THE ONTARIO CO-ORDINATE SYSTEM AND ITS RELATIONSHIP TO URBAN DATA BANKS AND DATA MANAGEMENT PROBLEMS

by R.A. Smith *

Introduction

This paper outlines the reasons for the development of the Ontario Co-ordinate System and indicates how it may be utilized by urban communities.

Initially the system was proposed as a basic framework to which survey, mapping and engineering projects could be related. The system may however have more impact on our communities by the facility it provides to develop urban data banks and data management systems. The Municipality of Metropolitan Toronto started the development of a co-ordinate or control survey system several years ago and I will outline its development and proposed applications.

Co-ordinates

One of the oldest sciences in the world is measuring distances on the ground - surveying. From the measurements taken maps are produced. To act as the framework of a map and to fit maps together it is necessary to have some type of a reference or co-ordinate system.

Most people are familiar with the reference system of parallels of latitude and meridians of longitude. This system is useful for navigators and when making maps of the world or of a country. When working on a small part of the earth's surface a different reference or co-ordinate system can be used because a small part of the earth appears to be flat. By having two guide lines, one north and south and one east and west, the distance east of the one line and north of the other can be determined. Let the distance east of the first guide line be known as the "X" distance and the distance north of the other guide line be known as the "Y" distance. By this simple direct method a point can be expressed by its X and Y co-ordinate values and once the position is fixed it can be shown on maps, charts or plans. The point can also be located from survey monuments of known locations on the ground. To relate maps, engineering and survey projects together it is necessary to have survey monuments, or permanent marks, on the ground with known X and Y values. These are determined by establishing a network of direction and distance monuments, all related to the first mentioned guide lines. The survey network also includes the establishment of elevation monuments called bench marks.

Survey Problem

Control Surveys were not established to relate parcels of land in Ontario; instead a Township system of lots and concessions was developed. The origin of this system goes back to the settlement of Upper Canada. By the second and ninth Indian purchases of 1783 and 1787 respectively the lands in the Metropolitan Toronto Area were acquired by the Crown. In 1786 the Governor-General ordered the Surveyor-General to commence surveys of lands in Upper Canada. Starting in 1793 the lots and

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concessions in the Township of York were surveyed and about the same time the town site of York, or Little York as it was known, was laid out. Surveys of the Township of Etobicoke started in 1795 and proceeded gradually until their completion in 1869. The Township of Scarborough was surveyed in 1800.

These surveys were of a low standard of accuracy by todays standards for City surveys. They were carried out under very difficult conditions and were performed to satisfy the needs of men who were going to settle a rugged land full of giant trees and swamps. In this country we inherited the traditions of private ownership and sancity of property boundaries brought over by our forebearers from the old world. In the new wilderness there did not exist stone fences, hedgerows and physically demarked boundary lines similar to those in European Countaries. It was therefore necessary for surveyors to proceed the settlers and place survey posts at the corners of properties to be settled. The complete farms or holdings were not staked out, posts were planted on the front corners of the parcels along the limits of proposed roads. It was left to the settlers to establish the sidelines between their properties. Rules were laid down for how these lines were to be run and often surveyors were hired to start the owner off in the right direction. He would then continue to project his side lines back as he cleared the land. Eventually large numbers of property disputes were being brought before the courts. The Line Fences Act was established as a cheap and economic way to settle fence line disputes. Those empowered under the act would view the fence line on the ground and make a decision concerning the type of fence to be built and when it was to be built. They could also engage a Surveyor to fix the location of the fence line. Unfortunately we have few records of these decisions. Land Surveyors are even conscious of property boundary problems, many were caused by low standards of survey, by survey errors, by the continuing loss of survey monuments, by the misinterpretation of survey evidence, by trespass both innocent and malicious and by the lack of any organized Government participation in the maintenance of the basic survey fabric of our communities. As the urban areas developed the survey fabric developed as a patch work quilt loosely held together. Developers were encouraged to divide and re-divide parcels of land. With the advent of heavy construction methods almost all survey stakes, near new developments, are graded out. This destruction together with the questionable value of most old survey stakes resulted in a state of general survey decay in the Metropolitan Area.

Registry Offices were developed to store the records and documents concerning the state of land ownership. Cadastral plans and Municipal Tax Maps were developed by fitting together survey plans, records, documents and deeds, but no provision was made for the maintenance and updating of the basic survey fabric.

Metropolitan Toronto Control Survey System

In 1959 there was an urgent need for a system of precise control survey monuments and up-to-date maps. Metropolitan Toronto was one of the few large cities in the North American continent without an organized system of control surveys. The development of electronic distance measuring instruments in the 1950's and the advances made in aerial survey techniques and in the field of electronic computers made it economically feasible to consider embarking upon a system of control surveys and base maps for Metropolitan Toronto.

For practical reasons there must be a mathematical relationship between the plane co-ordinate ("X", "Y") values of a point and the geographic co-ordinate (longitude

and latitude) value for the same point. At the point where the plan touches the curved surface of the earth there is a direct relationship between these points. The farther the survey is extended from this origin point the larger the discrepancies between the true values on the curved surface and plane co-ordinate values become. There are several mathematical methods of relating the one system to the other. The one chosen for the Metropolitan survey was the Transverse Mercator Project System in 3^{o} zones of longitude.

Through the constructive assistance and encouragement of the Association of Ontario Land Surveyors, the Surveyor-General's Office for the Province of Ontario, and particularly the Federal Department of Energy, Mines and Resources, then known as the Department of Mines and Technical Surveys, a program for the establishment of a co-ordinate survey system for the Metropolitan Area was started in 1960. In the first stage 22 first order control stations were established. The exact geographic position of each station in terms of latitude and longitude was determined by the Geodetic Survey of Canada, to an accuracy of 1/100,000. These points are well monumented and are spaced 4 to 5 miles apart throughout Metropolitan Toronto. With the assistance of the Topographic Survey section of the Federal Department approximately 500 secondary control survey stations at a density of 2 per square mile have been established. To this system will be added approximately 10,000 control survey monuments spaced as close as 500' apart. When control monuments are at a density in accordance with the intensity of development of an area, the legal property surveys can be related to the network.

Legal Surveys

About 80% of the surveys performed to widen Metropolitan Roads are related to the control network and co-ordinates are calculated for all points and corners in these surveys.

Land Surveyors have promoted the idea of co-ordinate surveys for several years. In 1962 the Association of Ontario Land Surveyors submitted a brief to the Minister of Lands and Forests recommending "Changes in the Administration of Land Surveying in the Province of Ontario". To ensure the orderly development of communities and to protect the rights of individuals to determine and maintain their property boundaries the Association recommended the establishment of a Provincial Co-ordinate System.

Engineering

The Ontario Department of Highways had always shown keen interest in co-ordinate systems. When they were faced with the necessity to widen Highway 401 from 4 lanes to a 12 lane freeway they adopted the system of control surveys. They related the project to the first order stations in Metropolitan Toronto. The system had so many advantages that co-ordinates are now used on almost all major highway engineering projects.

Recognizing that a Province wide system of co-ordinates was required the Ontario Department of Highways submitted a brief to the Minister of Lands and Forests reinforcing the opinions of the Association.

Ontario Co-ordinate System

On June 21, 1967, The Honourable Rene Brunelle, Minister of Lands and Forests planted "Ontario Post One" at the Parliament Buildings thereby initiating the Ontario Co-ordinate System. Metropolitan Toronto lies in Zone 10 of the system and the Metropolitan Control Survey is now an integral part of the system.

Mapping

Knowing the area to be covered by each zone, in the Ontario system, it was possible to develop a mapping system for the area. Maps are a very basic and important tool for surveyors, engineers, planners, assessors, realtors, developers etc. Today it would be impossible to develop and manage our urban communities without maps. A City is much like a giant factory and no captain of industry would develop such a complex without a map or plan layout so he could analyse problems and eliminate bottlenecks as they come up for consideration.

Mapping plays an important part in urban planning and development. It is admitted that a poor map is better than no map at all. However when we look at the cost of producing and reproducing poor maps and the damage that can be caused by misinterpretation of facts it is not a good investment to continue without an adequate map series. A map should be accurate and should show primary information required at an appropriate scale, simply and clearly for the application to be made.

In 1967 the Metropolitan Council authorized the initiation of the Municipal Map Series. Plans will be prepared at a scale of 1"/1000' for regional planning, 1"/400' for town planning, 1"/200' for local planning, 1"/100' for engineering planning and 1"/40' for engineering design and construction. The maps will be prepared in three series, Topographic showing roads, buildings, trees and ground elevations, Utility showing underground sewers, watermains, hydro etc. and Cadastral showing lot and property boundaries.

Digital Mapping

Because all physical features on the ground are located at a fixed X and Y co-ordinate it is possible to store all the information shown on a map in a computer. Using an automatic plotting machine attached to the computer it is possible to recall the information and have it plotted on a map. As the X Y location of the point to be plotted does not change it is possible to plot the information at any required scale. The accuracy of the new map is directly related to the accuracy of the position of the information given to the computer.

This type of mapping is called digital mapping and is a new type of mapping just being developed which will be excellent for maintaining and updating a series of accurate maps. The stored information can be called a survey data bank and will be continually added to as conditions change. The idea of storing information on a computer related to its X Y position, makes possible the development of a new method of filing land transfer information.

Registry and Land Titles Records

If all legal property surveys are related to the co-ordinates then the corners of

all parcels of land are co-ordinated. This means that it is possible to automatically plot all parcels of land. By adding the co-ordinate values for the corners of new parcels it is possible to plot the new parcel related to the pre-existing ones. By using a type of television screen related to the computer system it is possible to have the plan of the area you are concerned with flashed onto the screen. If a copy of the plan is required, a plotter could prepare it in a few minutes. This could lead to the elimination of Registry Plans as we know them today.

The next step is to have all the deeds and mortgage documents memorized by the computer so that they too can be flashed onto the screen. By assigning a co-ordinate value as a filing address for each parcel it is possible to file all the information concerning the parcel in the computer.

Geocoding

Geocoding is the assigning of a co-ordinate address to information relative to its origin on the earth's surface. Behind this address can be filed many items about the location. By assigning a co-ordinate address to a land registry parcel we are geocoding the parcel. On a computer it is possible to store and retrieve data by co-ordinate address and to add to the record. It is also possible to find the records whether old or new of all the parcels immediately adjacent to the one being investigated.

Information stored by geocoding of individual parcels is stored by location and can be aggregated into larger blocks or areas. The limits of the areas to be chosen may be irregular and can be chosen with complete freedom. There is no reason that only land transfer records should be filed by geocoding. Almost all records gathered by Municipalities are related to individual parcels of land and these could be geocoded. If the land registry records are already filed by this method than additional information could be stored behind the co-ordinate identifier. There is no reason why the municipal records should not be coded first and the land records at a later date. The exact co-ordinate values of the corners or boundaries of an individual parcel of land are only another of the records to be filed behind the co-ordinate address of a parcel. It is not necessary to know this information in the initial stages of the development of a land registry or urban data bank. The integrating of many types of records of the many and varied Public Departments would be of immense value in the planning and development of urban communities.

Urban Data Banks

Our social system is based upon three basic economic factors land, capital and labour. Land is obviously related to the co-ordinate system. Capital in the form of factories, plants, machinery are all situated on the land and can be related to co-ordinates. Labour can be related to co-ordinates relative to the location where a person lives and the location where he works. The three basic items in our capitalistic system can all be related to co-ordinate location. It is therefore possible to use geocoding as the common identifier in the development of a general information file or urban data bank. A method of continuous and periodic recording of all changes in information must be built into the system in order that the data bank can serve its ultimate purpose. It is necessary that we have current data and historic records. Some of the types of information which I believe may be of value are: -

a) Property Information -

Property identification is the first pre-requisite for data analysis. Accurate

property identification is the base for all subsequent data reference. It is necessary that the property identification be at the smallest unit, that is the property holding, in order to enable the aggregation of the data at any level for analysis and decision. The property information could include the registered parcel number, the street address, the co-ordinate address (geocoding) the lot and plan or block number, the ward number, census track number, census block number, assessment roll number and any other commonly used property data.

b) Physical Property Information -

Land use and physical property information would be added to the data bank. This information is required because all planning decisions are based upon the patterns, characteristics and use of physical property. Much of this information is contained in the Registry Office, building, utility, telephone, zoning and assessment records. Desirable data would include physical data concerning the size of the parcel, topographic characteristics, drainage run-off information, utility connections, waste disposal facilities, number of buildings, floor areas, percentage or parcel covered by building, set-backs, number of stories and height of building, number of rooms, type and classification of construction, year of construction, condition of buildings. In addition it may include data to indicate whether the parcel is residental, institutional, manufacturing, wholesale or retail of one of many types. It is also necessary to record restrictions against the property such as zoning, building set-backs, deed restrictions, proposed road widenings and airport and schooling restrictions.

c) Economic Factors -

The next classification would be economic factors, this would include market value of property, assessed value of property, relationships between present and ultimate or best use of property, potential income of the area, business establishment and failure rates for the area and property sales. Economic information would be maintained concerning labour force employed at the location by salary, class, occupation, sex. Also required is information concerning materials being manufactured or used, source of raw material, the location of markets and the need for communication and transportation facilities.

d) Social Information -

The next series would be social information, this would include the number of persons resident at a location, the number of householders, the number of occupants per room, the race and sex of occupants, their age and education, family incomes, employment status, place of work, the number of children in school and the location of the schools, birth and death data and welfare and crime data. From this information we can make better studies of people and attempts to understand how they live, their family characteristics, why they move, what type of environment they prefer.

e) Transportation Information -

As a Roads Department employee I would be amiss if I did not indicate the need for transportation information. This would include the vehicle registrations by residence per location, means of transportation used by employees and residents, facilities for off-street parking, location of lanes and characteristics of access

to parcels, on-street parking facilities, ratios of cars to employees and all types of information concerning roads, railways, airports, terminals, docks, railyards and their capacities. It is evident from our changing technology that our present modes of transportation will not continue for a long period of time but in order to accommodate any new transportation methods, we need to know a great deal more about the movements of people and goods.

Data Management Systems

It is not sufficient to simply have a system which is a large ledger for the storage and retrieval of data. Because of the tremendous volume of data it is implicit that the programs developed go a step further and permit manipulating, calculating, sorting and re-sorting the data for the purpose of making effective management decisions.

The management program should be developed to handle any type and amount of data. The system must therefore not be rigidly tied to one type of identifier nor restricted by a preconceived method of input routine. The program should accept information with any system of identifiers. The co-ordinate is therefore not considered as the prime identifier for structuring the filing system in a computer. Geocoding is a common identifier which permits the initial integrating of various records which may be filed in their own unique way. However, the few systems the better. The program should include the ability to re-organize information in the computer according to any common item selected by the user. The program should be able to select information in the data bank and add, subtract or integrate the data with other data, thereby creating new significant data. This new information must then be stored for later use. Large amounts of data will be sorted, integrated with other data, re-sorted, manipulated and then refined before being printed out in a concise form in statements and figures answering the users problem or providing true data from primary sources for decision making.

The program should receive and print out information in a simple format familiar to the individual or department requiring the service. Any intermediate steps to translate the data should be performed by the computer. A data management program will be a core program with any number of satellite programs according to the tasks to be undertaken. The data bank will consist of a core data bank connected to satellite data banks. The core bank containing all common information and the satellites will contain common information of interest to one department plus data peculiar to that department. The interconnected system will permit the automatic up-dating of both core and satellite data banks and the printing out of notifications of data changes that may effect the department.

Impact

There is no doubt that public works programs will benefit from the new surveying and mapping systems described and from the material available in a data bank to make decisions, especially with the aid of a data management program. Similarly all departments will be better able to solve problems and make recommendations.

In the future urban development projects will not be undertaken without the City fathers having a clearer understanding of their long and short term impact. Although the short term effects of a project may be obvious and appear good, the long run implications may not be so desirable. All types of work undertaken both private and public must be weighed to determine whether they are really in the best interest of the people.

For example highway planning has now passed the stage of simply building a ribbon of concrete down the road. We are becoming more and more involved in trying to understand the economic and social impact of our construction projects, both on those properties in the immediate vicinity of the job and on the complete urban area.

We can make significant studies at all governmental levels with the necessary raw material and the ability to handle it. There are very grave social problems involved in the development of complex and comprehensive data banks. With all the information in an urban data bank related by a co-ordinate grid it would seem possible for a Municipality to manipulate the people rather than serve the people. We should remember that a comprehensive filing system in a large municipality really contains the type of information a Town Clerk has in a small community.

With the large number of specialists on staff in a large community we are able to make effective use of the data to solve problems related to people living together in rapidly expending urban areas. With this information, experts are able to forecast what will happen next year, month or week and then explain why it did not happen. We must face the social problems involved, including the invasion of privacy but at this stage we should not withhold the creation of data banks on the assumption we can avoid the problems. If the public sector does not develop and control the data banks, the private sector will. We must remember that communities are for people and that all our public programs should be oriented towards understanding people in their environment and creating social conditions which satisfy their needs or aspirations. It would appear that the development of complex data banks, data management systems, comprehensive and accurate survey and mapping programs will help us to achieve this goal.