Automated Cartography And Regional Planning

– The N.C.C. Experience

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INTRODUCTION

Those of you who have visited Canada's Capital have been exposed to some of the more visible accomplishments of the National Capital Commission. Depending on the season, we hope that you have noticed the Driveway systems, the tulips, our Greenbelt and Gatineau Park; you may have even skated on the world's longest outdoor skating rink or have ventured onto our bicycle paths. The National Capital Commission, through the National Capital Act, enjoys the mandate of influencing general development within the 1800 sq. mile National Capital Region. The Act requires us to "prepare plans for and assist in the development, conservation and improvement of the National Capital Region so that the nature and character of the seat of the Government of Canada may be in accordance with its national significance".

At the turn of the century, the fulfillment of this role was relatively straight forward. Local municipalities were fully occupied with day by day survival problems and long-term planning was a luxury gladly left to the federal government. This opportunity probably peaked shortly after the Second World War with the Greber Plan which eventually resulted in the relocation of the railways from the downtown area, the extension of Gatineau Park and the establishment of the Greenbelt around urban Ottawa.

PLANNING POLICY DECISION

By 1968, we found ourselves in need of a new long-range plan, but there was strong evidence that new and vigorous provincial and municipal organizations, with fully qualified planning staff, had changed our working environment. We could either adopt an adversary attitude, use our extensive land holdings to control local planning concepts, or look for a method of cooperating and influencing others in order to achieve the goals previously stated. Furthermore, our Act empowered us to "conduct investigations and researches in connection with the planning of the National Capital Region". The development of an automated, geographically based information system was beyond the scope of any one of the local organizations at that time and this was selected as our contribution to the Regional planning task. It was justified on the basis of the following items:

1. To provide a bridge between the National Capital Commission and other governmental agencies in the region via the sharing of an integrated data base for planning purposes;

2. To provide a base for effective evaluation of planning decisions via information on market response to physical changes;

3. To provide management with fast access to information on planning operations and capital expenditure status;

4. To provide a framework for handling queries from parliamentary bodies;

5. To provide new thresholds of capability to use information in a plan-making process; and

6. To provide greater operational efficiency in day-to-day tasks by automated recall and manipulation of data.

IMPLEMENTATION

To achieve these ends, N.C.C. was authorized to create an automated information system consisting of six (6) components.

1. A geocoding system designed to convert data input by street address location identifiers to geographic coordinates, allowing information retrieval by arbitrary areas of interest as well as traditional areas of record such as census tracts;

2. A query system designed to facilitate querying and manipulation of large data bases;

3. An automated graphic display system for map making and data display;

4. A plan test system for testing, through simulation, alternative proposals regarding employment distribution, residential densities, transportation facilities and the effect of capital expenditures and priorities on planned growth of various sectors;

5. A planning operation system designed to assist in the internal, day-to-day, routine information processing needs of the agency, such as document retrieval, report generation and the production of statistical reports for fixed time-series intervals; and

6. A capital improvements and work scheduling system based on critical path methods. designed to integrate the planning and programming of all public works in the National Capital Region, including federal, provincial and local development.

In order to make this happen, those responsible for the proposed system were faced with many difficult tasks, most of which had to be undertaken simultaneously. The following are some examples:

1. Consultations with potential users
2. Design of the system
3. Funding and budgeting
4. Acquisition or retraining of personnel
5. Equipment specifications and acquisition
6. Location of sources of data, both at N.C.C. and elsewhere
7. Methods of collecting and updating data
8. Development of software

We were encouraged by the interest and support of Central Mortgage and Housing Corporation. It was anticipated that the project would have nation-wide applications later and up to $250,000 was granted to N.C.C. towards this purpose.

ACCOMPLISHMENTS

Of the six components noted previously, we have achieved, in the past ten years, certain levels of operation with respect to the geocoding system, an automated graphic display system, and the internal planning operation system. Some administrative needs of the N.C.C. are being met by the work to date and a few random exercises were performed and tested successfully utilizing data available.

There follows a brief description of the work done on property identification and statistical data correlation to property, even though the original objectives have not yet been reached.

1. Property identification and geocoding

By 1968, the installation of basic first and second order survey control networks had just been completed and a regional mapping program based on the 3° M.T.M. projection had just been initiated. In addition, a ten year legal

survey program to identify and coordinate the boundaries of N.C.C. properties had also just been inaugurated.

In order to provide a basis for identification of the relatively large parcels of land within the 800 square miles of the rural Ontario portion of the National Capital Region, some 200 rectified photomaps, scale 1:5000, were prepared. Subsequently, the basic township framework was identified on these maps by a registered Ontario Land Surveyor. To this framework was added the individual ownership parcels by the Ontario Ministry of Municipal Affairs (Assessment Branch). Based on the coordinate system shown on the photomaps, these data were digitized and recorded in the system as soon as equipment became available.

By means of automatic plotting equipment, we can reproduce the input at any desired scale. Positional accuracy is subject to the inherent weaknesses of rectified photo-mapping. The usefulness of the property parcel databank depends greatly on the care taken in the plotting and the frequency of updating. These latter factors are not under the direct control of the N.C.C.

Due to the ruggedness of the terrain of the rural Québec portion of the Region, orthophotomaps were prepared, but no progress has been made in the production of subsequent cadastral or property maps at this time.

For the urban portions of the Region, primarily Ottawa and Hull, the traditional line mapping at scale 1:1250, based on the same 3° M.T.M. projection had just been started in 1968. Production output lagged far behind that of the photomapping.

In order to design and test the System, it was decided to collect property data using existing municipal maps on which the 3° M.T.M. grid has been identified in a very approximate manner. This appeared reasonable at the time since it would provide experience in data gathering and in the principles of data storage and retrieval.

However, the developers of the total system failed to appreciate and utilize the improved accuracy of the new urban mapping which was becoming available at the rate of about seventy-five (75) sheets per year.

After the expenditure of large amounts of staff and equipment time on the recording of the entire urban Ottawa and Hull property parcel positions data on the municipal map base, it finally was recognized that the data in the system did not harmonize with the topographic features shown on the photogrammetric mapping.

The user familiar with and confident in the traditional map could not reconcile the interrelationships of property parcels with existing topography and he quickly became disillusioned with and suspicious of the whole system.

Only those users concerned with general or broad-brush aspects of planning could use the information system effectively.

A timely reorganization at N.C.C. resulted in the establishment of the System Development Division whose new Director quickly assessed the above situation and requested the preparation of controlled cadastral overlays to be the basis of property identification within the information system. These overlays are matched with existing photogrammetric urban map sheets and are being prepared by registered Ontario Land Surveyors. They are utilizing all available resources such as legal surveys based on the 3° M.T.M., field notes showing the relationship of fences or buildings to cadastral framework, and their technical and interpretation skills. The entire Ottawa urban area within the Greenbelt will be completed by August, 1978.

An example of an urban topographic map is shown on Figure 1 and its corresponding cadastral overlay is shown on Figure 2.

The overlay shown on Figure 2 is the basic framework to which property parcels are referred in the provincial registration system. But it is the constantly changing pattern of land ownership that is of interest to planners. Property ownership maps form the geographic base for our planning information system, since statistical data such as assessment, real estate transactions, census data and social data can be referenced to and plotted on these maps. The Pro-

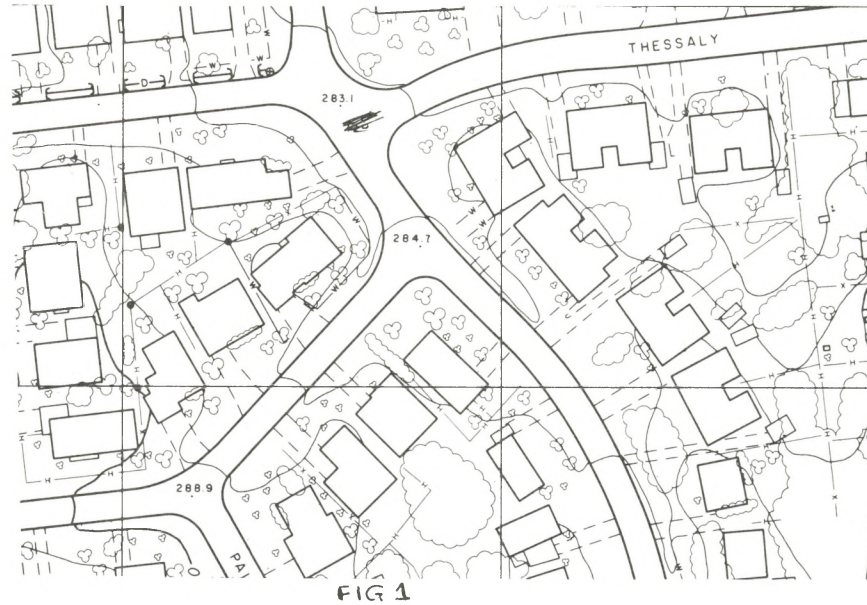

FIG 1

FIG 2

vincial Assessor's Offices are the primary source of current property boundaries and much of the statistical data.

The order of events that lead toward the property base maps is shown on Figure 3 and is self-explanatory. An alternate approach to part of the system is indicated by the dashed lines in Figure 3. This approach calls for the preparation, digitizing and editing of the cadastral overlays prior to the entry of property data at the Assessor's office. The certified cadastral overlays would be transformed into clean digital information using the graphic data entry and edit system and computer produced copies would be forwarded to the Assessor. Variations of actual property lines from the original cadastral framework would be added directly to the digital file using the editing system and the numeric information provided by the Assessor. It is felt that we should get the map information in digital form as early in the process as possible.

An example of the property ownership base is shown on Figure 4.

A great deal of experience was gained in the early 1970's in the capturing of property data based on the poorly controlled municipal maps. Our equipment is now obsolete and the end product is merely a file of coordinates and not a geographical base file. If we continue this project, utilizing new equipment and coding procedures, the actual digitizing will proceed in a manner determined by the data structures adopted. The software will be sophisticated enough to remove much of the burden of routine error checking from the operator. With easy entry of feature codes and descriptor strings and better software at the edit stage we hope to improve the overall efficiency. The goal of the process up to this point is to produce an error-free digital map file which, after some reformatting can be incorporated in the geographic base file and linked to other data elements. The geographic base file can then be used as the basis for subsequent map production.

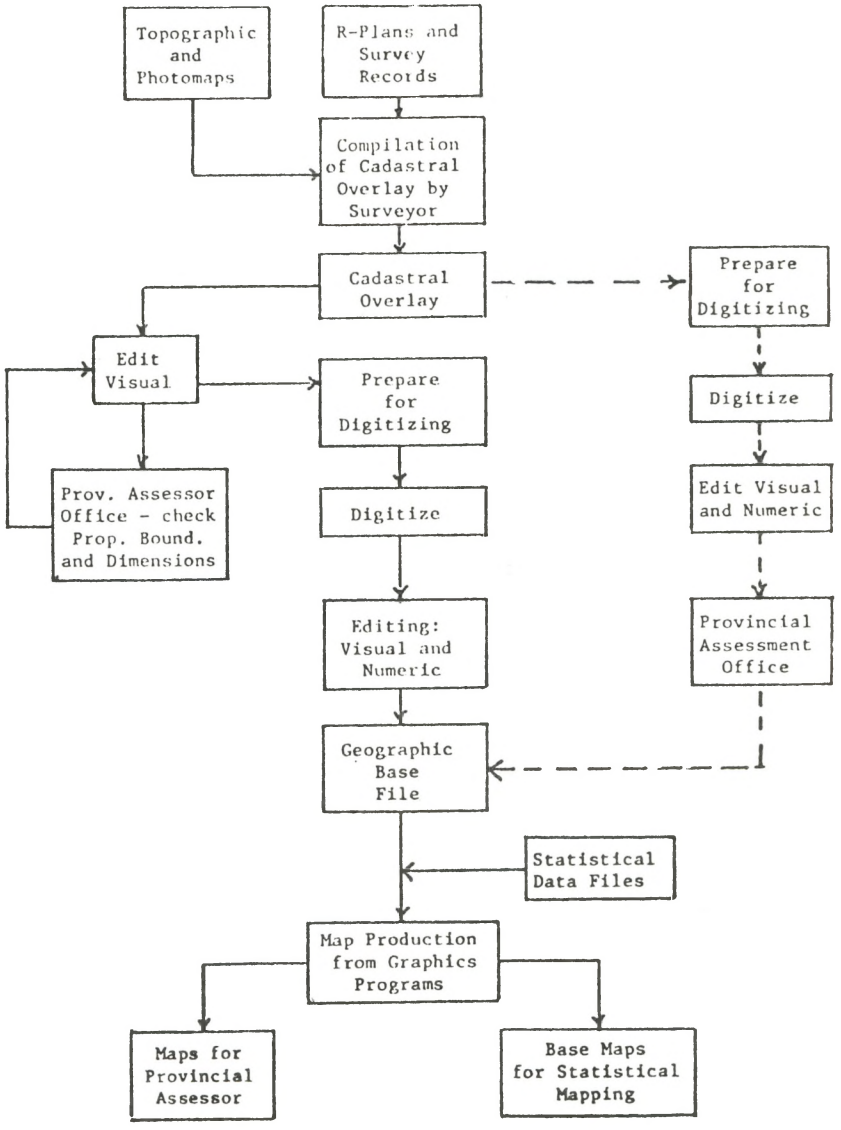

FIG 3

2. Statistical Data

A great deal of statistical data are available for any area such as the National Capital Region. The data one can collect includes:

Assessment Data
Real Estate Transactions
Census Data
Fire and Police Calls
Visits by Social Agencies
Home Addresses and Places of Work

Unfortunately, even if the data is available in machine readable form (and it not always is), it comes in a variety of formats. Actually, the format for individual items may change from year to year. Hence, it is essential to identify the data that are really required frequently enough to warrant entering them in a data base. If care is not taken here, enormous expense can be encountered in building, using, and maintaining the data base. Special programs can be written to extract infrequently wanted material, as required.

In the N.C.C. development, we have most of the above data available and do process some of it to meet planning needs. Our immediate plan is to build a relatively small on-line data base for the commonly used elements. Included will be such elements as:

Assessment Roll Number
Street Address
Polling Subdivision
Assessed Value
Occupants, by age group
Geocentre Coordinates
Census Tract
Zoning Boundaries
Sales Value
Property Use

Certain other data, such as place of work, social insurance number, job classification for Federal Government employees would be extremely useful and would be obtained if possible.

The long range plan calls for an ability to accept queries from planners and the processing of these queries to plain statistical answers, geographically referenced statistics and graphically displayed statistics, all without human intervention. That is a very ambitious target indeed. Right now, the production of graphical displays require computer programmer intervention. We intend, though, to set up a number of standard-

ized 'library' programs to meet frequent requests.

As a result of work to date in the above areas, we are able to provide information concerning population moves and densities, real estate values and estimated populations served by bus routes, displayed graphically on base maps. The map base is available for schematic displays of utilities and traffic flows. Our immediate requirement is to achieve a reliable production status for the system, through program improvement and the acquisition of more effective data entry and plotting equipment.

OBSERVATIONS BASED ON N.C.C. EXPERIENCE

What can be learned from our years of work, and what advice can we offer to those who are contemplating entry into this field?

1. Throughout the entire development period of a Planning Information System, the user and the provider of the services must work very closely together. The user must be convinced of what he really needs and have a thorough knowledge of the services the System is capable of providing. He must share this understanding with the provider who must restrain his promises to what he can deliver. In our case, the two groups lost touch years ago and some mutual susp'cion still lingers at this time. This situation was compounded by the early retirement of the originator of the proposal, a planner with strong leadership qualities, and a frequent turnover of senior staff during the ten year period.

2. Sources of data must be assessed both for quality and continuing availability. To have a key data source dry up could sabotage the usefulness of the tool. On the other hand, unexpected access to new and useful data may challenge the capacity of the system as designed. It is necessary to be continually seeking out alternate or back-up sources of data. We are very dependent on outside data sources which are subject to political influences.

3. Cost-benefit reviews are necessary at regular intervals. To maintain a current system means equipment updates or changes, software development and staff training on a continuing and expensive basis.

4. The temptation to deviate from the project development program and goals must be resisted. Failure to do this will confuse both the user and the producer and delay the completion of the project until eventually all motives and promises become suspect. We consider that two years is the maximum period within which to bring a Planning Information System on-line. In our case, we spent nearly two years acquiring and massaging digital topographic mapping of a proposed site for a satellite city.

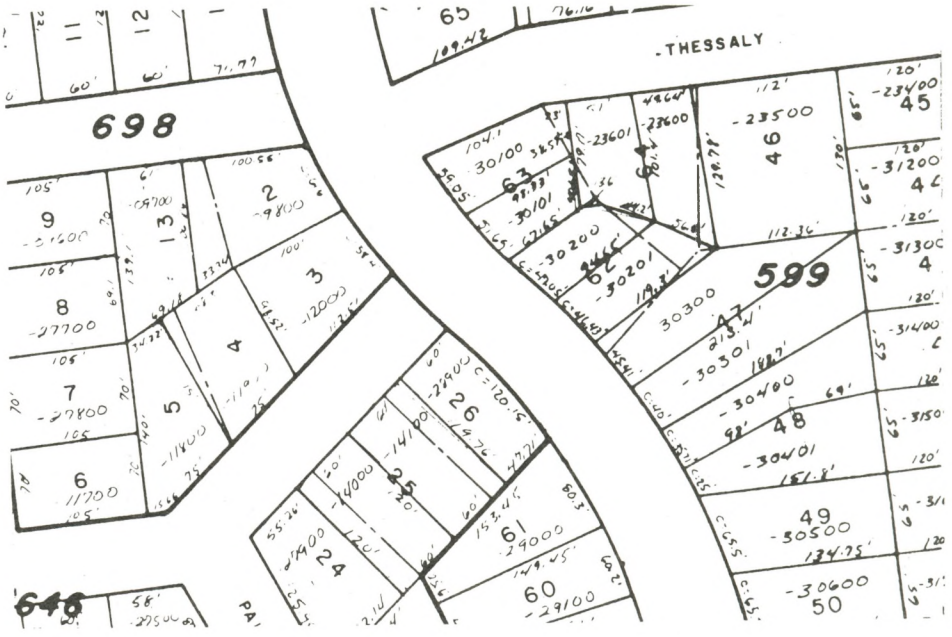

FIG 4

5. The "garbage-in", "garbage-out" statement still holds true. Surveyors, photogrammetrists, cartographers and computer experts have all had short-cut decisions come back to haunt them. In retrospect, the reasons for past short-cut decisions never seem as overpowering as the immediate problems they have created.