AUTOMATED LAND RECORDS AND MAPPING IN LOCAL GOVERNMENT - A CASE STUDY IN SAN DIEGO

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I. Introduction

In early 1979, San Diego County's Department of Transportation formed a Task Force whose objective is to formally define a Land Identification and Information Management System (LIMS). The collection, analysis and display of land-related information is a significant part of daily operations of county governments nationwide since they are the political unit responsible for land information and record-keeping. Most land use recording and mapping systems used today are unorganized and uncoordinated since they have evolved from antiquated systems which have changed little from the days when America was still expanding westward. The current systems used in processing, storage, and subsequent use of this data that pertains to land use, acquisition, assessment and development are proving to be costly and inefficient.

San Diego County's LIMS Task Force is developing a land identification system which will combine these efforts into a single comprehensive and cost effective system. High speed, high capacity computers are now available which permit increased data storage, rapid access to this data and automated display and/or print out of the desired map-formulated products. LIMS will provide a central repository of all geographically oriented information in the County and provide a singular comprehensive file of land related data.

In this paper we will share with you some of the needs, the rationale, the problems, and the successes of our research and developmental efforts.

II. The Need, Rationale and System Criteria

The land area of San Diego County is 4,241 square miles, just slightly smaller than the State of Connecticut. This land area is divided into over 530,000 legally defined parcels of land. As an indication of the dynamic growth of San Diego County, the County Recorder processes over 110,000 deed transactions per year. This results in an average of 25,000 map changes to be made by County departments each year. This clearly demonstrates a need for an automated land information system to handle this volume of data.

What is needed is a cadastral geo-coded data base, a register which will contain the ownership, value, and quantity of the County real estate, and can be the basis of the real property assessment and taxing system. An automated land information system for local governments is required not only for the assessment and taxing process, but this system, if designed properly, will serve most all of the other spatially oriented recording needs of the County. These needs range the entire spectrum of local government operations, from transportation and engineering design through land use planning and zoning to the social services recordation and analysis. All of these activities currently use manual mapping as their primary means of understanding the spatial distribution of their data.

Today, in County government alone, we process sixteen separate map series which require a minimum of 83 people to maintain. These sixteen series range from the 200 foot photogrammetric topo series to the two-mile County Base map series. This labor intensive process is costly and nearly two million dollars is budgeted annually for the production and maintenance of the County's maps. A recent consultant's study completed for the City of San Diego estimated that over four million dollars was spent annually on mapping by the City and County governments, the regional planning agency, and the Unified Port District. Not included in this study were the mapping costs of the thirteen suburban cities, the public utility companies, the school districts, nor the many special districts within the County. Additionally, mapping costs incurred within the private sector by the title companies or the engineering and land development firms were not included. Adding these would no doubt push the total regional mapping costs beyond five million dollars per year.

As local government operations come under more rigid scrutiny by

both elected officials and voters, labor intensive operations such as mapping become candidates for streamlining, reorganization, and consolidation. However, any analysis which hopes to justify a new land information and mapping system must first examine such basic areas as the function of mapping, the need for a system accuracy, the technical and service criteria for the system, and the rationale for determining the user clientele and thus the size of the system.

What then is the function of mapping in local government? Basically, mapping serves local government as a visual and highly understandable information system. Only through the medium of mapping can such diverse factors as zoning lines, soil types, sanitation districts, transportation circulation patterns, etc., be readily discerned and understood. Thus mapping serves to identify the land use and ownership patterns, the jurisdictional boundaries, the environmental factors, and the physical features of the County. Any valid land identification and information management system should be based on a single comprehensive reference. In LIMS, this common denominator will be the legally defined parcel. LIMS, if prepared properly, will have the ability to create a universal map from which all other maps described above will derive.

Essential to the design of any new technology information system is a determination of the service criteria - how will it service the user? We consider these criteria to be essential to LIMS:

1. The system should be a singular comprehensive one and multi purpose in nature. We envision a "service bureau" with a vast data base of geo-coded information ready to be displayed by a wide variety of users to meet an even wider variety of applications.
2. The system should have a minimum labor requirement. Once the initial data base is built, a minimum labor force will be required to maintain the system software and hardware.
3. LIMS should eliminate unnecessary duplication of effort and documents. For example, the newly filed subdivision map can be entered into the LIMS data base once and then be available to any and all users via data processing and graphic display technology. Today this map is manually drafted and then re-drawn at least eighteen more times by various public and private agencies.
4. Finally, the system should have a rapid response time. The ability to display land information electronically at public counters in a few seconds or to both public and private planners and researchers within minutes is an essential criteria of any computer-based cadastral information system.

It is also necessary that LIMS be designed to meet three important technical criteria. These are:

1. Geodetic Accuracy - the correct placement of information as it exists on the ground,
2. Graphic Flexibility - the ability to selectively display any or all information as required,
3. Continual Maintenance - the constant update of information so that it represents the existing situation.

The geodetic accuracy of LIMS will be based on direct ground engineering calculations obtained from both the surveyed metes and bounds descriptions of the parcel's record documents, and from newly completed densification control surveys of section corners, 1/4 corners and grant boundary markers - all tied to the California State Plane Coordinate System. This process of utilizing system inputs based on engineering calculations in lieu of digitized in-puts from current map systems will produce highly accurate end results which represent real-world geographic values instead of digitized map data. Furthermore, digitizing from existing maps creates an initial system error which then is perpetuated through all future maintenance programs. Additionally, wholesale digitizing is a labor intensive operation and represents an extra and costly step in the process.

The graphic flexibility of LIMS will be far superior to existing manual mapping systems. Manipulation of data stored as electronic impulses is infinitely more versatile and faster than manually prepared hard copy. Electronic data is not limited to any particular size, scale, area, or content as is hard copy. Furthermore, the data lends itself to rapid statistical analysis that is not possible in a manual system. Of especial importance is the future capability of the data. Once captured, the data can be readily adapted to future technological developments.

Continuing maintenance of a system like LIMS will be much easier and more efficient. The direct entry of ground-based data as a normal function of daily County operations is practical. This technique eliminates the labor intensive redrafting process required by manual techniques. Updates will become an integral part of the land development regulatory checking process mandated by law.

The determination of the size of a land information system such as LIMS is based on a number of variables. Among the more important of these are:
1. The number of user agencies and the number of system input/output stations within those agencies.
2. The access/response time of the system to user queries.
3. The data base elements that will be stored and accessed.

Within San Diego County's government alone, eighteen departments

have been identified as probable LIMS users. Many of them will require multiple input/output stations to take full advantage of the system. The government of the City of San Diego (ninth largest city in the U.S.) will also need a large number of LIMS stations. Adding the requirements of the public utilities, the suburban cities, the many school, water, sewer and special districts, and the various private engineering and land development companies will determine a very large total system - regardless of data base size and response time considerations.

The many users noted above require a variety of response times to system queries. They range from a few seconds for those who operate public counter CRT's to overnight or even several-day response for some agencies which do not need on-line CRT response, but could utilize off-line X-Y plotter output on an "assured" in lieu of an "instant" response.

The most critical sizing determinant would appear to be the size of the data base. An initial estimate of the number of data elements which are considered essential to the construction of the data base yields a total of 362 attributes. These are only the Priority One (critical to system construction and utilization) and Priority Two (non-critical to system construction, but necessary to full system use) data elements. They will include such necessary data base components as: horizontal and vertical survey control; section, rancho, and subdivision boundary control; legal parcels; rights-of-way; flood plain lines; land use; transportation net; political and jurisdictional boundaries; demographic and earth science features; parcel attributes; and many other similar elements. Addition of the non-essential data base elements would be made after system implementation. The data base would be queried by a number of primary keys, all related to a geographic location on the ground. These would include:

1. Assessor's Parcel Number (map book, page & parcel)
2. Street address (city, street, number, direction)
3. Legal description (section, township, range, etc.)
4. Physical location (state plane coordinate)
5. Legal document (subdivision map, parcel map, etc.)
6. Parcel Pseudo Centroid (a visual X-Y coordinate within the parcel)

A very rough estimate of the total system memory storage capacity that will be needed is approximately 20 billion bytes of digital data. Thus LIMS will be one of the largest geo-coded land information systems ever attempted in the U.S.

III. LIMS Program Development

Soon after the LIMS Task Force was formed, it became apparent that

the design, development and implementation of a land information system of the size and scope envisioned for the San Diego region was beyond the capability of the County government. Assistance from outside sources would be necessary.

Discussions with vendors in the information systems and computer graphics fields led to the decision to form a study design team composed of County representatives and systems analysts from potential vendor companies.

Among the goals and objectives of the study design team are the means of land information acquisition, the data conversion and entry processes, and development of certain application packages. This requires the design team to investigate such diverse areas as surveying techniques, data base management systems and their structure, systems architecture, mass storage technology, user applications, and automated data entry.

Concurrently, the U.S. Geological Survey approached the County with a proposal that the two agencies develop a system to share mapping and surveying information collected at the local government level. This offer has resulted in an agreement between the County and the USGS to conduct a "Shared Digital Data Base" Demonstration Project involving the acquisition and processing of digital data in computer compatible format for a USGS 7 1/2 minute quandrangle.

While the design team effort is in progress, the County's Survey Section is conducting a densification control survey of the USGS quadrangle in support of the County/USGS Digital Data Base demonstration. Additionally, this survey effort is supporting the acquisition of aerial photography, orthophoto scanning, and aerial triangulation data to be used in the preparation of digital elevation models for the USGS.

Upon completion of the design team effort and the digital cartographic data gathering effort, a demonstration of a LIMS-type system within a small area of the 7 1/2 degree quadrangle will be prepared using hardware, software and personnel from all three cooperating entities: the County, the USGS, and the private sector. We will take the data resulting from the survey operations, convert it to X-Y coordinates on the California State Coordinate Grid system, and enter it into the data base. Next we will take the parcel record documents (covering about 75% of the County's parcels) and enter the data from the engineering calculations (metes and bounds descriptions) rather than digitizing. We will then tie this data to the densified control net. This then establishes a one-to-one relationship of the stored digital data with the ground,

and we can now add all other specialized information to the data base.

This demonstration should provide proof-of-concept and can be widely utilized in marketing the LIMS system to the many potential user public agencies and private companies within the San Diego region. It can also aid both the USGS and the information system vendor companies in their efforts to gain cooperative agreements and sales with other local governments around the nation.

A large and complex land information system such as LIMS is costly and difficult to develop and implement. As noted above, this process requires a major cooperative effort between local government, state and/or federal government and the private sector. In the case of LIMS, total development and implementation costs are difficult to calculate, however total program costs are estimated to exceed $20 million. Approximately half of these costs will be for the ground survey operations. The next major expenditure will be for the data conversion and entry into the data base. The costs of the data processing hardware, while not incidental by any means, are expected to be well below the costs of survey operations and of data conversion and entry.

Another positive aspect of the LIMS cost schedule is a multi-year implementation schedule that allows the total program costs to be stretched out over 3 to 4 years. Additional savings are anticipated by the use of emerging technology such as inertial positioning and survey equipment which will reduce survey costs significantly, and by the promise of advanced mass storage hardware using laser read/write-on-microfiche technology.

Despite the savings anticipated above, and the expected reduction in total regional mapping costs (from 5 million to approximately one million annually), the very large total program costs will be the most significant problem to solve in order to get LIMS on-line in San Diego County. A substantial financial committment by local elected officials, public administrators, federal and state agencies and private sector management will be required along with an innovative financial and management plan in order to get LIMS on-line and servicing the wide spectrum of potential users.

Cadastral geo-coded information systems such as LIMS will present a major challenge to local governments in the 1980's. This challenge can be met with the right combination of planning, technical expertise, management and financing. As LIMS is developed and implemented, we in San Diego County will continue to share our knowledge and experience.