design team.

As a result of the study various geographic data management procedures, issues, data and analysis needs were identified.

These may be summarized in three subsections:

1. Generic Municipal Functions in Baghdad.
2. Generic Data Management Procedures.
3. Generic GIS Applications.

Needs Assessment Summary

Generic Municipal Functions in Baghdad. Municipal functions, or tasks, and the types of data which support them, comprise the vital element which ties together the various AAA departments and other ministries involved in operations and planning in Baghdad. An examination of these tasks, together

with the manual and automated data bases which are used in supporting these functions, provided the fundamental framework upon which a conceptual model of geographic data entities and their relationships in Baghdad was developed.

Municipal agencies in Baghdad carry out over 100 basic tasks. These were consolidated into a series of 34 generic municipal functions as a result of information from the interviews and experience in developing similar lists for cities in other parts of the world. These generic municipal functions are shown in TABLE 1.

Generic Data Management Procedures. The 100+ basic tasks identified required the use of geographic data management procedures (e.g., storage, manipulation, analysis, retrieval and display). Analyzing the data management procedures needed by each agency was useful in identifying and managing the software and system requirements used for developing software and hardware specifications.

Generic GIS Applications. The analysis of GIS activities and needs of the various organizations revealed several areas of common interest and some areas unique to individual entities.

Among the areas of common interest were:

--A centralized base map generation and maintenance function.
--Automated update of files from operational transactions.
--Access to a comprehensive data base of parcel related data.
--A commonly used universal parcel identification system.
--Access to a data base of information concerning land development activities throughout the City and Region.
--A capability to analyze community facility service areas, site efficiency and clustering of events.
--A capability to process map data on the basis of variable defined polygons (administrative units, census districts, fire response zones, etc.).
--The capability to produce shaded thematic and data value maps of numerous data sets.
--Direct and convenient access to computer facilities and data bases.
--Need for an integrated AAA resource library.

EVALUATION OF EXISTING DATA AND SYSTEMS

Table 1

Generic Municipal Functions

1. Acquire & Dispose of Property
2. Process & Issue Parcel-Related Permits
3. Perform Construction Inspections
4. Provide Legal Notification
5. Conduct Street Naming
6. Review Site Plans
7. Review Subdivisions
8. Create Street Addresses
9. Perform or Compile Event Reporting
10. Conduct Dispatching
11. Perform Vehicle Routing
12. Conduct Traffic Analysis
13. Conduct Facility Siting
14. Administer Area Districting
15. Administer Zoning By-Laws
16. Conduct Land Use Planning
17. Conduct Engineering Design
18. Conduct Drafting
19. Conduct Land Title Searches
20. Perform Tax/Fee Billing Collection
21. Create & Manage Mailing Lists
22. Allocate Human Resources
23. Perform Facilities Management
24. Perform Inventory Management
25. Perform Resource Management
26. Miscellaneous Maintenance
27. Perform Map Management
28. Conduct Drawing Management
29. Perform Data Base Management
30. Conduct Development Tracking
31. Desseminate Public and/or Government Information
32. Respond to Public & Government Inquiries
33. Conduct Surveys
34. Maintain Library

The spatial units and related tabular data sets which comprise the elements of geographic data used for planning and operational tasks in Baghdad were identified. This assessment was based upon task descriptions identified in the user needs survey and upon on-site evaluation of map and tabular data.

A central component of CADIS is the data base of spatial and tabular information. This includes maps of spatial information and tabular data tied to the spatial information by means of geocodes. (Common geocodes include land parcel address, enumeration district number, traffic analysis zone (TAZ), etc.). These maps and tabular data provide the basic framework for day-to-day operations of the City and long-term planning.

The evaluation of these data elements included specifications and characteristics of each element and the interrelationships which have bearing on how these could be physically and functionally integrated to form a conprehensive data base for Baghdad.

The specific characteristics of each data element which were identified including the following:

--Source Organization
--Data Entity
--Variables
--Data Form
--Conceptual Municipal Geographic Data Model Component
--Cartographic Primitive
--Geocode

CADIS CONCEPTUAL DESIGN

A conceptual design for functional and data components of CADIS has been prepared. The concepts were based on the work described above as well as experiences and approaches from other city governments with similar information needs in different parts of the world. The concepts presented were broader than just geographic information concepts. They dealt with many processes and kinds of data which are dependent on geographic relationships or geographic location.

Overview

The overall conceptual design of CADIS is organized to meet the varied requirements identified in the individual departments and related agencies. The wide range of necessary capabilities are organized into a series of conceptual system components or "application modules" which are integrated

into the overall GIS. Each of these modules contains a set of software procedures which use, manage and update a commonly-stored database. The integrating concept of the system is that all application modules are built around a common data model containing all the geographically-related information. These 22 "application modules" are listed along one axis in TABLE 2. As evidenced by the information acquired in interviews and previous studies, the GIS concept for CADIS must address several basic classes of geographic information (maps and tabular data) shown on the other axis of TABLE 2.

Several basic principles were applied in developing the design of CADIS.

1. CADIS is structured around a common, integrated database which is available to all user organizations.

2. The database is to be developed in a logically consistent manner using modern principles of database management (e.g., minimum redundancy, transaction updated, user-oriented data definition, and a well-defined data model related to user requirements).

3. The CADIS database will be constructed according to an incremental phasing program and will be maintained through tranasaction updating as part of ongoing programs and operations. These transactions will be built into the operational procedures of each department.

4. The software for the application modules will be developed using an existing library of software tools from a DBMS designed especially for management of spatial data.

5. The CADIS software and database will be supported by a common and integrated hardware environment and a data communications system.

6. Management and implementation of CADIS will be by an interdepartmental committee with central coordination and technical support.

FIGURE 1 illustrates the CADIS conceptual system design. The design is composed of the 22 application modules using a set of geographic data management procedures or software tools, to access, manage and use common database components.

CONCEPTUAL DATABASE DESIGN

Table 2

Data Requirements Per Application Module

● High Dependence
○ Moderate Dependence

APPLICATION MODULE	DATA MODEL COMPONENTS										
	Base Map (Horizontal/Vertical Control)	Environmental/Physical Overlays	Environmental/Physical Tabular Data	Engineering Map Overlays	Engineering Tabular Data	Street Network Map	Street Tabular Data	Administrative Boundary Overlays	Administrative Boundary Tabular Data	Cadastral Overlays	Parcel Address Tabular Data
1. Baghdad Basemap System	●										
2. Land Subdivision System	○									○	●
3. Cadastral Mapping System	○									●	
4. Land Registration System	○									○	●
5. Roads Information System	○					○	●				
6. Transportation Analysis and Planning	○					●	●	○	○	○	
7. Building Permit System	○									○	●
8. Water Supply Management System	○			●	●	○					
9. Sewer Management System	○			●	●	○					
10. Administrative Mapping/Reporting	○							●	●	○	○
11. Property Management System	○									○	●
12. Land Use/Environmental Planning System	○	●	●								
13. Cultural Resources System	○	○	●							○	
14. Environmental Monitoring System	○	○	●								
15. Vehicle Routing System	○					●	●			○	
16. Facility Siting System	○	○	○	○	○	○	○	○	○	○	○
17. Development Tracking System	○			○	○	○	○	○	●	○	●
18. Land Appropriation System	○			○				○		○	●
19. Emergency Planning System	○					●	●	○	○	○	○
20. Emergency Response System	○					●	●				
21. Fire Inspection System	○									○	●
22. Contract Status Management/Reporting	○							●	●	○	○
23. Metropolitan Plan Review and Comment System	●	●	●	●	●	●	●	●	●	●	●

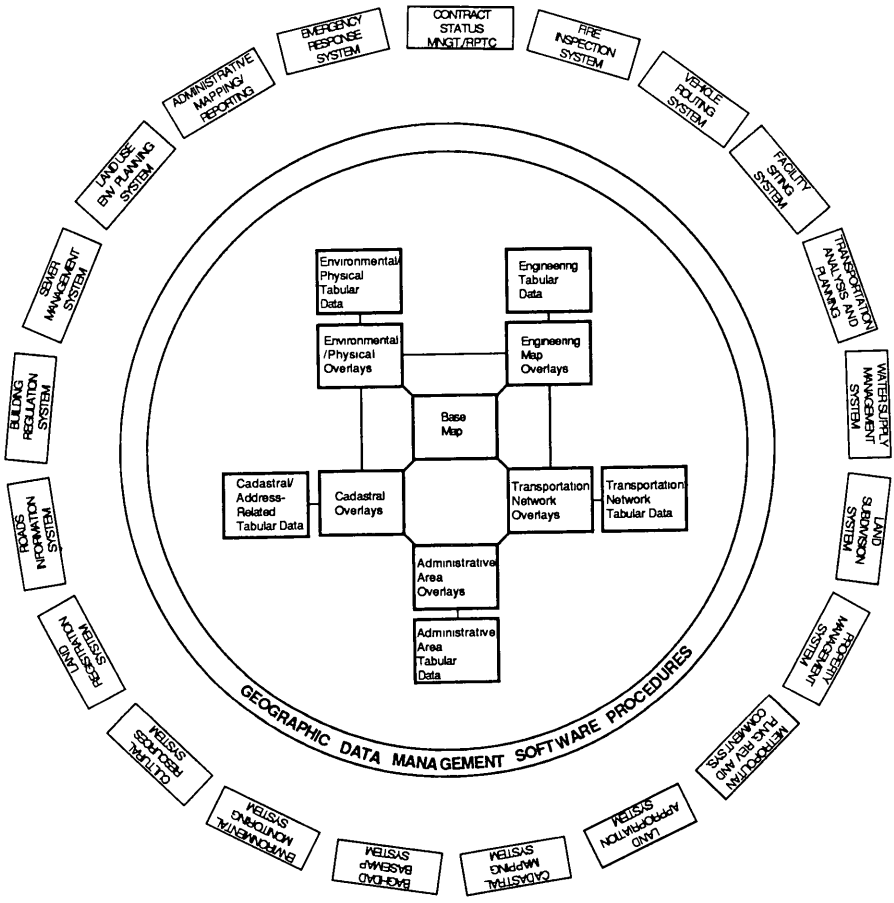

Figure 1

CADIS Conceptual System Design

Initial data evaluations revealed the existence of 15 potential spatial primitive "layers" associated with over 240 tabular data elements by means of a geocode or other geographic identifier. Further evaluation based on analysis of data requirements for carrying out the 22 applications modules revealed that this list could effectively be consolidated to six basic spatial layers corresponding to basic components of the Baghdad Municipal Data Model. These include:

--Base Map Layer
--Parcel Layer
--Environmental/Physical Overlays Layer
--Street Network Layer
--Administrative Boundary Layer
--Utility Map Layer.

SYSTEM SUPPORT

CADIS will require a support environment which consists of four basic components which will provide the infrastructure for the effective implementation and ongoing use of CADIS. These four basic components are:

--System Management
--Computer Hardware
--Computer Software
--Training.

CONCLUSION

The implementation of this design will require a six-year, three-phased effort. A plan for this implementation effort has been submitted to AAA.