National Research Council Canada
Conseil national de recherches Canada

PROCEEDINGS
of the
WORKSHOP
on

MAPPING & RELATED APPLICATIONS OF COMPUTERS TO CANADIAN POLICE WORK

13–14 April 1977
National Research Council
Ottawa, Canada

Editors:
J.E. Watkin
F.R. Lipsett

National Research Council Canada
Conseil national de recherches Canada

PROCEEDINGS
of the
WORKSHOP
on

MAPPING & RELATED APPLICATIONS OF COMPUTERS TO CANADIAN POLICE WORK

13–14 April 1977
National Research Council
Ottawa, Canada

Editors:
J.E. Watkin
F.R. Lipsett

ORGANIZING COMMITTEE

J.G. Arnold
C.R. Eves
S.R. Gwilt
A.H. Hall
F.R. Lipsett, *Chairman* and
Editor of Proceedings
J.E. Watkin, *Editor of Proceedings*

Single copies of the Proceedings may be obtained from:

Protective and Forensic Sciences Section
National Aeronautical Establishment
Building M-55
National Research Council
Ottawa, Canada K1A 0R6

Phone: (613) 993-3737/3778

Cat. No. NR 72-1/1977

ISBN 0-662-00815-4

Proceedings of the Workshop on

MAPPING & RELATED APPLICATIONS OF COMPUTERS TO CANADIAN POLICE WORK

Page

SESSION 2 — INTERACTIVE

Chairman — *C. R. Eves*, National Research Council, Ottawa

Reporter — *D. H. Douglas*, University of Ottawa

The purpose of this paper is to place the application of computers to Canadian police work in the wider perspective of geographic information processing in Canada, and to explore the possibilities of interlinkages between various systems currently being developed. Geographic information processing is being developed at various levels and for various purposes and there is a need for reducing the duplication of effort and for a greater degree of cross fertilization.

A comprehensive crime analysis research package (CARP) that includes spatial referencing of crime data, a link to recent census data, and extensive data manipulation and mapping facilities has been designed and implemented. The paper will provide an overview of CARP and focus on the following features: data organization, data aggregation and manipulation, interface with mapping routines, and structure of the spatial reference file.

A software package under development at NRC in conjunction with the Ottawa Police Force will be described. The police planner will be able to query data on calls for service stored on a magnetic tape. The data will be displayed on-line on a simplified street map of the urban area together with a statistical summary.

Intelligent terminals will be defined and described, and their impact on computerized systems in general will be discussed. Specific plans for their use in the CPIC network will be described, and possible future uses for intelligent terminals will be discussed.

THURSDAY 14 APRIL

SESSION 3 — ANALYTICAL

Chairman — *A. H. Hall,* National Research Council, Ottawa (Ret'd)

Reporter — *Z. Jaksic*, National Research Council, Ottawa

This paper deals with the establishment of a nationwide system of police geofiles in the United States based on compatible coordinate systems. Due to the interlinkage resulting from shared coordinate bases, data from various localities over wide areas can be collected and merged to perform spatial and aspatial analysis. The values of this system are discussed both from the standpoint of United States' desirability as well as the implications of such an effort to Canadian efforts in mapping of police data on a large scale. A background is given concerning the development effort on geobase files of police in the U.S. on a national scale. Current implementation policies and successes are addressed as well as their transferability to a similar program in other nations.

An outline will be given of a computerized mapping program which resulted from joint efforts of the city of Atlanta, utility companies in Atlanta, and the Georgia Department of Transport. Police applications will be discussed, including those presently in use and those planned for the future. They include dispatching assistance and graphic representation of spatially oriented crime data.

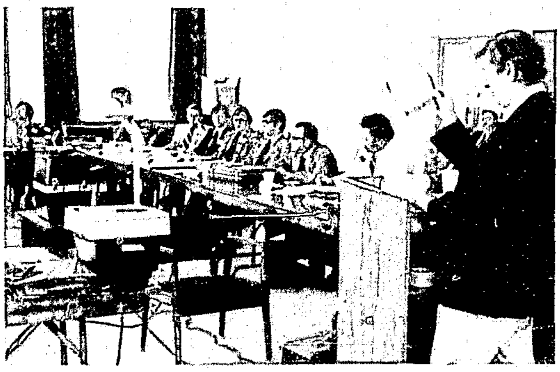
This paper will trace the growth in Canadian police computer usage with particular reference to the past decade. Despite limited resources the absence of direction from senior government, some worthwhile results will be noted. Where resources and direction have been supplied, as with CPIC, there has been an effective level of usage. The paper raises questions for policy in future development.

The concept of personal privacy is relatively new and still developing, as a result of increasing automated use of personal information. Protecting personal privacy in the use of personal information requires not only a controllable and a relatively secure EDP environment; it also requires that there be no misuse of personal information after it leaves the area of secure storage. This paper will look at information security as an essential but insufficient element in protecting data and its uses, within the larger but as yet ill defined concept of personal privacy.

In recent years, particularly, the operations research and management literature has suggested alternative models and approaches for using computers and computerized approaches for planning and evaluation in criminal justice. The present paper will deal with one specific type of model which might be used in a planning and evaluation exercise, and will concentrate on the relative advantages and disadvantages of computers in planning and evaluation, as well as the necessary conditions for their effective use.

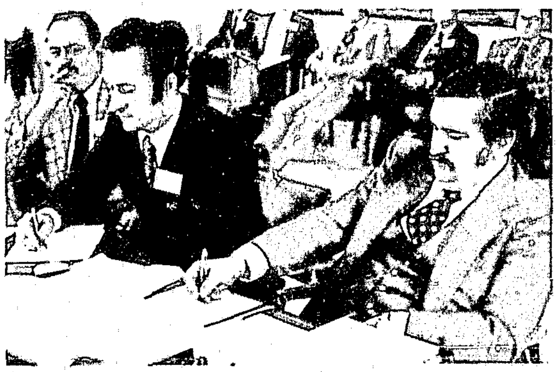
Over the past decade there has been a significant growth in the use of computers by U.S. police departments. Survey work performed in 1971 and 1974 has shown this rise to be especially apparent for "routine" or "structured" computer applications where the technology is used to carry out straightforward, repetitive information processing activities—applications which, in many cases, were already being performed manually before the introduction of the computer (such as real time police patrol and inquiry files, traffic records, and crime statistical reports). This paper will discuss the evolution of computer use.

In general, though, the growth of information technology has been at a rate somewhat slower than what police departments had predicted in the early 1970's. Further, when computer applications extend beyond "routine" uses to "non-routine" efforts, such as resource allocation or computer-aided-dispatch where the machine begins to become a tool for decision-making, strategic planning and man/machine interaction, the results to date have been mixed. The process of implementation is far more complex and unintended consequences arise. A series of case studies performed under the direction of the author have provided useful insights concerning the implementation and impact of information technology, and this paper will discuss some of these conclusions.



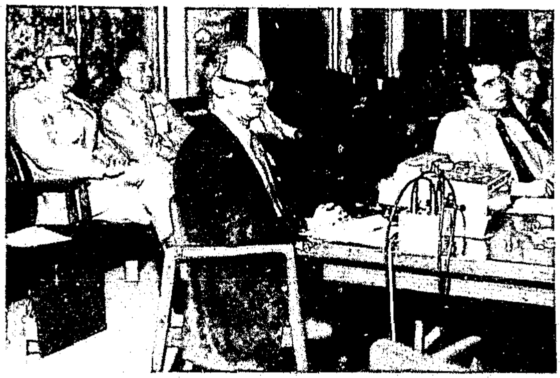
D.H. Mead responding to a point

Top row (left to right) — K.R. Thomas, E.L. Hayes, W.H. Brodhecker, J.G. Arnold, G. Turnbull, K.R. Cocke
Front row — R.A.K. Meyer, R.J. Friesen



J. Lecompte, B. Gregoire, M. Lalonde

S.R. Gwilt, J. Gongos, R.G. Cassidy, C.R. Eves, R.P. Gravel



F.R. Lipsett, A.H. Hall, J.E. Watkin, K.W. Colton, R.G. Fujaros

S.K. Chang, C.R. Eves, F.R. Lipsett, B. Butler

SOME OF THE PARTICIPANTS AT THE WORKSHOP

PREFACE

When inviting participants to this Workshop we tried to include those whose interests ranged from methods which had already found application in police work to ideas that might be no more than a gleam in the eye of a geographer, sociologist or computer scientist. Those invited included policemen, professors, government scientists, and consulting engineers, so as to provoke discussion by presenting differing points of view. That we succeeded should be apparent from the transcribed discussion following most of the papers. The discussion required extensive editing, and the editors take responsibility for any errors.

Our main impression is that the field is still in its infancy. One might think that police work does not vary greatly from place to place and that therefore an analysis of operational problems using the most recent computer technology would lead to similar systems. This does not appear to be the case. (Colton, p. 194 conclusion 4). For example compare the British and Canadian systems as described in the talk by G. Turnbull and those by K. R. Thomas and R.A.K. Meyer. Both systems work well but the requirements they are designed to meet, one of localised police command and control and the other of crime information, are quite different. The CADRE System described by W.H. Brodhecker, soon to be installed by the Ottawa Police Force, will include some command and control functions but will also connect with the CPIC, a crime information system.

Great variety appears in the papers describing geocoding for police needs. In systems currently functioning in real time G. Turnbull shows a map projected on the screen of a special cathode ray tube but the resolution of the position of the police cars is only a square of 1½ km sides. On the other hand L. Holmes' Boston street file has resolution to a block-face or large building, but the location is given in written form rather than on a map. The system described by V.M. Davis for mapping Atlanta, Georgia has resolution to a single lot, as this precision is needed for location by utilities who share the system. The police output is in map form (not in real time) and is used for the geographical analysis of crime.

D.R.F. Taylor commented that the linkage of police work with other systems has received only limited consideration. Only a few of the systems described at the Workshop have been designed for use outside the police services. For example the street indexes in the United Kingdom and Boston are apparently not in use by the fire or ambulance services, which would have similar problems.

Apart from real time applications P.O.Hanson *et al.* described the wealth of data in police files that is neglected for sociological research. Information for this purpose is useful only if it can be correlated with other data, and only the data in the police report can be used in this way. This data almost always includes the location of the occurrence and thus is precise and usable. Much of the work described at the Workshop was concerned with correlating the geographic location of a crime with other parameters. But perhaps we are only doing this because it is possible. The paper by K. Colton (p. 198) throws a dash of cold water on this attitude.

There was little discussion or reference to studies on the value of geocoding crime. However, D.H. Mead (p. 146) described the detection of juvenile criminals by geographical analysis. D.R.F. Taylor (p. 72) questioned the value of Arnold and Lipsett's work to the Ottawa Police Force. P.O. Hanson (p.91) said the discouraging reaction of experienced sergeants to his efforts was "So what?" Colton (p.197) related similar experiences.

Geocoding is not the only way to analyse crime data and Hanson described others. But as all the research is in an early stage it would be premature to judge it now. Time will be required for applications to be developed and demonstrated. However as systems develop it should become possible to estimate their value in increasing police effectiveness.

Thus these proceedings describe recent work in many places and summarize the work in a way we hope will be useful and possibly illuminating.

The editors

OPENING REMARKS

by

C. R. Eves

National Research Council, Ottawa

It is indeed a pleasant task for me to welcome you to this workshop on "Mapping and Related Applications of Computers to Canadian Police Work".

We especially welcome those who have come from the United Kingdom and from the USA to be with us. We do hope that your stay in Canada will be interesting and enjoyable.

This Workshop is being held under the auspices of the National Research Council Canada. Although I have been employed at the Council for only slightly more than 16 months, nevertheless, during my prior 35 years' service with the Royal Canadian Mounted Police, I had considerable contact with NRC. In the formative years of the RCMP Crime Detection Laboratories, for example, during the late 1930's and the early 1940's, NRC conducted many forensic examinations at the request of the RCMP. Later, after those Laboratories became self-sustaining, NRC scientists played continuing roles as advisors, consultants and friends. For many years, therefore, all Divisions, representing various physical science and engineering disciplines, have continued to provide scientific and technological assistance in support of law and order in Canada.

Since 1974 this support of law and order has become more formalized and goal-oriented through a bilateral agreement between NRC and the Canadian Association of Chiefs of Police (CACP). This led to the formation of the NRCC/CAP Technical Liaison Committee (TLC) and to the provision, by NRC, of the Secretariat for the CACP Operational Research Committee. The TLC has established twelve sub-committees on various aspects of police field operations and equipment.

Under its broad program of National Police Services (NPS), which services are available to all Canadian police departments, the Royal Canadian Mounted Police (RCMP) has developed and operates a dedicated, on-line, nationwide, police computer network known as the Canadian Police Information Centre (CPIC), also known in some circles as the 'C-PIC'.

Apart from CPIC, however, various computer applications to police field operations, particularly in mapping and related applications, have been developed on an 'ad hoc' basis in Canada by research groups, such as the Computer Graphics Section of NRC, in close cooperation with local municipal police departments, such as the Ottawa Police Force.

Recognizing the need to identify these various computer applications available to the Canadian Police community and knowing the wealth of expertise already available in the USA, in Britian and in Canada, it was decided to hold this Workshop on "Mapping and Related Applications of Computers to Canadian Police Work" and to invite internationally recognized computer specialists to participate. From the impressive list of speakers at this Workshop, we cannot help but gain a clearer picture of the "state-of-the-art" in this field of specialization.

47417

UNITED KINGDOM PRACTICE IN THE USE OF LOCATION INFORMATION

GORDON TURNBULL

POLICE SCIENTIFIC DEVELOPMENT BRANCH, LONDON
ENGLAND

Introduction

The growth in the use of location based information in the U.K. for minute by minute deployment and longer term management of resources has gained great impetus since the introduction of computer based command and control systems, in 1972 (Burrows 1971, Harwood and Broom 1972). Before such systems were implemented 'manual' methods of data collection (Holt and Lee 1970) had shown the value of location based information both in the short and long term but the overhead on the communication controllers and in particular the patrolmen was generally found to be unacceptable. How could this situation be improved? Whatever system of data collection was used it had to be an integral part of police operations, it had to cover all resources and be as continuous and as automatic as possible. Only when these criteria were achieved would the data be accurate and its capture not overburden the patrolman or the controllers. Most importantly, all this has to be done at an acceptable cost. Before describing how this problem is being tackled in the U.K. I would like to describe the command structure of a typical U.K. Force.

Two Tier Structure of Majority of U.K. Force

The majority of Forces in the U.K. have a two-tier command and control structure in that operations in the field (Criminal Investigation, Traffic, and Uniformed Patrols) are directed by both central and local agencies. (Fig. 1)

A typical U.K. Force will contain a number of towns and conurbations surrounded by rural areas. The Force is divided into a number of divisions or local operational units, each of which has some degree of autonomy. Each local agency deploys and supervises foot and mobile resources using U.H.F. radio. In addition to local resources there are resources which have a Force-wide responsibility and these are controlled centrally using V.H.F. radio. These resources include traffic cars which patrol motorways and major trunk roads and special function cars such as crime cars, rural patrol vans and dog carriers.

Requirement for real time information

An incident, or call for service, may require central resources, local resources, or a mixture of both. Most U.K. forces operate a centralised trebble 9 system and all trebble 9 calls are received by H.Q. Control. However, trebble 9 calls only represent about half of the total number of calls for assistance, the remainder come via local stations

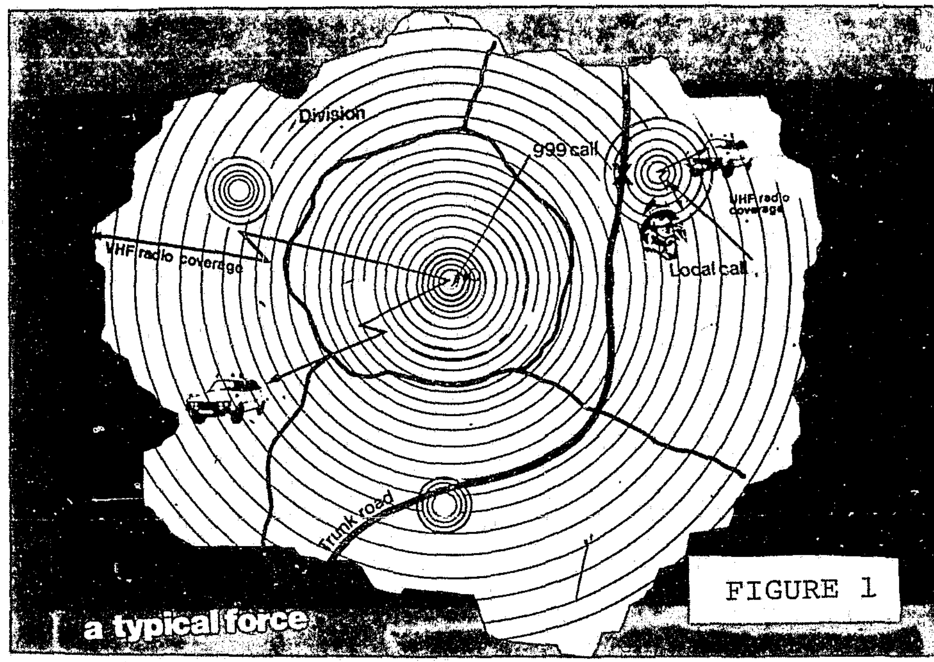


FIGURE 1

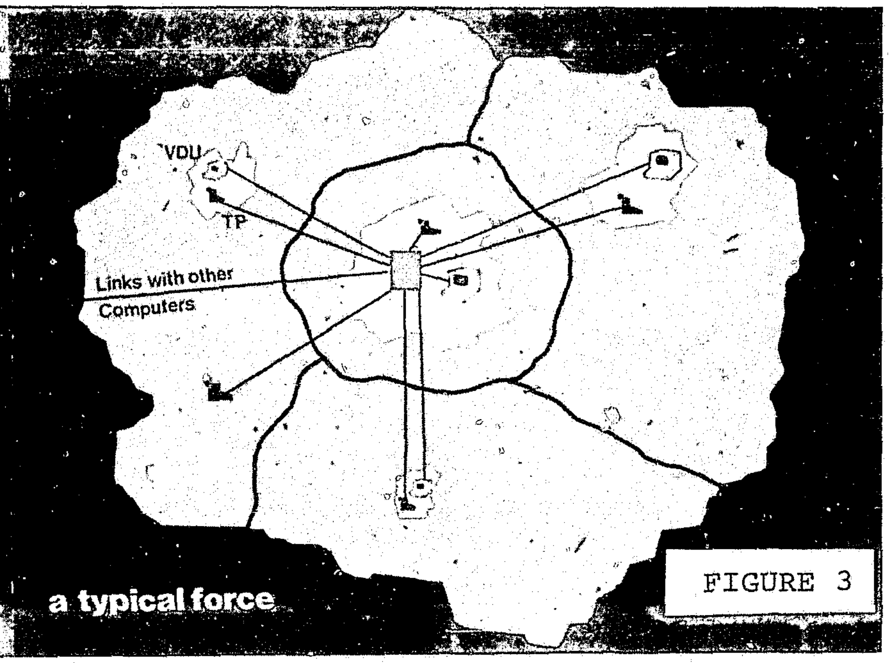
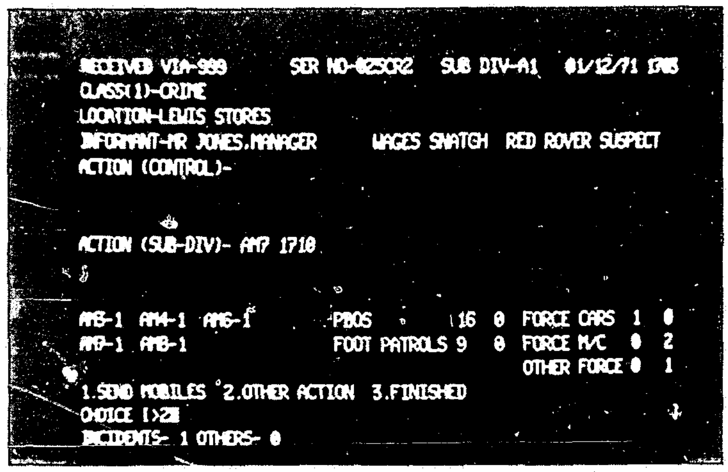


FIGURE 3



Sub-Divisional Control FIGURE 4

and of course both the central and local controls can be informed about the same incident. Thus information about a given incident in a given location may arrive by a variety of methods and be dealt with in one of a number of ways.

Therefore, particularly in the U.K. where we have this two tier command and control structure, there is a need for quick and accurate distribution and collation of incident data and actions taken as a result of a call for service. Also, good communications are needed between all controls, and between a given control and the available resources, to ensure the incident is being handled correctly and efficiently. Once the right controller has the right information he then must deploy the most suitable resource. To do this he must have access to firstly the number and type of resources on duty and secondly the status and location of these resources.

Requirement for long term information

So far I have only mentioned that information which is required for immediate reactions to calls for service. There is also a requirement for information for monitoring of performance and for tactical and strategic planning. In other words we need to be able to monitor both incident and deployment patterns and to plan how deployment may be improved in the future.

Reconciliation of real-time and long term requirement for information

To reconcile the short and long term requirements for location and other information a compromise is required to ensure that enough high quality data is collected without over burdening either the controller or the patrolman. Police operational computer systems in the U.K. are now being designed to provide both aspects of information right from the outset rather than the management information being merely, an adjunct to Command and Control.

Automatic Vehicle Location

There are no automatic vehicle location systems in operational use in the U.K. although a number of systems are being evaluated by the London Metropolitan Police. At the present cost of A.V.L. systems there appears to be no strong desire to implement such systems, in the provinces. The tendency there has been towards low cost semi-automatic digital encoders.

Current Operational Police Computer Systems

There are now two police command and control computer systems in operation with a further dozen at various stages of development (Fig.2). There has been a terrific increase in the last two years in the number of Forces embarking on computer based Command and Control systems. The basic philosophy underlining the majority of systems follows.

	BIRMINGHAM	WEST MIDLAND	GLASGOW	STRATHCLYDE	STAFFORD	SUFFOLK	DORSET	WEST YORKS
Population (000)	1,088	2,785	900	2,578	985	562	566	2,080
Average Number of Incidents per Day	590	1,600	960	1,600	360	300	190	1,520
Operational Date	2/72	4/78	5/75	3/78	6/77	3/77	5/77	4/78
Number of CPU's	1	2	2	3	3	1	2	1 Ø
VDU's H.Q.	7	17	9	9	10	7	31	8
Outstations	12	37	7	20	18	7		32
M.S.S. Teleprinters H.Q.	- -	2	2	2	2	3	25	4
Outstations	-	48	18	48	23	15		36

Ø Initial Configuration

Figure 2 - POLICE OPERATIONAL COMPUTER SYSTEMS IN U.K. - EXISTING AND PLANNED

Basic Police Operational Computer System

In a typical Force a central computer at Force Headquarters is linked directly to a number of V.D.U.'s in the central control room and by 2400 band leased telephone lines to V.D.U. terminals in each station deploying foot and mobile patrols (Fig. 3). The computers used are quite small having typically 200 K bytes of core store 5-10 megabytes of disc store, 3 or 4 magnetic tape drives and of course the use of peripherals for input and output.

The basic system provides two facilities, that of Incident Handling and Resource Availability. Normally each controller's console in the central control room has identified facilities and a controller can receive calls from the public, dispatch resources by radio and have dialogue with the computer via a V.D.U.

On receiving a call for assistance at the central control, for example, the controller types in details of the incident and any action taken on an incident proforma. On entry of the location of the incident it is automatically sent to the relevant local station. Figure 4 shows how it appears on a V.D.U. in a Birmingham sub-division. You will notice that the bottom half of the screen is taken up with a resource display. If necessary the most appropriate resource is selected and the controller contacts the resource by radio and inputs details of his action on the log. The incident is shelved until any further action is required or the results are known. The incident is accessible by either party at any time to add to the log.

In addition to a V.D.U. in each local agency there is normally also a teleprinter and the teleprinter network is integrated with the computer system to provide hard copy as well as an additional input to the computer (Plunkett 1976). A facility which has become almost standard on CTC systems is a link with the National computer. This makes the National facility much more readily available to the patrolman. Resource availability information not only appears on the incident log but can also be retrieved in a number of different formats to meet different needs e.g. all resources of a given type in a given area. I will mention a little later how this information is input.

These are the basic facilities provided by U.K. Policy dedicated computers but a whole range of new applications are not being actively investigated and the most interesting areas are shown in Fig. 5. That then is the background against which we are attempting to use the information provided by such systems to make more effective use of our Police manpower.

	Birmingham	West Mids	Glasgow	Strathclyde	Stafford	Suffolk	Dorset	West Yorks
Incident Handling	✓	✓	✓	✓	✓	✓	✓	✓
Message Switching		✓	✓	✓	✓	✓	✓	✓
Resource Availability	✓	✓	✓	✓	✓	✓	✓	✓
Street Index		✓	✓	✓			✓	✓
Cartographic Res. Disp.			✓	✓				
P.N.C Link	✓	✓		✓	✓	✓		✓
Crime Recording			✓	✓	✓		✓	
Duty State					✓		✓	
Local Indexes					✓	✓	✓	
LA Link							✓	
Arrest & Process							✓	
Accident Recording							✓	

Figure 5

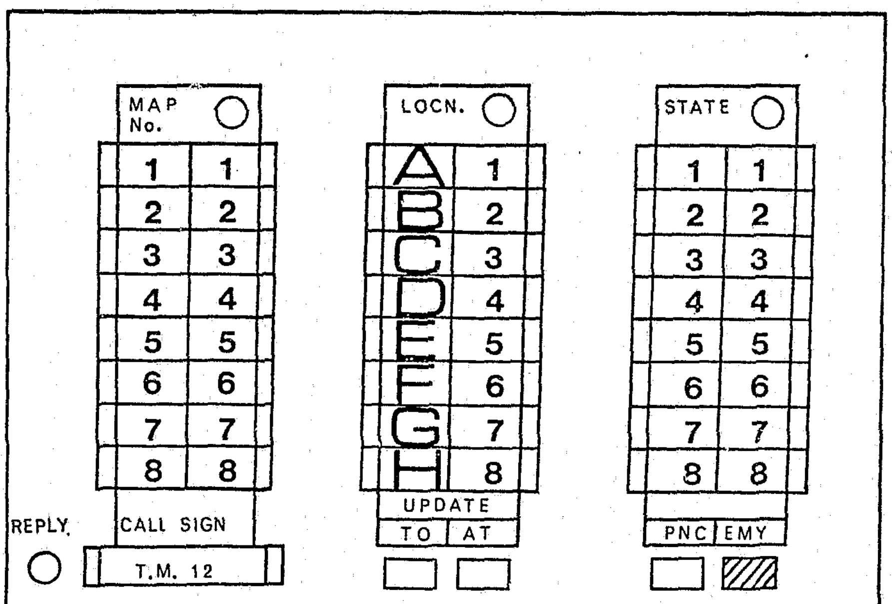


Figure 6

OPERATIONAL USE OF LOCATION BASED INFORMATION

Mobile digital communication

Considerable use is made of mobile digital communication to input status and location information in real time to computer aided dispatch systems whithout the need for manual intervention by controllers. Although two-way data transmission and the use of the full range of mobile terminals is being investigated the trend has been towards simple one-way data transmission deviced. These are relatively cheap, say 300 Pounds or $550, and therefore can be used widely. A typical force is planning to have every V.H.F. vehicle fitted with such a device. At the last count 13 forces were using encoders with a further 12 in the process of implementation.

A typical encoder is shown in Figure 6. This particular device has been operational in Glasgow since 1975, status and location information is input using button switches of the latching type. The first double row of eight buttons allows the input of 64 different map numbers. In Glasgow the area covered by the cartographic resource display system requires only 17 maps each representing an area of 12 x 6 km. The next double row of eight buttons allows for the input of up to 64 locations per map. The Glasgow maps have 32 grid squares on each map. Therefore, if required, a further 32 special locations e.g. Police Offices or road block positions could also be input.

The third double row of eight buttons allows for 64 status codes to be input. The information set up on the switches is transmitted to the computer by pressing the button marked 'TO'. When this button is activated the reply light comes on. When the computer has received and satisfactorily decoded the transmission, a signal is sent back to the unit which extinguishes the light.

<u>Callsign</u> In order that the computer may correctly identify the resource transmitting the information the radio callsign of the resource in coded form is prefixed to the data. This is achieved using a small binary coded plug-in cord which is inserted in the front of the unit.

<u>Arrival at an Incident</u> When a resource is dispatched to an incident a record of that deployment is made on the incident log stored in the computer. The status of the resource is changed automatically to correspond with the code of the incident to which it has been committed. En route to the incident the resource is not required to update its location. On arrival, however the resource is required to infrom the computer of its arrival. This is done by pressing the button marked 'AT' which tells the computer that the resource is now at the location of the incident to which it was last despatched. This fact in the form of the time of receipt of the arrival signal is recorded in the incident log.

Pressing the P.N.C. button causes an audio visual indicator to operate in the enquiry unit to indicate that a particular resource wants to make an enquiry of the national computer.

The EMERGENCY (EMY) button may be used by a resource to indicate that urgent assistance is required. Pressing the button causes an audible alarm to sound in the control room and the callsign of the resource on the status board is made to flash. The implementation of this facility provides an incentive to crews to keep their location information up to date since it is possible for the computer to provide to Force Control the last location transmitted.

Personal Digital Communications

An evaluation of personal digital communication is being carried out by the Directorate of Telecommunications in the Dorset & Bournemouth Force to establish the usefulness of this facility. Although the prototype being evaluated is larger than the production version would be, results obtained so far are encouraging.

Cartographic Resource Displays

A considerable amount of work has been done in conjunction with Ferranti Ltd. in the development of cartographic resource displays. These displays enable operators to see displayed on a map the availability and approximate location of selected Police resources in the neighbourhood of an incident requiring Police presence.

There are eight identical consoles in the Strathclyde Policy H.Q. In addition to the usual radio and telephone facilities each console has a normal visual display unit for incident logging and information retrieval etc. on the right and a cartographic display operates independently and thus up to eight different displays and may be produced simultaneously.

The display is produced in two parts. Firstly, there is a background of a coloured map of an appropriate section of the city. The map appropriate to any specific location is chosen by the computer in response to location details typed in by the operator. The maps show an area of either 6 x 3 km or 12 x 6 km and are divided into $1\frac{1}{2}$ km grid squares (Fig 7).

The second part of the display is alpha numeric. The location of the incident in question may be shown on the display by a flashing symbol located in the correct position relative to the map background.

Also displayed are the radio call sign and status code of selected Police resources in the vicinity of the incident. This information is displayed in the relevant grid square. In this example TMS is the callsign of a traffic car and the code 4.2 indicates that it is double manned, on patrol and available.

Accuracy of Displays

Inaccuracy of displays on the rearport V.D.U.'s arises from two sources. (Brett 1975, a, b). Firstly there is an inherent inaccuracy deriving from the physical construction and operation of the display system. Secondly, the data displayed on the screen may be erroneous since vehicle crews manually input details of their location and availability and also because after a cartographic display has been called to a screen vehicles shown on that display may change their position and/or status and such changes will not be indicated on the screen until the display is requested again. Even if the inaccuracies could be reduced to negligible proportions, the location of the vehicles would still be shown on the display as being anywhere within a square with 1.5 km sides. However, as yet, it has not been established on a cost/effectiveness basis, that there is an operational requirement for more accurate system.

Inherent errors in the displays caused by the method of photographing and mounting the slides have been reduced to a level which is unlikely to be bettered significantly to affect the operational decision made by controllers. Vehicle crews appear to be quite capable of inputting status and location data to give virtually 100% correct status information and locations which will be correct in about 90% of cases for 1.5 km location squares. Failure to adopt correct procedure may, however, reduce the level of location accuracy considerably to around 50% correct.

Delays in utilizing information once it has been displayed may lead to further error. In future systems consideration is being given to automatic refreshing of displays either after each update is received or on a regular time basis, say every 10 seconds.

Use of Cartographic Displays

In our initial evaluation (Hughes 1976) of resource displays in Glasgow it was found that the use of the cartographic display appeared to vary with the shift, from use in about 50% of incidents to essentially all incidents, according to the time of day. In the main the cartographic displays were used prior to dispatching a resource, though in some instances reference was made to the display after taking action. Although on the other hand it has been found that the status board was consulted prior to taking action on virtually every incident and could be regarded as the main source of information regarding current resource deployment.

During the initial implementation, both the street index and the resource location system were subject to frequent error and the cartographic resource display was then unreliable. Therefore controllers formed the habit of not using their displays a habit which has tended to persist with some controllers. This serves to illustrate a general point with which I'm sure you're all familiar. It is of great importance when introducing a system such as a command and control system to ensure that all parts of the system function correctly and at the outset otherwise 'short-cuts' which may later

Figure 9

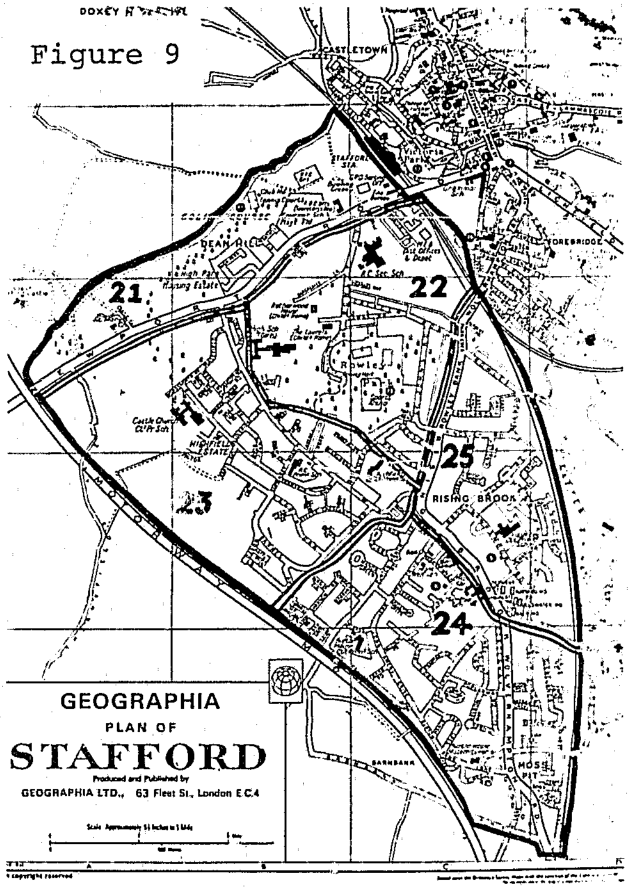
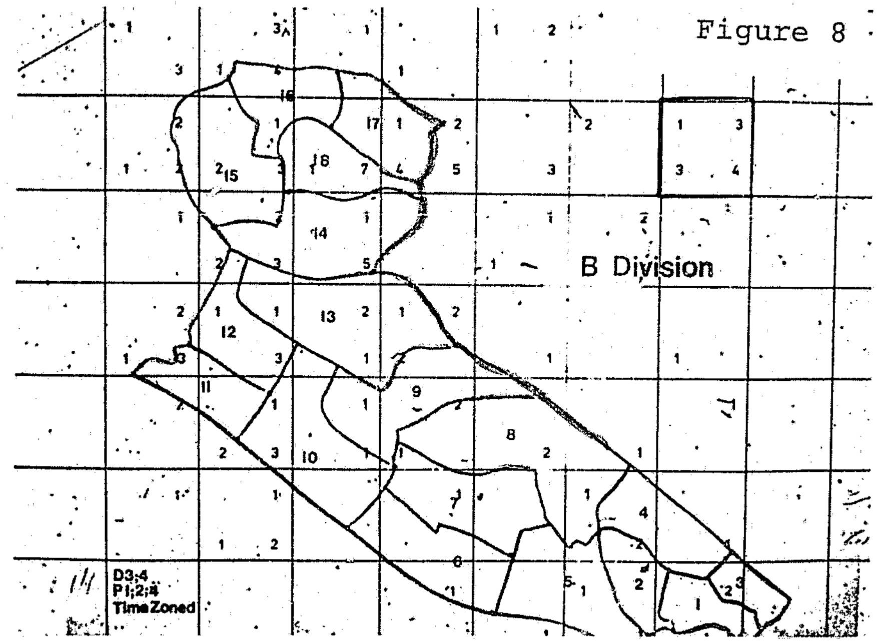


Figure 8



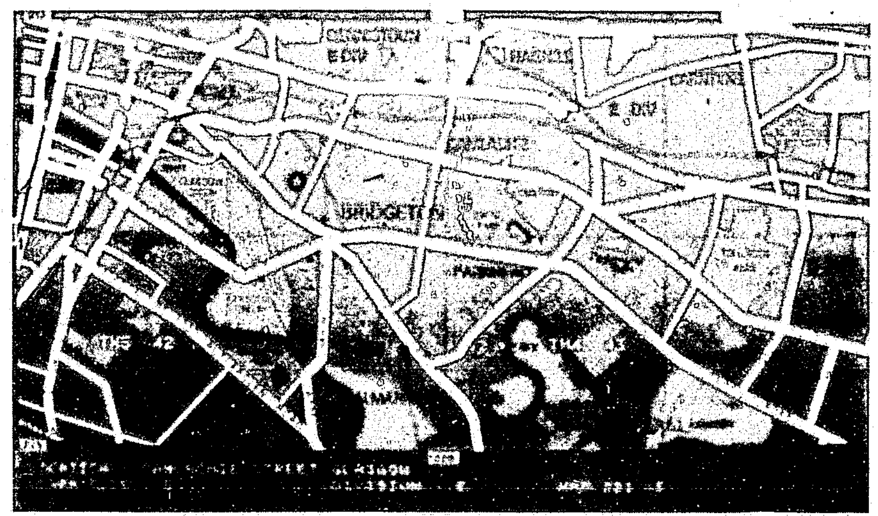


Figure 7
(Original in Color)

become difficult to eradicate are developed to compensate for non-functioning elements.

MANAGEMENT USE OF LOCATION BASED DATA

I think it is fair to say that we in the U.K. are at a very early stage in the development of location based information for Police Management. This first management information system (MIS) which could be called a complete package went live in April 1976 in Glasgow (Blessed and Bailey 1975). This system is produced by the dedicated computer in the Force Headquarters and is totally independent of outside agencies with software prepared in-house. The Glasgow Management Information System is based on incident logs, crime reports, status changes via V.D.U.'s and status changes via mobile digital encoders (CYFAS). The system produces lists, analyses and maps on a daily periodic or on a request basis.

Figure 8, shows a typical map of a Division in Glasgow. It is produced by overlaying an acetate map on ordinary line printer output. The map shows beat boundaries and kilometer grid squares and is manually traced from an ordnance survey map. The figures appearing in each grid square relate to crimes/incidents etc. occurring within that square in a given period. This particular map is an example of an incident map and is produced daily for Divisional Chief Superintendents and Chief Inspectors (Operational). It indicates the total number of incidents occurring in a Division during the preceding 24 hours. The top left figure in each grid square relates to the period 0600 to 1400 hrs., the top right to 1400-1900 hrs., the bottom left to 1900-2300 hrs. and the bottom right 2300-0600 hrs.

Similar maps are produced which show the weekly incidence of a selected crime or crimes by crime classification, and the daily incidence of selected occurrences over the proceeding 24 hours, 7 days and 28 days.

Evaluation of MIS

During November and December, 1976 the effectiveness of the total MIS package was evaluated by a group of operational officers and scientists. The group interviewed many users of the system and submitted a comprehensive assessment of the package.

The main findings of that evaluation was that the original system was not being utilized to the best advantage. The main reasons were found to be firstly lack of interest and a reluctance to adopt new methods; secondly lack of knowledge among those interviewed as to what information could be gleaned from the system and how to retrieve it; and thirdly some senior officers felt that the information was incorrect. The evaluation included a crude utility analysis (Farr 1976) using an approximate weighting factor for each decision level and an estimated usefulness of each report in the package from a cross-section of the Force. The analysis produced both potential and actual utility of each management report.

Following this evaluation the MIS package has been amended and a more comprehensive training program initiated.

Our experience so far suggested that the gestation period from the implementation of a given management package to the effective use of that package appears to be longer than a year and could possibly be of the order of 2-3 years.

Location Basis of MIS

Both the Glasgow and Birmingham Management Information Systems are based on grid references for the location of incidents, crimes, and Police activity. This method has been found to be suitable for dense urban areas and ideal when incorporating such devices as cartographic resources displays. However, the method has limitations when it is applied to Forces which include large rural areas. In this type of environment, readily identifiable areas (RIA) or geographical atoms, as you may call them, are then preferable.

Unfortunately, or fortunately, our towns and cities are not very geometric. Therefore R.I.A.'s cannot be neat groups of blocks of houses with parallel sides but of necessity must be irregular areas which are bounded by major features such as motorways, rivers, railway lines etc. They are chosen because they are naturally distinct areas from the point of view of the occurrence of incidents, crimes and patrolling activity. Figure 9, shows part of a typical town divided into RIA's. One county force hopes to produce its maps by digitising the outline of the RIA's and the major features and to superimpose the crime, incident and activity figures using a graph plotter. Since patrols are allocated by beat, which can be a whole number of RIA's or atoms, this seems to be the obvious basis for monitoring incidents, crime and police activity in this type of environment. In addition, it is easier for resources to input their location by area rather than grid references. There is now a trend to the useage of RIA's in computer based MIS systems, at least in the county Forces (Turnbull and Chapple 1975). However,I must report that at least one large Metropolitan Force is going to adopt both grid references and R.I.A.'s.

I would like to end by mentioning a line of research which we only embarked upon about 6 months ago. It is an attempt to relate occurrence of incidents and crimes collected by a Command and Control system in a given area to the demographic characteristics of that area, i.e. rateable value, average earnings social standing, average age. It is too early to report any meaningful results but one of the major problems has been to collect the social data on the same location basis as incident, crime and traffic data. Although the police areas are contiguous with Local Authority boundaries, there the similarity ends at the moment. However, there are moves within Local Authorities to produce geographically based files of all major social and geographical items which will be of enormous value to this line of research.

REFERENCES

1. BLESSED, S1, and Bailey. S., 1975
Management Information System Model 1- User System Specification
H.O., P.S.D.B., Tech. Memo. 39/75.

2. BRETT, R.J. 1975 a
Accuracy of Vehicle Location Displays
Home Office, P.S.D.B., Technical Memo 18/75

3. BRETT, R.J. 1976 b
Glasgow Project - A Study of Alignment Errors in Cartographic Resource Displays, H.O. P.S.D.B., Tech. Memo 24/75

4. BURROWS, A.T. 1971
Progress Report From Birmingham, H.O. Police Research Bulletin No. 18.

5. FARR, T.H. 1976
Towards an Evaluation of a Management Information System
H.). P.S.D.B., Research Note 3/76

6. HARWOOD, J and BROOME, R. 1972
Birmingham Command and Control Project and it's Use for both Operations and Planning H.O. Police Research Bulletin No. 20

7. HOLT, A. and LEE, M.J. 1970
A Study of the Policing of Areas with Low Population Density
The Inst. of Management Sciences XVIII - International Conf. 1970

8. HUGHES, K.A. 1976
An Initial Evaluation of the Resource Displays in the Strathclyde Police Command and Control System
H.O. P.S.D.B. Tech. Memo. 15/77

9. PLUNKETT, C.J. 1976
Teleprinter Network Evaluation Study Incorporating Computerised Simulation of Various Typical Teleprinter Networks
H.O. P.S.D.B., Tech. Memo, 28/76

10. TURNBULL, G. and CHAPPLE N.L. 1975
The Staffordshire Project - A County Police Computer Experiment
H.O., Police Research Bulletin No. 26

DISCUSSION

D.R.F. TAYLOR: We are interested in your basic special unit concept and in the difficulties you are having using grid references by themselves. I wonder why, in the U.K., so little attention has been given to the possibility of using segment inputs. For example, I know that you are experimenting with this in St. Helens using a segment approach which would follow the motorways, the rivers and the railway lines. This should in many ways be a more natural system for your information than the awful grid system you seem to be attracted to. I wonder if you would like to comment on this.

G. TURNBULL: As I intimated toward the end of the talk, I think we are moving towards the segment idea. However, I think we have probably been constrained by technology in the early stages, because it was easier for technologists to use the grid system. I think now the chance of using the segment approach for this sort of incident or other social factors is better, but I agree with you entirely.

47418

C.A.D.R.E.

COMPUTER AIDED DISPATCH AND RECORDS ENTRY

W. Harvey Brodhecker

Ontario Police Commission

Background

In late 1974, the Technical Services Branch of the Ontario Police Commission was approached by several police forces with a view to automating their communications centres. It was decided that certain standardization may reduce costs in this area and therefore a study was initiated and funded by the Ontario Police Commission.

Ontario consists of two large forces - Metropolitan Toronto Police Force and the Ontario Provincial Police Force. Because of their size and unique policing responsibilities, these forces were not considered candidates for standardization. Instead the next size of force and municipality was identified. These were municipal or regional forces varying in size from 180 men to 610 men and policing populations from 112,000 to 414,000 respectively. The municipalities identified were, Durham Region, Halton Region, Hamilton-Wentworth Region, London, Niagara Region, Ottawa, Peel Region, Sudbury Region, Thunder Bay, Waterloo Region, Windsor, and York Region.

Early in 1975 the CADRE project team was established and given a mandate to study the requirements of the major police forces of Ontario and produce a report outlining their requirements. This multi-discipline team consisted of sworn personnel from six of the larger police forces as well as data processing and radio communications specialists.

Purpose

My presentation today will consist of a brief overview of the requirements as identified by this project team. If you wish more detailed information I suggest you obtain a copy of our functional specifications. To do this you will have to make an official request in writing to the Chairman, Ontario Police Commission, 25 Grosvenor St., 9th Floor, Toronto, Ont.

I should also mention that the CADRE Functional System Description has been approved by the Advisory Committee on Communications and Technical Services (ACCTS) meeting of April 29, 1976 as the standard for development within medium sized forces in Ontario.

Study Approach

The study started with an "ivory tower" design. The purpose of this design phase was to familiarize the police personnel with computers and communications, and the specialists with the realities of police work. This phase identified the magnitude of the system and helped the computer people realize the potential computers have for application in the police community. A decision was made at this point to also include local records entry within the study and acronym CADRE was born.

The next phase was a series of visits to some 19 places which had implemented parts of what we envisaged within a CADRE system. We saw successes and failures but we noticed one major lack. There was no overall plan of development. In fact, certain forces found themselves unable to economically bridge the gap between their CAD systems and their records systems.

After the trips, the team put together their system design. The first step consisted of identifying and describing the major functional areas in a police force and attempting to determine an ideal hardware utilization in each of these areas. The second step consisted of a detailed analysis of each area. This analysis was performed in isolation as well as in relation to other functional and performance requirements of each area, in sufficient detail to produce descriptions of message, file and report contents. This phase produced the functional specifications. A third step evaluated other items such as costs, industry supply and service capability, police community reactions, tendering options, and liaison.

System Objectives

Many systems objectives were identified. One of the most important from our point of view was that the system had to be modular and capable of phased implementation. As a minimum, the following three modules were identified (Data Base Access to CPIC, Local Records, and Dispatch/Status/Complaint Entry).

CADRE Overview

The CADRE system for municipal police forces in Ontario is composed of computer and radio communications hardware and software designed to provide each police force with:

- Records Entry and Local File Management capability
- Statistical and Management Reporting facility
- Direct data base query capability from the field as well as locally
- Computer Aided Dispatch facility

To achieve these objectives, each police force will be equipped with a computer system under their own control.

A number of CRT/keyboard terminals, as well as hard copy printer terminals, are provided in each of the functional areas of the police force. The functional areas are data entry and query in the records area; complaint entry, dispatch and supervisory in the communications centre; information desk; remote division; and criminal investigation, administration, youth etc. in the special divisions (See Figure 1).

The computer system itself is connected by telecommunication's lines to each of the remove divisions or precincts within the police force and to the national data base in Ottawa (CPIC).

In addition, each of the field units are equipped with mobile terminals connected to the computer system by means of a digital radio communications link. The mobile terminals have a visual display screen and full alphanumeric keyboards with a number of special function keys for entering status changes and the most common query types.

The CADRE system is designed to support a number of local files. These files will be created and maintained from the normal reports and documents currently in use at all police forces. The computer system is designed to capture the main classification and statistical data from these documents and to provide a rapid and efficient indexing facility for retrieval purposes. No attempt is made to completely replace the manual files in that no narrative text is entered. Sufficient data is captured to enable the system to produce the required statistical, management, and operational reports.

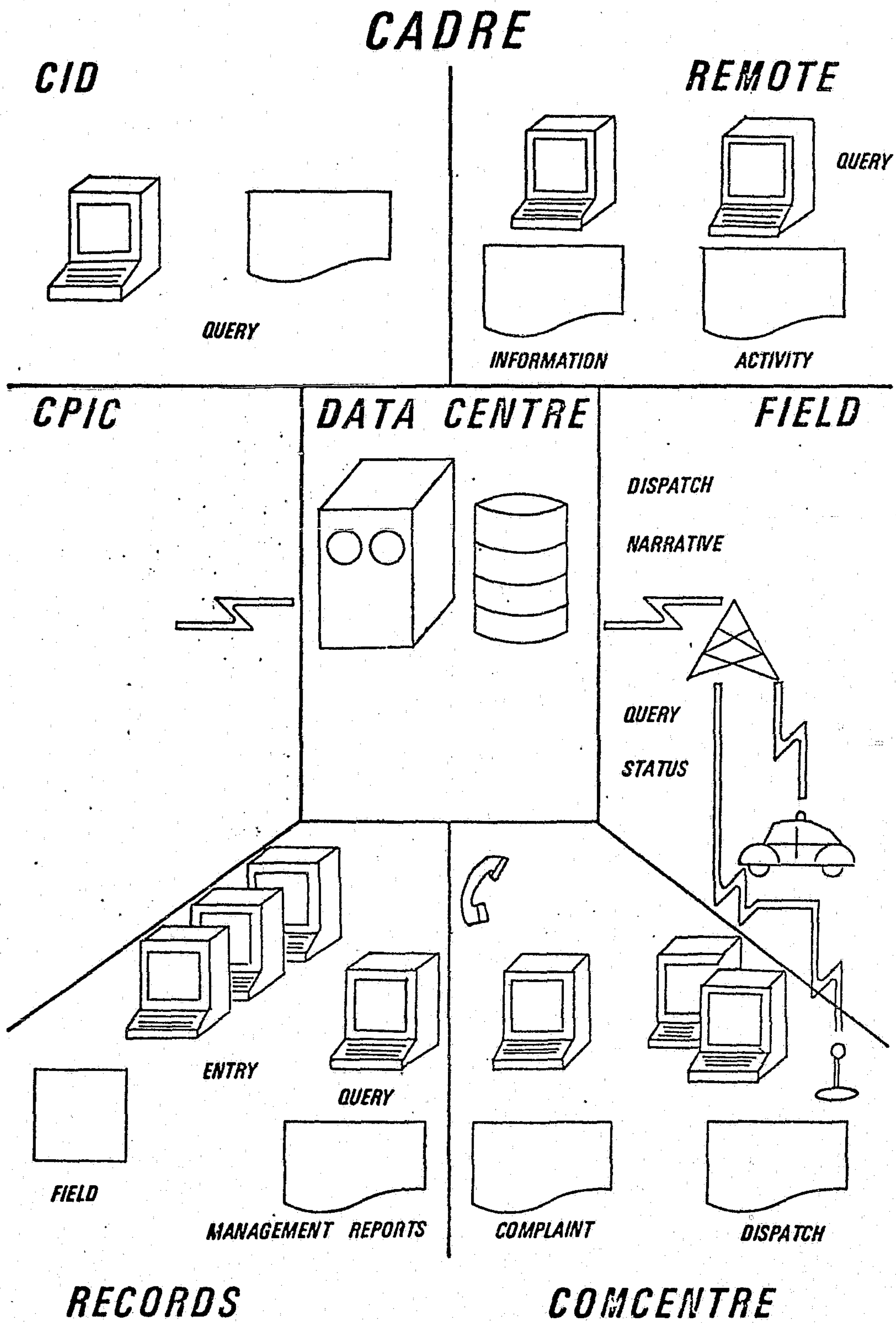

CADRE
CID
REMOTE
QUERY
QUERY
INFORMATION
ACTIVITY
CPIC
DATA CENTRE
FIELD
DISPATCH
NARRATIVE
QUERY
STATUS
ENTRY
QUERY
FIELD
MANAGEMENT REPORTS
COMPLAINT
DISPATCH
RECORDS
COMCENTRE

Figure 1

The Computer Aided Dispatch (CAD) component of the system consists of facilities which are provided to the Complaint Taker and Dispatcher positions in the Communications Centre. These facilities are designed to provide support for field units and to expeditiously handle calls for service from the public and to dispatch field officers to service these calls.

Special query functions will be provided which will be used by the special division within a force. Also the remote division will be able to maintain status of its vehicles and have query facilities.

Data Centre

The data centre consists of two central processing units. These are provided with each system to provide back-up facilities if the primary unit fails for any reason. In addition, the system is equipped with the normal computer peripheral units such as magnetic tape units, direct access disk storage devices, printers, etc. These are mini-computers and not large mainframes.

Records

The following local files have been pinpointed for automation. The incident file records are generated as a result of a call for service by the public. This is the only file which is not updated through the data entry function but is created directly as the events take place in the communication centre. An occurrence report results from an incident deemed worthy of a report or an event which an officer encounters that he feels should be reported. Motor vehicle collisions are reports submitted following investigation of motor vehicle accidents.

A criminal record consists of information about individuals who have committed criminal offences (serious crimes). The night listing file contains information about businesses which are checked at night by the police to ensure that they are secure. The observation file is a file of suspicious people. The firearms registration file exists only at forces empowered to register firearms. A file consists of summons and S.C.T's. Offences falling under the Summary Convictions Act include provincial statutes and municipal by-laws. Some forces in the province register bicycles. BOLO means Be On the LOokout for and is essentially the source of daily bulletin type information in a police force.

Data Base Access

The system is designed so that any terminal can be given the facility to access the data base. This includes local terminals in the force or in car terminals in the field.

The facilities that can be assigned to these terminals by transaction type are local file query or CPIC query. Within the local files, access within a specific file by its keys is allowed. The most common local file searches will involve one of the three major indices across all files. These are a name index, address index and licence number index.

A security system has been devised which allows a police force to provide the following limitations on system areas.

1. Certain terminals can be restricted to specific functions only.

2. Certain terminals can be restricted to specific personnel only.

3. Certain functions can be restricted to specific personnel only.

Even with all these facilities the need for a special type of query was identified. A standard input format for a special query would be invoked. A file name or code would be entered along with a list of access criteria. Commas between elements indicate "OR" conditions and new lines indicate "AND" conditions. Two types of output would be produced, a summary output or detailed output.

Complaint Taker

The complaint taker's responsibilities are:

- Answer calls for assistance from the public

- Evaluate calls for assistance and decide what action should be taken in response

- Give advice where it can reasonably satisfy the needs of the caller. (Up to 2/3 of all calls can be handled in this manner.)

- Determine priority of calls for service

- Expedite transfer of pertinent information to Dispatch position and thence to field units

- Provide information and service support (Tow trucks, Ambulance, Special units) for Dispatcher.

As calls for service are received, the pertinent information is entered into the computer by means of a CRT/keyboard terminal. The system will access local and CPIC files to perform:

- Address Verification and Hazardous Location Check

- Name Checks

- Street to Beat assignment

The completed incident information is then automatically transferred to the appropriate Dispatcher. Incidents can be recalled and remarks added by the complaint taker such as Tow truck or Ambulances called, etc..

Dispatcher

The dispatcher's functions are:

- Expeditious dispatching of calls for service as determined by the Complaint Taker.

- Determination of which unit or units will respond to the call for service by:
    - priority assignment
    - unit availability (status)
    - type of incident

- Co-ordination of field units in a manner that optimizes effectiveness as reflected in force policies.

- Monitoring and maintaining status of all field units.

- Keeping management informed of major incidents on a real time basis.

- Providing other types of support for the field units as required (e.g. queries, services, etc.)

The Dispatcher is provided with a continuously updated display of the status of all units in his area of responsibility. As he receives the incident information, he selects a unit, assigns it to the incident, and transmits the data to the field officer by digital and/or voice radio transmission. As units are dispatched and subsequently cleared, the status display is updated to reflect the new status.

Certain functions are time dependent in the system. One example is the stop/check. An officer, when performing a stop/check will push a stop/check status button. This will start a timer which if not cancelled by the officer will raise an emergency condition with the dispatcher. An emergency button is also supplied on the mobile terminal.

Field Support

The patrolman will be equipped with an in car terminal. The following are some of the functions which these mobile terminals can perform. When an officer signs on/off he can enter administrative and activity information. Certain status change buttons are supplied for "EN ROUTE, AT SCENE, IN SERVICE, STOP CHECK, BUSY, EMERGENCY, OUT OF SERVICE". An officer can receive incidents and incident summaries. The main purpose of the terminals is the query facility to local files and CPIC.

Management and Statistical Reports

Since most of the operational and administrative functions of the police force will, to a certain extent, be computerized as a result of the CADRE system, a great deal of information will be easily available for the production of various statistical and operational reports. The CADRE system provides for a number of basic reports. It is the intent that the requirements for additional reports will be determined by the individual police forces once actual operational experience has been gained.

In particular, the system will provide management with reports and information in the following areas:

- Personnel and Equipment

  A number of file listings and exception reports highlighting such items as vehicles due for service, personnel reviews and skills.

- Statistics Canada Report

  The monthly statistical report required by Statistics Canada.

- Crime Statistics

  A number of analysis reports based on crime occurrences. Breakdowns are provided by type, patrol zone, hour of day, and day of week. These reports are designed for planning and tactical purposes primarily.

- Incident Analysis

  A number of analysis reports based on the data collected from the calls for service. Breakdowns are again provided by type, patrol zone, hour of day and day of week. Additional statistics are provided on the number of times that the prime unit is able to answer calls for service by type etc. These reports are designed primarily for manpower, workload and patrol zone planning.

Additional operational reports are provided for control purposes.

Remote Divisions

The function and use of remote locations is by no means standardized from one region to the next or within a region for that matter. In some cases an attempt has been made to contain complete functional areas by locations (e.g. Records section in one building and Administration section in another). In other instances the remote locations are limited to operational divisions within the police force.

From a system and operational viewpoing however, all of the terminals are designed to function in an identical manner. Any restrictions placed on the use of the terminals will be an administrative function rather than a technical or system limitation. In other words, any or all functions provided by the CADRE System can be performed from any terminal if desired.

The typical functions to be provided for the remote locations are:

- Information Desk Facility
- Inquiry Function
- Activity Log

Satellite Police Forces

It will be desirable if smaller forces surrounding a major force could use some of these facilities. The modular design of the CADRE System from both hardware and software viewpoints permits the installation of terminals in any location. The design also provides for easy separation and identification of files. The provision of the CAD facilities are more difficult from a technical and practical standpoint.

Future Development

Currently the CADRE system has been used as a base for tendering a system for the Ottawa Police Force. Implementation will be done in phases. It is expected that the implementation of the full CADRE in Ottawa will take two years.

DISCUSSION

K.R. COCKE: Will the Ontario Police Commission be assisting financially in the implementation of CADRE?

W.H. BRODHECKER: Not in this fiscal year.

S.W. WITIUK: I understand they were assisting Ottawa with resources.

W.H. BRODHECKER: They are giving them people to look after things. We actually asked for funding from the Provincial government to purchase software for the City and also for assistance in purchasing hardware. We got turned down. The Ontario government is under severe budget restraints.

V.M. DAVIS: Can you give me an estimate of your costs?

D.G. LYON: About $2 million for Ottawa, for the whole thing.

K.R. COCKE: How do you think your system differs from those, say at Dallas, Jacksonville or Daytona?

W.H. BRODHECKER: One of the problems in the United States is that the US systems - and I don't mean this in a derogatory sense - developed a very fragmented approach. There was a large influx of money and, as a result, they did not necessarily do adequate analysis on the front end, and have ended up painting themselves into a corner. Some examples were people automating their communication centres. Now when they want to change their records system and to cut corners technically, it is going to cost them a lot of money. One of our objectives was to ensure that this wouldn't happen in Ontario.

W.J. BROWN: Has the duplication of effort between what you and the RCMP are doing ever been studied?

W.H. BRODHECKER: We have been closely involved with the RCMP. I wouldn't say that there is any duplication of effort. The RCMP know what we are doing and vice versa. Input from the RCMP included rough copies of their documents and were submitted from the start for Ontario functional specifications.

G. TURNBULL: Once the contract is written will it be directly usable for subsequent systems or will it have to be tailored to meet local needs?

W.H. BRODHECKER: We believe that the software can be written so that it will be transferrable to most forces with minor modifications. Resource personnel can do them. In general the overall structure of the software can stand and major revisions will not be required.

M. WOOD: One question on feasibility comes to mind. What kinds of tests were performed, and were complete demand tests simulated?

W.H. BRODHECKER: If you are talking about loading capacity, we took a hard look at loading characteristics, so that the system will be able to handle the existing load in Ottawa without any problems. Given the computers, the methodology, and the fact that we are going to digital channels for Ottawa, we did not see a loading problem.

M. WOOD: Could the system be expanded to take in, say, Toronto?

W.H. BRODHECKER: No. There are definite problems with Toronto. The initial decision was made to leave Toronto out because of its size and because it is a unique force.

G. TURNBULL: You mentioned that some of the forces in the United States painted themselves into a corner. Could you elaborate on the problems they would encounter in adding records?

W.H. BRODHECKER: As an example, in the communications centre there may be a unique operating system which is resident in the computer. It may not be able to record a case, to get out information, or to transfer it to another computer.

4/74/19

IMPLEMENTATION OF A GEOGRAPHIC BASE FILE IN A COMPUTER-AIDED DISPATCHING SYSTEM FOR THE CITY OF BOSTON

LYNDON HOLMES

ADL Systems, Inc., Burlington, Mass.

Introduction

In 1975, a computer-aided dispatch (CAD) system was developed by ADL Systems for the City of Boston, Massachusetts. A geographic base file (GBF) is a key component of the CAD system. This paper describes the manner in which the GBF is used in on-line dispatching operations support, the problems encountered in implementing the GBF, and planned future enhancements.

The experiences described reflect real world experience; the viability of the approaches described has been validated by successful use of the CAD/GBF systems for more than a year.

Background

The City of Boston, Massachusetts, has a population of between 600,000 and 700,000 people, comprised of a broad mixture of ethnic groups. The city occupies an area of approximately 45 square miles, which includes the central city itself, and a number of neighboring communities, collectively known as Boston Metropolitan area.

The three public safety agencies within the city (Police, Fire and EMS) operate largely independently, under separate controlling agencies. A 911 emergency telephone system provides for the routing of all emergency calls to the central Police Communications Center. Police and EMS dispatch facilities are co-located in the Police Headquarters building; fire dispatching is carried out at a separate location, with emergency fire telephone calls rerouted on a "hot line" basis from the Police Communications Center to the Fire Alarm Headquarters.

For purposes of Police field operations, the city is divided into 11 geographic districts (commands), with each district being sub-divided into patrol sectors (between 2 and 15 patrol sectors per district). One patrol unit is assigned to each sector; in addition, a district will be covered by one or more wagons, along with patrol supervisors (Sargeants or Lieutenants).

Two major activities in the Communications Center support complaint handling and response unit dispatching:

- Up to 16 telephone complaint operators received emergency calls from the public, and enter all complaint data into the CAD computer system.

- Five radio dispatchers (each responsible for 2 or 3 districts) make dispatch decisions, control the activities of field units, and maintain the activity/availability status of all response units.

Description of the Geographic Base File

The GBF was developed over a period of several years, and was first used in a batch computer environment, to process and validate complaint location data. This period of use allowed the data in the GBF to be purified and enriched to the point that a powerful GBF now exists.

The GBF consists of two major files:

- A base file, containing one record for each street segment in the city. A street segment is defined as a single block face.
- A dictionary file, containing records for every street name, abbreviated street names, common street name misspellings, intersections and special locations. Special locations include churches, public buildings, schools and any other structure commonly known to the public.

The base file segment record (originally derived from a U.S. Census Bureau DIME file) contains the following information which is used in the CAD system:

- The range of street numbers on the block face (always odd or even, and generally spanning a range of 50 or 100 house numbers).
- The correctly spelled street name, including street name prefix (e.g., North, East, etc.) and the street name suffix (Avenue, Park, Road, etc.).
- The section of the city in which the street segment occurs. Boston has an uncommon problem that the same street number and street name can occur in multiple areas of the city. For example, 115 Washington Street exists in five different sections of the city. Each section of the city can, however, be identified by a unique geographic name, reflecting the growth and coalescence of the various communities that now make up the City of Boston.
- The Police district and patrol car sector in which the streets segment exists.
- An indicator as to whether the street segment falls within the jurisdiction of the Boston Public Housing Authority (special response units may be dispatched to complaints at these locations).
- The census tract and block numbers in which the street segment occurs.
- The police incident reporting area, used for the accumulation of crime and emergency activities statistics. Even though patrol sector boundaries may be redefined during a resource allocation activity, reporting area boundaries remain constant.
- State plane X-Y coordinates for both ends of the street segment. These data are not used in the CAD system at this time, but would be an essential part of an automated vehicle location system.

- Foot patrol unit radio call-sign. If the street segment is part of a designated foot patrol beat, the radio call-sign of that foot patrol is included in the street segment data record.

- A unique identifying number for the street segment, which is used as a pointer from a dictionary file record to the corresponding street segment record in the base file.

When a location name is entered into the computer system, the dictionary file is first searched to establish the type of location name entered, and to insure that a particular street, intersection or special location name does in fact exist. Four basic type of records exist in the dictionary file:

- Correctly spelled street names. A record exists for each unique street name in the city, complete with street prefix and suffix. The record also contains pointers (street segment record I.D. numbers) for each section of the city in which the street occurs. Thus, a particular street name may contain up to 5 pointers, representing possible multiple occurrences of the street name in different sections of the city.

- Commonly misspelled or abbreviated street name records. The misspelled street name or abbreviation is contained in the record, along with the corresponding correct or full street name spelling. This correct spelling is then used by the computer to access the correctly spelled street name dictionary record, and hence the appropriate street segment records.

- Street intersection records, consisting of the pair of correctly spelled street names. These records also will contain pointers to street segment records for as many multiple occurrences of the intersection as exist in the city.

- Special location name records. These contain pointers to the appropriate street segment record, and also contain the corresponding street number (if any) of the structure.

The computer-aided dispatch system currently provides complete support for complaint data entry, dispatch decision assistance, response unit status maintenance and historical data recording. A complete and versatile geographic base file is used as an integral part of the complaint-taking and dispatching activities.

In the near future, the CAD system will be enhanced to provide communications access to all district stations, and will provide enhanced functional capabilities, including access to local and remote (state and NCIC) information files.

Objectives of the Geographic Base File

The Geographic Base File enables the CAD system to provide both real-time tactical support to police operations; it is also the basis for substantial data analysis, used both for short-term crime analysis studies, and longer-term resource utilization and reallocation planning.

In a tactical mode, the GBF is used to validate all incident locations entered into the computer system. This assures that the reported location in fact exists, and also enables key geo-code data to be appended to the complaint data by the computer system. The district of occurrence is used to send the complaint information from the telephone complaint operator to the appropriate district dispatcher. The sector determination from the GBF enables unit dispatch recommendations to be made to the dispatcher by the computer, recommending first the assigned sector car for the sector in which the complaint occurred, plus units in adjacent patrol sectors.

Off-line analyses of incident data enabled the Department to analyze activity by district and patrol sector, by time of day, and by type of complaint. These data are used on a regular basis as input to a series of resource allocation programs, which result in periodic restructuring of sectors within each police district. Thus, as longer-term trends emerge in the frequencies crime and emergency service requirements in different parts of the city, the Department can reallocate field strength in an optimal manner.

Current Use of the GBF

This section describes the manner in which the Geographic Base File is currently used in the CAD system, and discusses some of the problems and shortcomings of the approach.

When a complaint operator enters an incident into the CAD system (see Screen 1) three key items of location information must be entered - the street number, the street name and the section of the city. When these data have been entered, the complaint operator depresses a special function key which instructs the computer to validate the street address, and if correct, append all appropriate geo-code data to the complaint record. This address validation occurs in a fraction of a second, and if any error is detected, one of a number of error messages will be displayed to the terminal operator. The address information may then be corrected, and reverified. If a misspelled name is entered, and a misspelling dictionary record exists, the correct street name will be automatically inserted by the computer. If the operator enters a street number and name, but omits the section of the city identification, the computer will:

- Automatically insert the section of city if the street exists in only one section of the city.
- Prompt the operator to enter a specific section of city if the street number and name exists in more than one section of the city (see Screen 2).

If a special location name is entered (e.g. Police Headquarters), the computer will automatically add the street number and street name to the address information (e.g., 154 Berkeley Street/Police Headquarters). The computer will also automatically display the district and sector of occurrence, confirming the successful completion of the address verification.

If address verification cannot be accomplished (for example, if a recently constructed street is not yet reflected in the Geographic Base File), the complaint operator may override the computer by determining a district of occurrence and entering this data (this allows the computer to send the complaint data to the correct district dispatcher).

Following the completion of complaint data entry, the computer automatically routes the complaint data to the radio dispatcher responsible for the district in which the incident was reported. When the dispatcher is ready to dispatch a unit to a complaint, the computer will recommend several response units for dispatch (see Screen 3). This recommendation consists of:

- A foot patrol unit, if the incident occurred at a location covered by a foot patrol, and if the foot patrol is an available and active unit.

INCIDENT ADDR- 1.NO *115* 2.STREET *WASHINGTON ST*
3.SECTION *DR* 4.APT 5.FLR 6.DISTRICT *3-2* 7.ROUTE
8.NATURE *MVACC* 9.PRI 10.SOURCE *CIV* 11.SERVICE RESPONSE? *P*
12.PHONE *555-1234* 13.VICTIM 14.CALLER *JOHN JONES*
15.CALLER ADDR *132 WASHINGTON ST DR*
REMARKS- 16. *3 AUTOMOBILES AND 1 TRUCK INVOLVED*
17. *POSSIBLE INJURIES*
18. *SPILLED GASOLINE - FIRE DEPT NOTIFIED*

- -

SCREEN 1. COMPLAINT FORMAT (Variable data are italicized)

```
                           ***A03 INVALID SECTION. CHOOSE MT HP DR

INCIDENT ADDR- 1.NO 115  2.STREET WASHINGTON ST
               3.SECTION   4.APT       5.FLR      6.DISTRICT      7.ROUTE
8.NATURE       9.PRI    10.SOURCE     11.SERVICE RESPONSE?
12.PHONE          13.VICTIM                         14.CALLER
15.CALLER ADDR
REMARKS- 16.
         17.
         18.


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

SCREEN 2. COMPLAINT FORMAT WITH UNDEFINED SECTION OF CITY

```
CC 12345678  REC'D ON 03/27/77  AT 08:15  BY 1234
ADDR: 115 WASHINGTON ST DR                                      DISTRICT 3-2
NATURE: MVACC  PRI: 1C  RESPONSE: P
PHONE: 555-1234  VICTIM:                    CALLER: JOHN JONES      SRC: CIV
CALLER ADDR: 115 WASHINGTON ST DR           ROUTE AREA: D           HOSP:
REMARKS: 3 AUTOMOBILES AND 1 TRUCK INVOLVED
         POSSIBLE INJURIES
         SPILLED GASOLINE - FIRE DEPT NOTIFIED

RECOM ASG. FOOT 3-51  H/A      CYCLE 3-21  CARS 3-2 3-4 3-1
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

SCREEN 3. DISPATCH RECOMMENDATION

- A housing authority unit, if the incident occurred in one of the Boston public housing projects.

- A motorcycle unit, if a motorcycle has been established as a dispatchable unit for this sector.

- Up to three sector cars. A patrol unit responsible for the sector in which the incident occurred will generally be the first choice; adjacent sector cars will be second and third choices.

This dispatch preference is established by a "dispatch preference list" which is defined for each patrol sector in the city. Communications center staff may update this preference list whenever necessary to reflect changing operational conditions. The computer will not recommend a response unit if that unit is currently assigned to another activity, or if the unit is not currently on the air.

The CAD computer maintains an on-line history of incidents for a period of approximately three to four days. While these incident data are maintained in the CAD system, access can be made to a specific incident or sets of incidents based upon certain descriptive information. For example, all motor vehicle accident responses that occurred in a particular time frame can be accessed from the incident file and displayed on an operator's terminal. The census tract and block geo-code information contained in the incident record is used to provide a proximity match on location data. For example, if an incident actually occurred at 50 Washington Street two days ago, the person requiring access to the complaint data may not remember the specific street number, but may know that it was in the 50's range. By entering any street number that is in the same census tract and block as the actual complaint location, the computer will extract and display all incident records which match on a census tract and block basis.

Numerous off-line reports are generated from the accumulated CAD complaint and dispatch data. These include reports showing activity by patrol unit, sector, district, reporting area, etc. They are used both for short-term analysis of responses and activity, and for longer-term strategic planning of patrol force redeployment.

The present implementation of the GBF has a number of short comings. Corrections, additions or deletions to the file cannot be processed directly on the CAD system. A series of programs on a large mainframe computer must be run to develop input files for the CAD/GBF. This occasionally causes a "no-find" situation to occur during the address verification process, for a street that is actually valid.

The approach used for the handling of misspellings is quite straightforward and efficient in terms of the use of various computer resources. In addition, a technique is used to develop a report of unfound misspelled street names, and the corresponding correct street name as finally entered by the complaint operator. However, the computer system does not provide any sort of listing of sound-alike names to the operator when a misspelled street name is entered. This could be accomplished by using various key-matching techniques (e.g., soundex). However, such an approach would

```
                           03 WARRANTS 04 FLAGGED DATA 09 FIREARMS
CC 12345678 REC'D ON MM/DD/YY AT HH:MM BY 123    VER 02 CREATED AT HH:MM BY 567
ADDR:27 MUNROE ST RX APT 10 FLR 3                                  DISTRICT 2-5
NATURE:VANDAL PRI:2A RESPONSE:P XREF/CC:54321987 MISCEL       VOID TO:
PHONE:727-4963 VICTIM:XXXXXXXXXXXXXXXXXXXX CALLER:XXXXXXXXXXXXXXXXXXXXX SRC: XXX
CALLER ADDR: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX      ROUTE DISTRICT: 14
REMARKS: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  HOSP:XXXX
         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
APT 2D   FLOOR 2      SIDNEY WASHINGTON        HOMICIDE    02/17/73  BR01245
RECOM ASG. FOOT XXXXX T/P XXXXX CYCLE XXXXX CARS 2-5 2-6 2-3 HOSPITAL XXXX
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

SCREEN 4. DISPATCH DISPLAY WITH HAZARD DATA

necessarily use much more of the computer resource, and also increase significantly the address verification response time. The use of manual street listing directories for the few occasions in which problems are encountered in street name resolution has proven to be quite effective and satisfactory.

Many streets exist with the same name but different suffixes (Street, Avenue, Road, etc.). When a street name is entered, the computer requires that the specific suffix be entered as well, so that a unique street name identification can be made. Quite frequently, the telephone caller provides only street name (e.g., 512 Washington) without identifying the suffix. The complaint operator must then make a judgement as to what suffix to use, or must ask the caller for the specific suffix. It is possible that some alternative dictionary structure could circumvent this problem.

Future Use and Enhancement of the Geographic Base File

The CAD system is currently being enhanced in a number of ways. These enhancements include:

- The incorporation of hazardous location data into the geographic base file. If a field report is submitted for a complaint, and the field report indicates a potential hazard at the incident location, the CAD computer will automatically generate a hazard indication for that location. Additionally, firearm registrations or outstanding warrants at a particular location will generate a hazard entry. When a complaint is subsequently received from the same location, the radio dispatcher will be alerted to the presence of this potential hazard (see Screen 4) and will be able to pass this information to the response unit.

Capabilities will be provided for the direct, on-line updating of the geographic base file. This will eliminate the present delays in maintaining the file, and will ensure the greatest possible accuracy in it.

Although no immediate plans exist for automated vehicle location, the state plane coordinate data contained in the geographic base file would be a key item in the development of such a capability.

The structure of the GBF would enable street number validation to be performed on an individual house number basis (as opposed to the current house number range validation). Although this would have significant operational value (e.g., it would avoid responses to vacant lots!), the cost of acquiring and maintaining specific house number data appears to be prohibitively expensive. Consequently, the Department does not plan to adopt this technique at the present time.

Conclusions

The geographic base file implementation in the CAD system at the Boston Police Department has proven itself to be operationally very successful. Accuracy of location information has increased substantially since the introduction of CAD/GBF. Since address verification is now performed at the point of initial data entry into the information system, the percentage of correctly geo-coded locations has increased significantly. The accuracy of location information also avoids attempted dispatches to non-existent addresses. The value of the CAD system to the Boston Police Department would be substantially reduced if a geographic base file had not been included in the system.

However, it must be recognized that a substantial amount of effort was involved in the creation of the geographic base file. This effort was required at:

- The technical level, to develop the procedures and techniques for creating GBF.
- The clerical level, in collecting, processing and editing data for some 35,000 street segments records, and 30,000 dictionary records.
- The field level, collecting special location information from department staff at the district level.

During the five years in which the geographic base file was developed for the City of Boston, a substantial amount of pioneering in the development and use of GBF was accomplished. The problems encountered and resolved by Boston are common to many cities. It would appear reasonable that these experiences could be of value to many other cities considering the development of a GBF, whether or not the GBF would be used in a CAD system environment.

47420

COMPUTER COMMUNICATION IN AN ON-LINE ELECTRONIC DATA PROCESSING ENVIRONMENT

K. R. THOMAS

Royal Canadian Mounted Police

Thank you for the opportunity to talk about a favourite subject, the Canadian Police Information Centre Communications Network (CPIC). At this session, I would like to give you some background information regarding CPIC, what its purpose is, what it does and how well it does it. However the majority of my talk today will be concentrated on the communications systems it employs.

Introduction

The Canadian Police Information Centre is an automated information system designed as a centralized data base serving all police forces of Canada.

This central data base consists of records contributed by all user agencies throughout the system. The data base files are organized as follows:

(1) Approximately 580,000 records on the person system file in categories:
- Wanted
- Missing
- Parolee
- Prohibited (from Firearms, Alcohol, Driving)
- Charged (with serious crime)

(2) 188,000 records on the vehicle system file with categories:
- Stolen
- Abandoned
- Connected to a Crime
- Stolen or Lost Licence Plates
- Pointer Vehicles, cross referenced to other data files in the system.

Records on this file include vehicle types such as trucks, motorcycles, trailers, aircraft, boats and boat motors as well as snowmobiles.

(3) The stolen property file containing some 316,000 records on three categories:
- Guns
- Securities (including money, bonds, counterfeits)
- Articles

This file contains records of property that are uniquely identifiable and, at present, covers everything from precious works of art to household appliances, from stocks and bonds to farm animals.

The records that make up these files are supplied and maintained by the agency or department that holds the original complaints in each case. Having once entered a record, that agency is the only authority permitted to alter or remove the record. However, any operational agency may query the files.

The Criminal Record Synopsis is a more recent addition to the system. This file contains approximately one million records.

However, it is maintained only by the RCMP Identification Services at Ottawa, but is available for query purposes to any operational agency. The file output contains a capsule version of an individual's criminal record complete with biographic and physical descriptors. Each record is supported by an associated dossier and fingerprint data.

Thus, the data base is an effective consolidation of police operational information on a coast-to-coast basis and its tactical advantages are realized many times a day. This is best illustrated by the growth of CPIC since beginning operation in July of 1972. There are presently 900 terminals connected to the system, generating over 7,000 messages in a peak hour and over 700,000 messages per week. The response times from the system is still maintained at under three seconds per query message. The growth has not stopped yet, nor do we anticipate any slowdown.

The Communication System

In order to successfully utilize the Data Base system, a communications network had to be designed to provide rapid service to more than 1,000 terminals spread across a country more than 6,000 kilometers long. This would include terminals situated in some of the more remote northern areas, as well as the densely populated areas of the southern portion.

Since each CPIC record is really only an abstract of a case file plus an index to the agency which holds the hardcopy file, a method of confirming the validity of each positive response with the originating agency was vital. It was, therefore, decided that a limited, fast response message switching capability had to be included in the initial design. This narrative mode presently accounts for 27 per cent of the traffic and has provided much tactical flexibility to the system.

It was desirable, due to the rapid response criteria, that each terminal be on or appear to be on, a dedicated line in order to avoid queueing/polling/ calling delays. The system had to be designed for a traffic load of 40,000 messages per hour and have an availability in excess of 99 per cent to all users based on 24 hours a day, 7 days a week.

If we terminated the lines at the "central" Host processor, we would be faced with enormous line costs, as well as using in excess of 90 per cent of the Host's processor power, just for communications protocol handling.

From these considerations, it was decided to have a "Front End" minicomputer located at Ottawa (the Host site) and eight regional minicomputer (or switchers) at strategic locations from coast to coast (Fig. 1). The Front End computer would be capable of terminating up to ten switchers over 4800 bit per second (BPS) full duplex lines, as well as two 370 computer interfaces to the host computer at approximately 90,000 bytes per second each. The Front End also accomplishes several other important tasks in the system:

(a) It provides for conversion from the ASCII character set, used by the communications lines to the EBCDIC character set used by the Host (IBM 370-168) and the reverse conversion system.

(b) It provides data to the Host on a single line - connected to a selector sub-channel of a multiplexor channel and, in fact, controls and times the transfers of data blocks. The Front End does not emulate a device such as a mag tape or disk. It is a discrete unit to the Host and special EXCP programming was done, in house, to accomplish this.

(c) It provides backup and recovery information required by the Host processor as well as the switchers.

(d) It removes the communication protocol handling from the Host Computer.

The switcher directly connects 80 terminal lines as well as four 2400 PBS Time-Division Multiplexors (TDM), representing 68 more terminals, for a total of 148 terminals (Fig. 2). One 4800 BPS line connects the switcher to the Front End. The terminal speeds range from 10 CPS to 30 CPS.

The TDM's handle 17 terminals each at 15 CPS and are directly terminated by the switcher. The multiplexing/demultiplexing is done by the software package. In 1971, we were warned against taking this approach because it was feared that it would take too much processing power and had not been tried before. However, we now find that this method, for the 68 TDM connected terminals, uses approximately 21 per cent of the processor compared to the 80 directly connected terminals which take approximately 44 per cent. The programming effort was not as significant as was at first feared.

Other benefits include lower cost. Only one TDM is required rather than the normal two, (one at each end of the line). Only one termination port on the switcher is required, rather than the 17 in the normal configuration. This was a major consideration, since in 1971 a minicomputer capable of terminating 148 lines or ports was very rare indeed. We did not know of any!

From the cost point of view this network has proved to be successful. Our average terminal is located 1300 kilometers from the Host site and costs $400 per month for equipment, service, lines, modems, time division multiplexors and switcher related costs, excluding personnel costs.

The medium speed (4800 BPS)line is truly full duplex and, through the use of ring buffers, up to eight segments of data can be transmitted before an acknowledgement is required. With this protocol, texts have proven that we can achieve a sustained efficiency of 88 per cent pure data, or 92 per cent if one considers the formatting and framing characters as part of the data segment.

The message data is segmented into 128 character blocks and forwarded as soon as the block is full. In this way, the communication delay is kept to a minimum and the message data is protected as soon as possible by the Host placing it on secondary storage. The Host processor builds the segments back into messages.

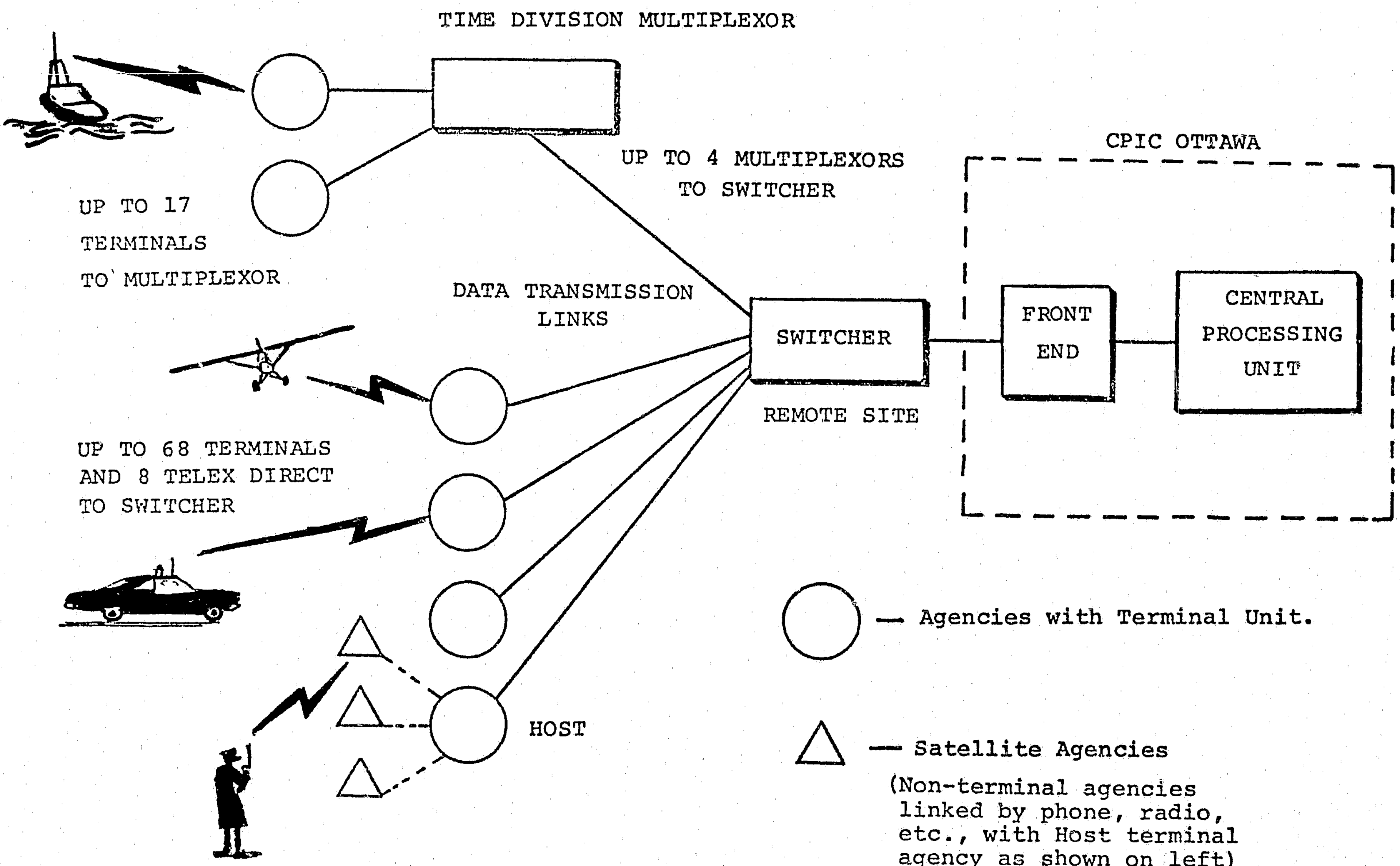


Fig. 1 CPIC System: Network Components

The switchers are manned 24 hours a day by trained operator/technicians who are responsible for operating, maintaining and repair of the computer as well as checking, testing and identifying line problems.

The configuration I have just described, has met our requirements for economy, efficiency, capacity and availability since coming on-line in July of 1972. As a point of interest, even though the switchers are not duplexed, or backed up, as are the Front End and Host Processors, the availability has averaged out at 99 per cent for the overall system.

Performing tests have been run against the Communication System and have demonstrated its ability to handle more than 50,000 messages per hour.

Problem Areas

While the current system (Fig. 3) is performing satisfactorily, we must look to the future and anticipate how long the system will last. It is time we took into account what we have learned from this system and applied those lessons to the next system. In running the performance test I just mentioned, we find that the Host Processor reaches saturation levels long before the communications system. We must somehow balance the workload better. The communications system should do all of the communicating and the Host Processor should apply itself, as much as possible, to the pure data processing/data base functions.

This I feel is a lesson we have learned; separate the Data Base processing from Data Communications. The Data Base has a separate processing requirement with large files, operating and Data Base Management Systems, Data Centre applications, and with more strict controls on any system changes. The Data Communications Network is a constantly changing system driven by demands for more terminals, different terminal types, higher speeds and other system interfaces. These are needs which can and should be met in a much shorter time frame than is possible on the Host Data Base Processor. Transaction loads tend to have less impact on the Communications System than on the Data Base Processor.

Even though the system has averaged 99 per cent availability, the data switchers, by not being backed up, are susceptible to one or two long outages per year. While I am sure that everyone here would agree that 99% availability should be more than satisfactory, we must look at

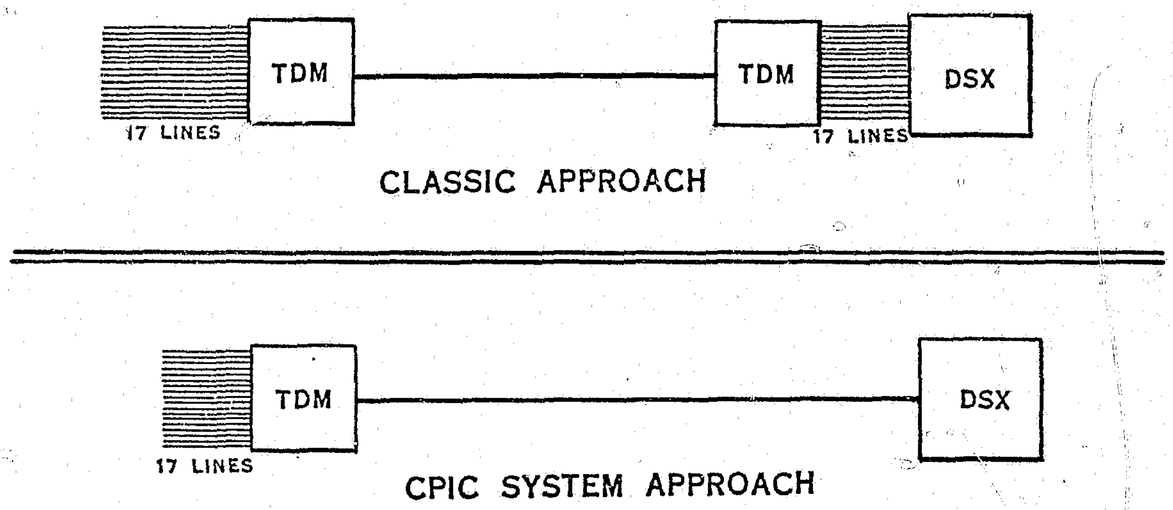


Figure 2

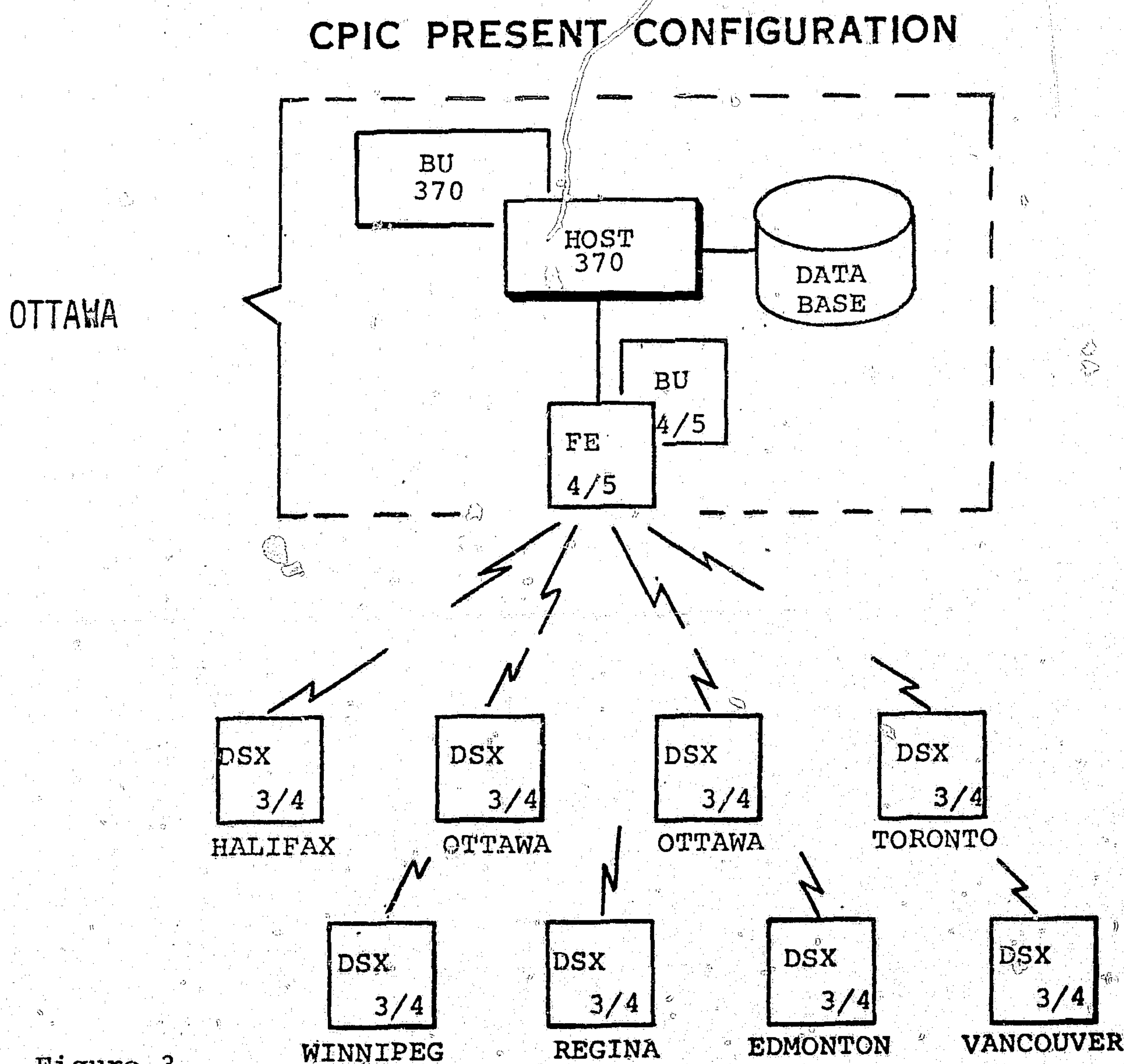


Figure 3

the realities of that figure. That 1% of downtime is equal to 1 hour and 40 minutes a week, still not bad, especially if it occurs in the off peak hours. But if the system stays up for two months solid, then we can have almost two full shifts of downtime and maintain 99%. The police community cannot tolerate that type of outage. This is in fact somewhat our experience. We have one or two long, over 3 hour, outages at each site per year.

The present system has another disadvantage. The Front End processors, since they are directly connected to the Host channel, must be located within a 50 foot radius of the Host. In any disaster situation, fire, flood, the system would be out of service for a considerable period of time, possibly weeks or months. Therefore, we must have some form of emergency backup. This requires that an alternate Front End and Host be available at a remote location.

While the communications interfaces have been designed to be as efficient as possible, the protocols used do not easily lend themselves to interfacing with other equipment. There must be a plan to provide a simpler external system interface.

As the police community awareness of the value of computers grows, the requirements for processing power are also growing. The next system must provide for a variety of terminal types such as intelligent terminals, remote job entry terminals, and Communication Centre clustered terminals.

The economies realized by remotely locating the switchers can be again increased by having some of these switchers in the densely populated areas more powerful and terminating more lines. The pocket switching and digital services that are now available must also be considered. Many economies are possible by utilizing these services, but they must be planned for and the system must be adaptable to them. For instance, with digital facilities it may be more economical to remove a TDM and directly connect those terminals; however the terminal ports must be available.

With the present use of the limited message switching, already at 27 per cent, it becomes obvious that we must provide for a full and complete message switching capability. We must provide such things as broadcast patterns, message, priorites, formal administrative messages, retrieval, etc.

Lastly we feel that we must provide a system design, and a system, that will be capable of functioning under known and even anticipated conditions for more than five years beyond the implementation date.

The New Communications System

Before starting the design of the new communications system, certain constraints and goals were laid down. In anticipation of a replacement of the Host processor by 1980/81, it was determined that if there was to be a new communications system, then it must be in place by 1979 at the latest. This time constraint would help to lessen the impact of multiple system changes to the user. Five Global Goals were then defined as follows:

Global Goals

(1) Access shall be provided to files, records and systems as recommended by the CPIC Advisory Committee and approved by RCMP Management.

(2) Reliability of the system shall provide unrestricted access of CPIC maintained files and facilities to all terminals 99 per cent of the time.

The longest contiguous outage shall not exceed 30 minutes except in the event of a natural or man-made calamity where restoral of service shall be within 48 hours.

(3) Performance shall be sufficient to guarantee system response to a CPIC transaction within 15 seconds 90 per cent of the time and within 45 seconds 99 per cent of the time.

(4) Integrity of the records maintained on the CPIC system shall be such that no record will ever be lost and only the agency who entered the record will be permitted to alter or remove it.

(5) The system must be easy to use in order to minimize human operator errors, and to maximize the productivity and throughput of the people involved.

This last item is a vital goal. In the original system the base of operating was addressed quite strongly, we felt. But time has proven that out of the 4000 terminal operators there is a turnover of approximately 2000 a year due to transfers, promotions, casual staff. Also, the loaded costs at $10,000 per operator is equal to 40 million dollars per year. This is 75 per cent of the total annual cost of CPIC to the Canadian taxpayer. The new system must be more tolerant of operator error, and assist the operator in increasing throughput.

From these goals and from the experience we gained, a list of system objectives was constructed. These objectives are:

(1) To provide for an increased number of terminals at each switcher site.
(2) To provide for a variety of terminal types and speeds at each switcher site.
(3) To provide for external systems interfaces with the communications network.
(4) To provide for increased traffic loads throughout the communications network.
(5) To provide better system reliability through improved recovery methods that will minimize loss of data.
(6) To provide for full message switching capability.
(7) To provide emergency backup capability for the central system.
(8) To relieve the host computer system from as much of the communications workload as is feasible.
(9) To provide a system design capable of functioning under known and anticipated changes for more than five years beyond the implementation.
(10) To phase in the new communications network design with little or no disruption to the user.
(11) To provide security throughout the communications network as required for the highest level within the system.
(12) To increase system availability to the user, through functional distribution of applications where feasible, through minimizing restoration time of facilities following a failure, and through duplexing of equipment wherever possible.

The new CPIC Communication system design has been finalized and approved. (Fig. 4).

The first thing that one might notice is that the entire system is now duplexed and backed-up. The Host processor configuraiton remains the same although it will function differently. All message switching functions have been removed. The host will now operate on a complete transaction in, complete transaction out basis. The Front End/Message switch will do all transaction segmenting/desegmenting as required by the communications protocol.

CPIC FUTURE CONFIGURATION

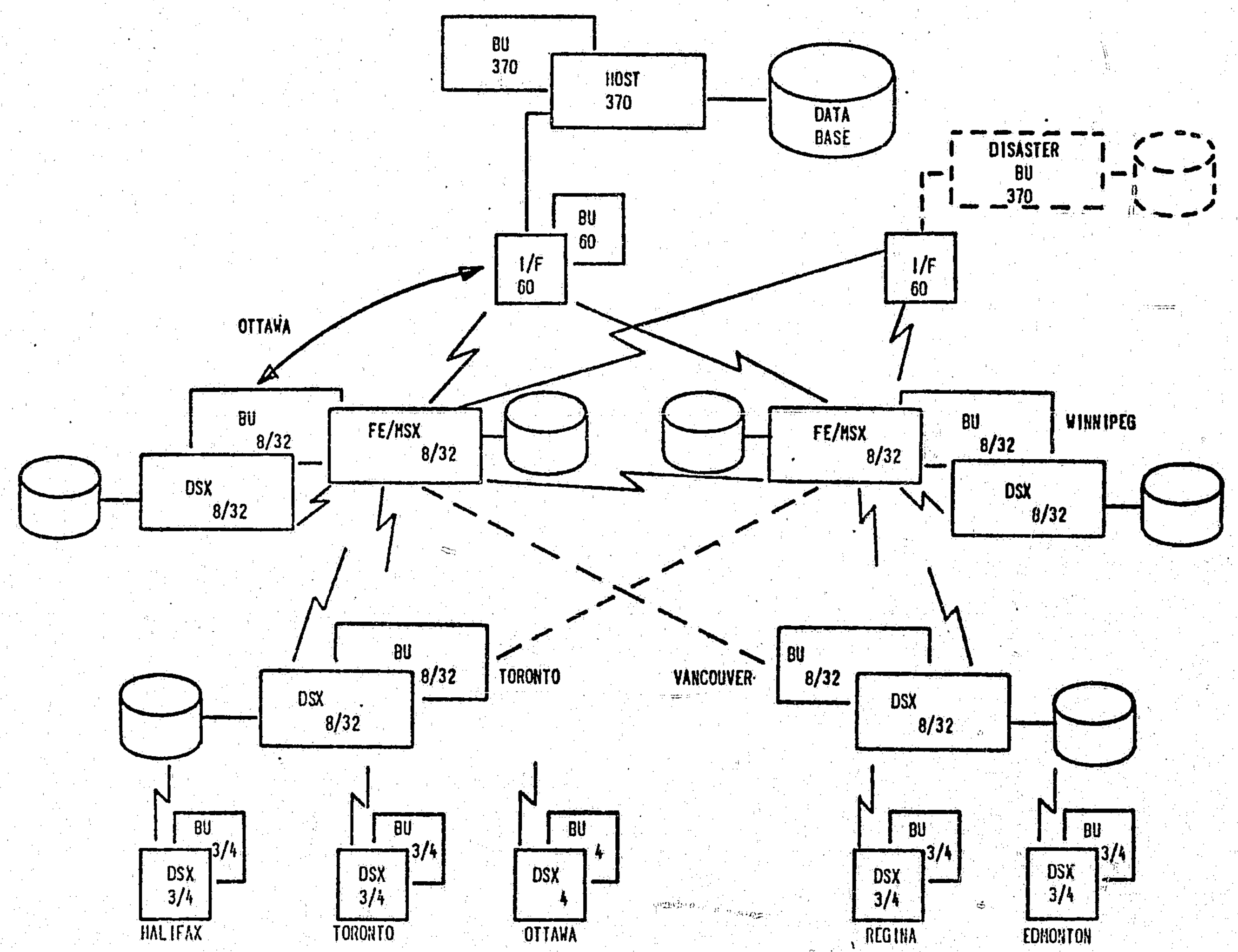


Fig. 4.

The feature, plus the removal of the message switching will enhance the life expectancy of our host system.

The Interface processors are small, stand-alone units. They are a very fast processor which will be able to handle our projected loads. They have been designed as a data pump and their main function is to allow the Front Ends to be remotely located from the host. The Interface processor is still directly connected to the host channel but is connected to the Front Ends via a communication line. The interface processor will do the ASCII/EBCDIC conversion.

By its smaller size it is capable of being placed at a remote backup host site for minimum cost.

Each Front End/Message switch has the capability of terminating all of the Data Switchers and handling the entire communications workload. These two Front End systems are now separated by a distance of 1500 kilometers to assist in our plans for disaster backup. They each have secondary storage for improved recovery capabilities as well as for message storage, retrieval. All of the message switching functions will now reside in these Front End/Message switchers.

The two locations selected as FE/MSX sites, also have the new Data Switchers and one space processor system will serve as backup to either the FE/MSX or the DSX.

Two other sets will also have the new DSX and as a result we will have good coverage from these four sites for higher speed terminal devices, external system interfaces, such as mobile terminal systems, as well as support for different terminal types, such as intelligent terminals.

The existing system equipment will be moved around, as installation of the new equipment is completed, to lower volume areas and will again be backed up.

The communications line facilities are all backed up by dial-up lines. In this fashion, any DSX can communicate to either FE location. Both FE's can communicate with either interface location as well as being able to communicate with each other.

As an added backup facility, some of the higher volume users will have their terminals 'cross-hatched'. This means that if they have four terminals installed at a location, let's say Vancouver Police Department Communication Centre, two of the terminals connect to the Vancouver DSX and the other two terminals may connect to the Edmonton DSX. In case one of the DSX sites is not operational, Vancouver still has some terminal access.

With this system the recovery and reliability aspects will be greatly enhanced, the life of the host system has been enhanced, the terminal and external system interfaces have been enhanced and increased in numbers and speed, and, we hope, the design is flexible enough to ensure that it meets our requirements through 1985.

Closing Remarks

The work has started on the development and programming of this system which must, of course, be phased in so as not to disrupt current operations and will continue until completion in 1979.

We still regard the Canadian Police Information Centre as a young, growing system. Developments in system design and hardware demand that we keep a very flexible posture to ensure that our committment to serve the Canadian law enforcement community is as well met in the future as it has been in the past.

DISCUSSION

V.M. DAVIS: When we first got into this kind of business we found that we had a terrific psychological problem with dispatching. When the officer called in and the dispatcher responded on voice communication "The computer is down" the rest of that shift was totally lost. You may have had the same experience.

K.R. THOMAS: Yes, I've heard that comment several times. One of the things that puts pressure on us to make sure we stay up - and I think several forces would agree - is that when it's down we have an awful lot of guys with the problem. We just have to provide the continuity.

D.R.F. TAYLOR: You mentioned that the total cost of the system was about $60 million a year. I wonder for the future configuration what sort of estimate of cost you foresee, once the system is implemented.

K.R. THOMAS: The hardware and software cost of the system will not increase significantly, given the present configuration.

R.A.K. MEYER: I would also like to point out that the RCMP costs are about $12 million for all lines, terminals, hardware and software - the whole thing, including staff. The $60 million includes the total cost for every aspect of CPIC, including equipment, salaries and overhead for other forces.

S.W. WITIUK: Who is responsible for the information in your system? It would help if the agency which supplies the information basically owns it. As you know, in the United States there has been a problem with NCIC that some States didn't fund the maintenance of the files officially and were asked to leave. Can you foresee any problems in that area?

K.R. THOMAS: The problems are not too bad. Jack Hopkins will be talking about that later. We do find that if we use various soft line systems in conjunction with the validation lists it helps. The CPIC committee has dictated that the RCMP, Quebec Police Force and Ontario Provincial Police deposit these to make sure the records exist.

S.W. WITIUK: What kind of volume are we talking about?

J.R. HOPKINS: There are about 190,000 vehicles; about 600,000 on the person's file; about 300,000 on the property file. There are about a million criminal histories, which I will discuss later. It all comes to about 2.2 million items.

Z. JAKSIC: Although your system is highly flexible and very well backed up and there is a need for a centralized file, I noticed that each of the regional files is in storage. I wonder whether you have given any consideration to regionalizing the data base.

K.R. THOMAS: The reason for the secondary storage is for backup to cover the situation when communications lines are down. We don't want to interrupt anybody's operations.

J.R. HOPKINS: Perhaps I could add to that. We will probably run into a specially wanted person whose criminal history is stored centrally in Ottawa. If you want to do a local check it may not be sufficient. They may have information supplied by government offices, the same as for any wanted person under the Criminal Code of Canada. If he is wanted Canada-wide, the warrant is effective Canada-wide. So if you go to a province and get "no" you immediately have to go to the central site anyway.

47421

CPIC ON-LINE SYSTEM

CPIC Directorate, Royal Canadian Mounted Police Ottawa
J.R. Hopkins

INTRODUCTION

Since the beginning of its operational availability in July 1972, the use of the CPIC facility has continued to grow, resulting both from an increase in the number of terminals which can access the system and from an increased awareness on the part of Canadian Police Forces of its capabilities and its impact on law enforcement and the records management functions. The major files, accessible by the user community, are in general similar to those found in the majority of Police Information Systems; specifically a Vehicle System, a Wanted Persons System, a Stolen Property System and a Criminal History System. In many ways, the experience of CPIC closely parallels that of other systems with respect to traffic distribution, but differences in the available features do cause some significant differences. Modifications under development at CPIC are designed either to enhance the capabilities of the computer system or to improve the query response time. Changes to the phonetic name searching techniques and the dental identification feature represent examples of these modifications.

DEVELOPMENT OF THE CPIC ON-LINE SYSTEM

The need for automation within a police environment was first recognized in the early 1960's. Given the increasing crime rate and the increased mobility of criminals it was apparent that means would have to be found to enhance the ability of Police forces to store, retrieve and, above all, to exchange operational police data. Unfortunately, computer technology at that time did not permit the development of such a system. Recognizing the problems being faced, the Federal Government, at a Federal-Provincial Conference on Crime in 1966, committed to fund, through the RCMP, a National Police Information System. Coincidentally, computer technology had reached the point where such a system could be realized.

During the design of the CPIC System, certain criteria were imposed which had significant impact on the complexity of the undertaking:

1. Messages should be in as natural a language as possible, reducing the need to either remember or look up a variety of unfamiliar codes.

2. To conform with official Government policy, messages should be acceptable in both official languages.

3. A single query should, as far as possible, result in all reasonable and relevant information.

4. The maximum length of time for a message response could not exceed three minutes from patrol car back to patrol car during the peak hour conditions.

5. Search criteria used had to be those normally available and natural to an enquirer.

In order to satisfy the requirements of a bilingual, natural language message capability, message formats were designed allowing the use of full English or French words or expressions to identify the data elements being considered. In the interests of typing efficiency common abbreviations are permitted but no attempt is made to artifically allow character combinations which are not natural. For example, the keyword NAME is permitted but no abbreviation, whereas DATE-OF-BIRTH, being cumbersome, is more commonly used as DOB.

Because of the basic requirement of computers to be able to identify particular data elements, the imput language is somewhat stilted in that a sequence of keywords (to identify what) followed by the data element itself must be used. In order to compensate for the stilted nature of the data entry, no requirement exists for a specific ordering of the data elements in themselves. Briefly, to communicate with the system requires the use of three categories of information:

(a) An action verb such as ADD, QUERY, etc. to specify what is to be done.

(b) The file such a VEHICLE to specify to what system the action is to occur.

(c) Keyword:Data combinations, in any sequence, to indicate the data to be used in accomplishing the action.

On output, few restrictions are required that result in a stilted format, the prime aim being to present to the terminal operator a message that is as natural and readable as possible for quick comprehension and easy transmission to a patrol car. The language used is that as specified as being the prime language (English or French) for that terminal unless modified by the terminal operator.

Design criteria pertaining to single query and timing considerations led to considerable more processing complexities. In order to provide single query capability a cross-reference index is maintained showing the relationship that may exist within a group of related records whether within the same file or across file boundaries. For example, three individuals wanted for the same offence may be associated on the system one to the other (along with appropriate aliases) and references to Vehicle file entries. A query, generating a response by any of the records in the group, results in the entire group being returned to the enquirer for his information and subsequent action. Internally to the system, complexities arise in the areas of collecting messages from different systems and controlling the flow of the transaction through the many possible processing modules that may be required.

As stated earlier, it was considered that three minutes was the maximum permissible time for response from patrol car to patrol car. Allowing for communications from the patrol car to a message centre, typing of the query and its response, less than thirty seconds remained for computer processing and queuing time within the system. It was further assumed that the system should be designed for a transaction load of 20,000 during the peak hours. In order to accommodate such a load standard techniques as supplied by the computer manufacturers to access the data bases could not be used. Rather it was necessary to develop access methods that would permit distribution and intermixing of the data base over many devices to minimize access conflicts. In addition, an evident need was present to design on the basis of a multi-transaction process, i.e. more than one transaction must be being processed at any one time to maximize the use of computer resources under a transaction mix which requires a drastically varying spectrum of processing and data base access needs. At the present time, six transactions may be in process at one time resulting in an average queue time of .4 seconds under the current peak hour transaction rate of 7400. Simulations of the system indicate that the 20,000 per peak hour condition will not be reached until 1981 at which time any increase in the load will cause a quite noticeable increase in the response time.

THE FIND CODE:

The fifth criteria mentioned affecting the design namely the requirement to use natural criteria for a search led directly to the development of the FIND Code (Phonetically Indexed Name Directory) in that the natural and common way to search for an individual is on the basis of his name and therefore the prime search criteria and the file organization must be based on name.

Basically, the FIND Code is a method whereby any name entered on the system is coded according to its apparent phonetic possibilities. It had to be developed considering the multilinguistic nature of the country; a country comprised of two major ethnic groups, English and French and a multitude of other ethnic groups such as German, Italian, Slavic, etc. Other name searching techniques that had been developed and researched were developed in conjunction with one ethnic group, usually English.

An examination of existing techniques indicated that none would satisfy the design criteria that CPIC had set. With some techniques names that were considered to be phonetically similar, resulted in groups of names and records that were exceptionally large and would have caused considerable searching problems. Names which bore little resemblance to each other tended to group together too much and there was no possibility for alternate pronunciations of the same alphabetic sequence.

It is relatively easy for the human mind to look at the alphabetic sequency of a name and determine the most likely pronunciation depending upon similarity with other names and the way such character combinations are normally pronounced within an English and/or French environment. Given, however, the multilinguistic nature of the country, the same alphabetic sequency may result in different pronunciations depending upon the ethnic origin of the name. In addition, certain consonant combinations are at times a single sound and at other times mark a syllable junction. To the human mind the difference is usually apparent. To a computer it is not so obvious and therefore allowance must be made to permit a given character sequency to represent either one sound or a syllable break. For example, the consonant pair "RD" results in a single sound in a name like Ward but represents a syllable break in a name like Arden. Similar problems exist with other combinations such as "RS", "RDS", etc.

Names which generate the same FIND Code are grouped together as a set and as a result all records falling within the FIND Code grouping are considered in the first instance as possible respondents. One area where the FIND Code differs from many other techniques is in the multi-code generation aspects of the algorithm. Any name being considered may generate more than one code and the records pertaining to that surname are stored within all appropriate FIND Code groups. In the interest of reasonableness a maximum of 64 is allowed. Of the surnames present on the Criminal Name Index file, the maximum codes generated, sixty, result from the surname GRZECHOWSKI.

Recently, a review of the characteristics of the Criminal Name Index was undertaken to check its performance as compared to that considered to be true before the conversion based upon a test file of one million individuals used during the development stage. Certain significant differences occur which result in longer processing time for searches than anticipated, even though the number of individuals in both cases are about the same. The test file of one million yields 144,486 different surnames yet the actual criminal history file generates 231,165 "unique" surnames. As a corollary the average number of individuals per surname shows an equally marked variance being 6.44 in the former case and 4.42 in the latter. Logically, it may be anticipated that as the size of the file increases the number of individuals per surname should increase faster than the increase in the number of unique surnames. In the actual case this is not so.

During the development stage, sampling of the Criminal Name Index file showed a fifty percent increase in the number of name records generated per individual as the result of aliases and multi-FIND code generation. The actual ratio is 2.2 times. The reasons for this anomaly result directly from a variance in the definition of what constitutes a name between the sample and the true life situation.

In the test file only one name per individual was permissible and in the sampling only true aliases were considered, i.e. Jones alias Brown. During the conversion of the file, however, all names present in the manual files were recorded so that minor spelling variations which are not aliases in the true sense were maintained. As we have no way of knowing or checking, this seems the more reasonable and cautious approach in order to ensure that no valid information is lost. Unfortunately, the occurrence of these minor spelling variations is greater than anticipated and to compound the situation these tend in many cases to generate a considerable number of FIND codes. On the positive side, the proliferation of these minor mis-spellings increases the chances of a "hit" when the query is also mis-spelled.

As a result of this review, a further evaluation was undertaken to reexamine the appropriateness of the rules used in the determination of the FIND code. Minor adjustments are planned which do not detract from the overall effectiveness of the grouping but will result in fewer codes being generated from certain surnames.

One such rule refers to the handling of the consonant pair "RS". Most commonly an "RS" consonant pair in Anglo-Saxon names represent a syllable junction as in the name ANDERSON. In other surnames unfortunately the "R" may

be silent so both cases must be considered and the appropriate codes generated. Slavic names introduce a further complication in that an "RS" or "RZ" consonant pair may be silent. The result is a generation of additional FIND codes to accommodate the "silent RS" combinations. A reasonable reduction in code generation is achieved by only considering an original "RZ" combination (which is reduced to "RS") as having possible silent connotations, the true "RS" combination being much less likely to be so. The result for a name such as ANDERSON, which contains both an "RS" and "ND" consonant pair, will now generate four codes rather than eight (Note "ND" as well as "RS" may be a syllable break or partially silent). Theoretically then given such a character string the pronunciations may be ANDERSON
ANERSON
ANESON
ANDESON

The above illustrates briefly the complexities involved in attempting to phonetically code names by computer. Care must be exercised, not only in the rules themselves, but in the order in which the rules are applied. Care must be exercised in changing rules because any change results in name groupings different than before and one must ensure that the reasonableness of the groups still exist.

The change to the files which will have the greatest effect in reducing search requirements, partially offsetting the effect of the name variation problem, is the proposal to split the file into male and female segments. This is a rather obvious change to make but is illustrative of how varying conditions alter the design of computer systems. At the time the file was converted from the manual records, only eight percent of the file pertained to females. Studies indicated that the cost of reading an extra eight percent of the records for each male search, i.e. 92% of the time, was offset by the cost of storage which would be entailed through wastage if the file was split. Now, however, given the marked decrease in storage costs, combined with an increase in the female records to fifteen percent and the additional name variation records the situation has reversed and it is more practical to split the file. The result is an estimated reduction of close to 25% in processing requirements for name searches. As 75% of the total processing time used is consumed in name searching, this is a significant decrease in CPU needs.

On a query, the FIND code as generated only directs the search to those subsets of the file which will be considered for searching purposes. Descriptors such as the surname, given names, date of birth, height, weight and eye colour are used to either accept or eliminate individual records as possible respondents. With the exception of SEX no descriptor will automatically eliminate a record.

Differences between the search criteria and the data record may reduce the chances but the combined effect of all criteria in the query determine the results.

Two other search features are available for special cases:

(a) The ability to search groups eliminating as possible respondents individuals whose surnames are spelled in a specific manner.

(b) The ability to search when only the phonetic sound of the name is known. In this case surname spelling is ignored as a search eliminator.

THE "NO-HIT" FILE

One feature available with the CPIC system which is not normally found with other police systems is the "No-Hit" file used with the Vehicle system. Vehicle queries which result in a "NOT ON FILE" response are retained for approximately 72 hours and compared against additions to the file during that period. Where a match is found the agency adding the record is notified as to the time and the agency which made the prior search. The following examples will illustrate the value of this feature:

A. At 9:45 a.m. on September 5, 1976, a Chilliwack Township member found a 1971 Mustang abandoned just off the Trans-Canada Highway. A CPIC vehicle query produced a "No-Hit" response. Enquiries at a nearby service station disclosed that four males had left the car a short time earlier. The member obtained descriptions of the subjects.

At 12 o'clock another Chilliwack Township member checked four male hitch-hikers on the Trans-Canada Highway about four miles east of the abandoned Mustang. Their stated destination was the Chilliwack Bus Depot. Although CPIC checks were negative on the out-of-province subjects, their particulars were recorded by the member.

At 3:35 p.m. a "No-Hit" file enquiry was received from the Vancouver City Police advising that the Mustang had been entered as a stolen vehicle from that city. As a result, the two members involved compared notes and concluded that the groups they had checked were in fact the same individuals who had abandoned the car.

At 4:00 p.m. three of the suspects were apprehended at the Chilliwack Bus Depot. The fourth was later arrested hitch-hiking on the Trans-Canada Highway near Hope, B.C.

All four were subsequently convicted for vehicle theft.

B. On February 10, 1976, at approximately 9:00 a.m. a pick-up truck was reported as stolen. Upon entering the vehicle's description on CPIC at 9:03 a.m. Burnaby Detachment obtained a "No-Hit" file response. This vehicle had been checked only 12 minutes before by Vancouver City Police.

As a result of this information, the Vancouver City Police were successful in apprehending the subject and recovering the stolen vehicle a short distance from the point of the original check. Charges of Theft of Auto and Possession of Stolen Property were subsequently laid.

It is unlikely that either of these cases would have come to such a fast resolution without the "No-Hit" feature.

DENTAL IDENTIFICATION

At the moment the Persons system is being rewritten. This has been caused by the drastic increase in the number of records present on the system and the numerous categories which have been added since its inception in 1972. During the rewrite an additional feature in the area of dental identification will be added.

Obviously such a descriptor as dental features cannot be used as a positive means of identification without the assistance of dental specialists but it is hoped that it can reduce the number of possibilities which have to be further examined.

At the present time the number of unidentified bodies being found is increasing especially in the B.C. area. As personal papers are lacking and fingerprint searches fail to achieve an identification, dental characteristics remain one of the few possibilities.

In many of these cases a Missing Person record may exist on the CPIC system but there is no easy means of retrieving the record using the available post-mortem data.

The dental feature will allow for the addition of the dental characteristics in a Missing Persons record. In addition, as shown in Figure 1, post-mortem data may be added on its own. In this case an automatic comparison will be made against existing ante-mortem records to see if a possible match occurs. The reverse is also true, addition of ante-mortem data will be checked against available post-mortem records.

Figure 2 illustrates the format of a query and its possible response. It should be noted that the coding, using the International Tooth Identification System, identifies each relevant tooth as to its position in each quadrant of the mouth, upper and lower, left and right, and whether the tooth is absent or has been treated.

Scoring, as with other person searches, is based on the maximum possible score given the search criteria, with each possible respondent showing by its score its closeness to the query. Two conditions do, however, result in an automatic rejection as a respondent:-

1. Any tooth absent in the ante-mortem record but present in the post-mortem data.

2. Any tooth treated on the ante-mortem record but untreated on the post-mortem.

In this special case of the normal search, SEX is not an automatic eliminator, as partial remains may cause sex determination to be dubious. The value of AGE as a weighting factor varies both upon the difference in age between the post- and ante-mortem records and the difference in age on the post-mortem record as compared to age 20 because of the increased difficulty in determining age accurately after age 20.

Special conditions such as abnormalities, gold fillings or replacements may be noted and used in the scoring but no attempt is made to be too specific as to extensive dental treatment. Tests were conducted to examine the feasibility of extending searches to allow for the possibility of shifting of tooth position following an extraction. The results proved to be inconclusive and therefore will not be implemented. Multi-searches are far more effective if this possibility is deemed to be present.

Having determined that such a feature would be beneficial, it was decided to implement an extension to cover a disaster situation where a large number of identifications must be made (Figure 3). In this sub-set each disaster will have its own file and both ante- and post-

TENTATIVE RESPONSE - ADD DENTAL

```
ADD DENT TYPE:PM/SEX:M/AGE:20/MHT:170/MWT:62/HAIR:BROWN/
EYES:HAZEL/CASE:76PA-3-481/TTR:11 12 13 17 23 24 25 33 34 44 45/
TAB:16 27 38 48/DREM: BRASS-RIM GLASSES BLUE JEANS & T-SHIRT/

10 NOV 76/14:54/40

003

RE:   003

   DENTAL RECORD ADDED BY IC90007
   TEETH TREATED:11 12 13 17 23 24 25 33 34 44 45
   TEETH ABSENT :16 27 38 48
   TYPE:PM AGE:20 MALE 5 FT 7 INS (170 CMS)
   138 LBS (62KG) BROWN HAIR HAZEL EYES
   BRASS-RIM GLASSES BLUE JEANS & T-SHIRT
   CASE 76PA-3-481

   NO MATCHING ANTE-MORTEM RECORD ON FILE

   10 NOV 76/14:54/40
```

Figure 1

TENTATIVE RESPONSE - QUERY DENTAL

```
Q DENT TTR:11 12 16 22 24 36 46 47/TAB:14 15 21 23 37/TYPE:AM/
SPLT:GR/AGE:28/SEX:M

001

RE:   001
   QUERY-POSSIBLE HITS FOR
   TYPE:AM SEX:M AGE:28 TTR:11 12 16 22 24 36 46 47
   SPLT:GR             TAB:14 15 21 23 37
   MAXIMUM POSSIBLE SCORE  020

   ***NO:1          SCORE  013       ANTE-MORTEM
   TEETH TREATED:12 16 22 24 46 47
   TEETH ABSENT :14 15 21 23 37
   SPECIAL TREATMENT: GOLD PRESENT
   REMARKS: CONDITION POOR-GOLD IN 12

   DOE JOHN**WEARING BRN LEATHER COAT**MISSING**
   MALE 6 FT 00 INS (193 CMS) 200 LBS (90KG)
   BROWN HAIR BROWN EYES BORN 22FEB40 AGE 36
   CASE 123-76
   ENTERED BY IC90007 ON 1 NOV 76

   CONFIRM ALL HITS WITH ORIGINATING AGENCIES
```

Figure 2

TENTATIVE RESPONSE - QUERY DISASTER

Q DISASTER TTR:11 12 16 22 24 36 41 47/TAB:14 18 28 38 46 48/
TYPE:AM/SEX:M

002

RE: 002

QUERY-POSSIBLE HITS FOR
TYPE:AM SEX:M TTR:11 12 16 22 24 36 41 47
TAB:14 18 28 38 46 48
MAXIMUM POSSIBLE SCORE 019

***NO:1 SCORE 018 ANTE-MORTEM
TEETH TREATED:11 12 16 22 24 36 41 47
TEETH ABSENT :14 18 28 46 48
REMARKS: TEETH IN GOOD CONDITION

McVALE GEORGE AGE 25 MALE 5 FT 10 INS (178 CMS) 175 LBS (78.7KG)
CASE CD42-J-76
ENTERED BY IC90007 ON 1 NOV 76

CONFIRM ALL HITS WITH ORIGINATING AGENCIES

Figure 3

mortem data entered as obtained. It is hoped, of course, that this feature will never be used, but if necessary may aid in the identification process. A similar program was used following the DC-8 crash outside Toronto.

ON-LINE STATISTICS

As the number of terminal installations increased from July 1972 to the present so has the number of transactions being processed by the CPIC system. The average number of transactions/hour/terminal however, has grown by only 10% from 3.7 in 1972 to 4.1 today. This is to be as expected as most terminal installation during the latter part of the period were to less active policing areas. Of more significance however is the fact that during the peak hours active terminals are sending 10.15 messages with only 74% of the available terminals showing activity during the peak hour. As can be readily seen, there is yet considerable room for growth before all terminals become saturated but the busiest must have almost reached that point.

Weekly transactions (excluding narrative traffic) have now passed the 550,000 mark, a significant difference from the 70,000 at the end of 1972. An analysis of the traffic pattern shows 20% to the Criminal Record system, 31% to the Vehicle system, 45% to the Persons system, the remainder to the others. Of the total transaction load, 83% represents queries, with the Property system showing the worst query: maintenance ratio of 1:1. This is compatible with the experience found with other police systems.

CONCLUSIONS

Although considerable unused capacity remains within the entire CPIC system, CPIC feels that it is necessary to continue to strive to improve service to the users. As a consequence, periodic reviews of the performance are undertaken as a matter of course. Much of this effort must continue to be in the area of new features but some must be directed to an analysis of existing applications. Not only does the FIND code and the accompanying matching algorithm use considerable computer resources by their very nature, but considering both the Persons and Criminal Name Index, name searching is required for 65% of the transactions. As a consequence this is one area which requires and receives extensive monitoring.

References:

1. J.F. Phillips, The FIND Code, CPIC Publication 1973.
2. S.L. Kogan et al, A Computerized Aid to Dental Identification in Mass Disasters. University of Western Ontario Publication.

DISCUSSION

D. R. F. TAYLOR: It seems to me, bearing in mind some of the discussions we had earlier about the updating of records, that when you add all the possible sources of error of data input and a whole host of events you have a large potential error. I wonder if you could give us an estimate of what I would call the efficiency, bearing in mind all of the elements involved where errors can creep in; lack of update, lack of validation of files and so on, of your overall system of retrieval. The reason I ask is that the Scandinavians probably have the most advanced system of record keeping in the world with experience over two or three centuries of recording. Everybody has an individual identity number. And even in those parts they find a five percent or ten percent error with a very much smaller record base and a much more sophisticated and detailed record keeping system. How much efficiency do you think we are going to get?

J. R. HOPKINS: I think we will get a great deal of efficiency, if when you are dealing with individuals you try to stick with descriptive information.

S. W. WITIUK: Knowing about the environment of data, I would like to know what processes you have for retiring old data. I am also interested in knowing what training you do in the field if people are going to produce this data, and I am particularly concerned about time. Even if you supply very accurate data taken right from the driver's license, how accurate is a driver's license? It could be a stolen wallet and an inapplicable description of someone. I am sure we are all aware of the horror story that is documented throughout the world, of people believing that because it's automated through computers it must be right. What training do you expect and how do you retire the data?

J. R. HOPKINS: Retiring the data is carried out in one of two ways. One is a rule that agencies must indicate they have a valid data file. In theory, the validation will indicate that you should examine each of the records you have on the system frequently. In the case of a warrant the Crown Prosecutor may say "Look, it's five years old. In respect to this information I am not going to prosecute; the witnesses are dead or have disappeared. It is not worth it." In order to back that up again we have the audit proceedings and the manual audits. We do some computer auditing where the records may appear to require it.

Information from Vancouver is different from Montreal, and Montreal would be quite annoyed if they arrested somebody and Vancouver said "Well, thank you very much but we cancelled that warrant a year ago" and didn't pick it up. I am not implying that

Vancouver does this, but that sort of thing happens.

V.M. DAVIS: I am still concerned about how you get the records up. One of the worst cases I can remember in the United States with NCIC was where the entries were made from a centralized source of the whole armed forces. Everybody who was a deserter was listed, and 50 people were picked up on the basis of this information. This was after they had returned to their duty station, been court martialled or whatever, and had been discharged from the service. The files were still on record. Somebody arrested them and they were held up for 72 hours. This theoretically was in pretty bad shape for a centralized source supposed to have been audited (do you really still want these people?) and yet the errors were just never caught. It was not just once, but several times. How do you police that agency, and make them aware?

D.R.F. TAYLOR: Jack, if I could just continue, I accept that we are not 100 percent accurate, but what do you consider an acceptable margin of error? For example, in your audit are you talking about 10 percent or 20 percent or 30 percent error? I am afraid I am still a little suspicious about what I know of the record keeping activities all over the world in terms of the basic input to the system on which the whole thing runs, and I am wondering just how much error creeps into this system. It's alright saying we are not 100 percent accurate, but what have you experienced with the system so far on the size of the margin of error? I know you are taking steps to eliminate it, but what is it?

J.R. HOPKINS: It is two or three times higher than it should be. The errors of this ten percent or that ten percent come from agencies, not us. The reason is that smaller agencies are somewhat indifferent. The larger agencies are usually much, much better, and the majority of the records come from the larger agencies. Some of those ten percent may have been date of birth or a hyphen left out. You still have to keep in perspective what you are doing in giving a policeman information. We can't control what he does with it. You have to assume 99.9 percent of them will react in a rational manner. It's no different from the situation manually. You've got the information. If you are silly, you shoot first and ask questions later. No one has yet solved this.

D.H. DOUGLAS: What about searches for things like people who fit a description, the type of license plate on a car, color, and that kind of thing?

J.R. HOPKINS: We can do certain searches on-line. We can search on a partial license number, or partial vehicle identification number.

Searching for descriptives on the on-line system is too time-consuming. If you have to search a file with a million individuals you are likely going to get 800,000 responses, because most people are average, about 5 ft. 10 in. and 155 pounds. If you want someone who is 7 ft. 3 in., that's a different matter. But the majority of people fall in that rather narrow range. It's the same as the John Smith file. If you went and did a search for John Smith, be our guest, but you are going to get 400-odd John Smiths. If that's all you've got you may well be willing to look at all 400.

K.R. COCKE: Jack, I am concerned with your leaving the idea before this meeting that there is a ten percent error, because I feel you are very much on the high side. For example, on your criminal record synopsis I dare say there is little or no error, but perhaps the error rate on the property and things of that nature should and could be significant. But I think that maybe what some of you are forgetting, although I hope you are not, is that the policeman has to do certain things himself. If he gets a series of responses on an individual, he doesn't just get one name out. When you enter the name John Smith you get a number out. A certain responsibility rests with him to make further enquiries. If the man is yelling "I am not wanted" or "I paid that fine", or whatever it may be, he doesn't just arbitrarily drag that person in.

D.R.F. TAYLOR: If I could comment, the ten percent error rate quoted is surprisingly good, given the normal errors in systems of this type. I am far from being disturbed by the size of it, bearing in mind how Jack described the errors, and I am quite impressed by how good it is in relation to similar data banks and a whole host of things.

D.M. MEAD: May I comment that in dealing with the horror story syndrome there is an added feature that I don't think has been observed. In the last line of every message I saw (Figs. 2 and 3) is an instruction to go back and check with the originating agency to see whether in fact the data is valid. This is a very valuable additional check even if the information was completely valid at the time of entry. Going back, and assuming that it's only as good as it was then, takes away many of the horror story issues.

V.M. DAVIS: It is not always possible to check with the originating agency, particularly if it is small. I want to emphasize that the agency theoretically should have been able to respond instantly, but did not because everybody had gone home. It's a human failure.

J.R. HOPKINS: We have been trying to get around that problem. Because many smaller agencies have in the past closed down at night, they must give a re-routing. Now the other ones go back to them and

CONTINUED

1 OF 3

say, "Look, you're not going to get anything until morning. Let him go." They are not going to go back in the morning and do it twice. But between the large agencies there isn't that problem at night, because there is usually staff there 24 hours a day and you can depend on them.

L.A. COX: I think that with good judgement and sound design, which you seem to have, the problem of errors may not be as great as some of the horror stories, especially from the United States, might indicate. There is, however, another problem which is not errors but omissions, which can get you into just as much or perhaps more trouble. When I was working with the San Diego Police Department, I had a chance to do a thumbnail evaluation on the integrity of their system by waiting until I knew that their link with NCIC was down. I collared an officer who was pulling up in his car, identified myself, and said we were running a test of the system. I gave him a hypothetical situation; he was driving down the freeway and saw a green Ford for which I gave him a license number, said that this car was going 80 miles an hour, and would not respond to his lights and siren. He said fine, called in and ran a check through the computer system on the license plate. I said now you have finally stopped this guy and you get out and you see he is carrying a concealed weapon. The license plate I gave him is the license plate of a valid FBI car. Of course the State's registry doesn't contain it; only NCIC would. The NCIC link was down, so there is a person in an unmarked car theoretically without a valid license plate, not responding to the emergency signals and carrying a concealed weapon. Under those circumstances normal operating procedures would call for an immediate arrest and to take the guy downtown and not to listen to any excuses. This is the sort of situation where you have looked at the system to see where it was incomplete. The officer did not know that there was even a chance that another agency automobile would not be reported. Is there any way that you have looked at your system to see what information is missing that many people think is there? Or what is there to handle these omissions?

J.R. HOPKINS: In that particular case we would not store that information, basically on the grounds that any unmarked police car may be in undercover operations.

S.W. WITIUK: How much documentation is available? I want to know whether I can get hold of a FIND coding system, or a description of how it works. It would be useful in starting one of our own if we have to.

J.R. HOPKINS: The FIND code has been developed by CPIC and those agencies which are interfacing with CPIC. There is a restriction on FIND coding.

47482

GEOGRAPHIC INFORMATION SYSTEMS IN CANADA

D. R. F. TAYLOR

Carleton University

The topic of this workshop is mapping and related applications of computers to Canadian police work. Consequently most of the papers we have heard and will be hearing are on fairly specific topics directly related to the theme. This paper is somewhat different in that it will attempt to place the application of computers to police work in the wider perspective of geographical information processing in Canada and to explore the possibilities of interlinkage between systems being developed for police purposes in Canada and various other systems either in operation or development.

There is a distinct lack of effective communication in this field in Canada. A first, and perhaps vital, step is to ensure that researchers in Canada are aware of what others in Canada are doing. It is somewhat ironic that Canadians often find out what their colleagues are doing by meeting them at international conferences outside of Canada. I met John Arnold and Fred Lipsett, for example, at a conference in August of last year in Atlanta, Georgia and became aware for the first time of their work and how closely it was related to work in which both I and a number of other researchers in the National Capital Region were deeply interested.

Too few Canadians realize that in the field of Geographic Information, Canada, and the Ottawa area in particular, is one of the leading research centres in the world and the most likely place to find answers to problems is not the U.S.A. or Europe but right here.

Some steps have been taken to improve communication. A National Capital Geographic Information Processing Group has been formed which meets on a regular basis. Conferences have been held and proceedings produced to increase the availablility of information. I draw to your attention two such documents--Proceedings of Symposium on Geographic Information Processing, Carleton University, Ottawa, January 1976 (Taylor, 1976) and Proceedings of Workshop on Current Issues in Geographic Data Processing, Carleton University, Ottawa, August 1976 (Taylor, 1976). The second annual conference of the National Capital Information Processing Group was held at the University of Ottawa in early April of this year and proceedings will be available in due course. There is also the extremely useful recent bibliography produced by the Ministry of State for Urban Affairs of urban and regional information activity in Canada (Lauder and Lavallee, 1975).

Some similar steps to increase effective communication are also being taken on the international level with Canadians being particularly active in organizations such as SORSA (The Segment-Oriented Referencing Systems Organization), (Taylor, 1976) and various commissions of the

IGU (International Geographical Union) and the ICA (International Cartographic Association).

Witiuk (1976) and Yan (1977) have both examined in considerable detail many of the issues involved in exchanging spatial systems technology and it is not necessary to repeat all of the arguments for and against such an approach here. Witiuk poses the basic question, "Why exchange technology?" and I think this might well be examined within the framework of Canadian police work and the computer systems being developed to facilitate it.

Systems related to Canadian police work are being developed to meet highly specific perceived needs. There has been a tendency to develop systems to meet these specific needs in as effective a manner as possible, and, given this approach, perhaps not surprisingly, only limited consideration has been given to linkages with other systems.

The Canadian situation is by no means unique. Hanson and Utan have commented on the situation in the United States recently as follows: "The plethora of rich and diverse data housed within police information systems throughout the United States has received scant attention from the social science community. Among the more notable reasons for neglect of these systems are intermittent communications between police officials and academicians, the considerable resource commitments required to use these data sources, constraints imposed on using them, or sheer ignorance of the existence of police information systems." (Hanson and Utano, forthcoming). They go on to argue that the most formidable barriers are the large number of records and the logical structure of these records and consequently few academics can use such systems. Using the Buffalo Police Departments Information System, Hanson and his colleagues are working to improve the situation and to interface the data with other sources of socio-economic data available in the U.S. Perry Hanson will be describing this work later this afternoon.

If the situation in Canada is different from that in the U.S. then it is probably in the relative depth of the ignorance of what is going on and the lack of any substantive effort to alter the existing situation.

Most work relating to police systems in Canada has a set of specific objectives which have to be met. The package being developed by NRC and the Ottawa Police Force which will be described later by John Arnold and Fred Lipsett is a good case in point. It is clear that researchers and planners in the Ottawa area would derive considerable advantage from being able to utilize this system but what advantages could accrue to the Ottawa Police Force? They have a highly specific mandate, limited resources and a limited budget. Meeting the needs of others in terms of systems design and utilization could result in delays, increased costs, problems of confidentiality and numerous other assorted headaches.

The case for technical cooperation and the advantages this has is clear and has been documented by both Witiuk and Yan. Useful exchange can take place at at least four levels as identified by Witiuk:

1. The conceptual level
2. The algorithmic level
3. The systems level
4. The computational results level.

Technical cooperation can therefore be carried out without any change in the initial specific objectives of the systems design and few systems designers have any objections to this type of cooperation. In fact, most welcome it with considerable enthusiasm.

Witiuk's conceptual level could, however, be broadened to include not only the theoretical basis of a system in the technical sense but also the substantive issues and problems with which a system has to deal. An information system is a means to an end, not an end in itself. The Comprehensive Crime Analysis Research Package (CARP) being developed by Hanson et. al. in Buffalo is very different in this sense from the original crime-reporting system developed by Buffalo's Police Department in 1971. It involves the concept of merging police data with other socio-economic data such as that available from Census thus hopefully allowing a greater understanding of the complex socio-economic matrix in which criminal activities occur.

Hindelang commented some years ago that, "It is unfortunate that we in the field of criminal justice have spent a great deal of time, effort and money maintaining records of various sorts, but have spent relatively little time, effort and money using these records....Certainly we know something about temporal trends of offences, and the like. But in spite of the readily available data, we know little, for example, about the correlation of offence types with each other and the extent to which these correlations are invariat across temporal and geographic dimensions. Consequently, such efforts as crime-specific planning are difficult." (Hindelang, 1973)

His arguments could be taken further to suggest that more effective policing of our cities could be achieved by correlating police data with other socio-economic data. As both are increasingly in machine readable form there is perhaps for the first time a real opportunity of achieving this.

I am not of the school of thought which advocates an ever-increasing size and complexity. I think in Canada there is more than enough evidence around to suggest that the all-inclusive massive systems approach typical of information systems design of the 1960's was a mistake. I think a more successful approach is one where systems are designed to solve specific manageable problems but with an important additional proviso that in the design of such systems considerable care be taken to make it possible to add additional elements in the future and also to ensure to the greatest degree feasible their compatability with systems being developed for separate but possibly related purposes.

There is a danger, in my view, that Canadian Police Systems will continue to be developed in isolation and that other Canadian geographic information systems work will continue to ignore or be unaware of the work being developed by the Police. This, in my view, can only be mutually disadvantageous and it is to be avoided if at all possible. The fact the the National Research Council is hosting this conference is a positive and very welcome step but much more remains to be done. Even a step such as an examination of compatability of the basic spatial units used by various systems would be of considerable value. Had we done that in the Ottawa area a decade ago we would be in a much better position than we are today and the exchange of data between CGIS and Statistics Canada recently described by Yan would have been a much easier step. Although much has been achieved in mapping and related applications of computers to Canadian police work, the field in Canada is still young enough to allow us to learn from past experience both here and elsewhere.

REFERENCES

Hanson, P.O. and Utano, J.J. (forthcoming). The Utilization of Police Information Systems: A Research Strategy. Review of Public Data Use.

Hindelang, M.J. 1973. The Utilization of Criminal Justice Statistics. Review of Public Data Use. 1: 30-31.

Lauder, K. and Lavallee, L. 1975. A Canadian Bibliography of Urban and Regional Information System Activity. Ministry of State for Urban Affairs, Ottawa.

Taylor, D.R.F. (ed.) 1976. Proceedings of Symposium on Geographic Information Processing. Department of Geography, Carleton University, Ottawa, January 1976.

Taylor, D.R.F. (ed.) 1976. Proceedings of Workshop on Current Issues in Geographic Data Processing, Department of Geography, Carleton University, Ottawa, August 1976.

Taylor, D.R.F. (ed.) 1976. International Technology and Spatial Systems. Proceedings of the Fourth International Colloquium of SORSA, Asheville, N.C., September 2 - 5, 1976.

Witiuk, S. 1976. Issues in Exchanging Spatial Systems Technology. International Technology and Spatial Systems. D.R.F. Taylor (ed).

Yan, J.Z. 1977. Exchanging Spatial System Technology - Related Issues and a Case Study. Paper read to the Second Annual Workshop of the National Capital Geographic Information Processing Group, University of Ottawa, April 1, 1977.

DISCUSSION

D.H. MEAD: Many professions require more data. Isn't what you are asking for information overload?

D.R.F. TAYLOR: I would argue that; a complete lack of communication and information overload may be very much alike. As someone said earlier, his unit could fill trucks with material generated in the development of his system over time. This does not represent communication. But I could ask him: "Is there one source, in five or six pages, that simply, without jargon, tells what his unit is doing?" Now my own view point may be biased. Being an educator, I have a specific interest in ensuring that the student body in particular, and the public in general find out what is happening. We have information overload at the same time that we have lack of communication. Both are problems.

D.G. LYON: Is there a trend in the universities today to examine police forces? I think everybody at your university has my name.

D.R.F. TAYLOR: Yes. I'm sure you also have theirs! I think the answer is that there is indeed an increasing move to study such things as criminology in universities. But I think that the linkage between the people working in geographic information processing, which may not be linked to criminology at all, and what is going on in police work is very weak. I am not suggesting that this is unique to police information systems. It is a general problem. I picked on this one because it happens to be the theme of the conference. So yes, I think an increasing trend to study many walks of life is a welcome one. You might be inclined to point a finger at the universities in Canada and, with a great deal of accuracy, accuse them of an ivory tower lack of awareness in the realities of life round about them. I think that is changing quite dramatically, at least in recent years, and in my view it's about time it did.

D.G. LYON: I can see that some of the things that we have done in Ottawa have been influenced by the number of questions that have come from the universities and the high schools. We have changed our way of thinking in some ways.

D.R.F. TAYLOR: Another point I would make, and I think this is general, is the need for effective communication between the physical sciences and what we are doing, on a continuing basis. I am not sure that there has been enough communication between the physical sciences and the social sciences in this field. Much parallel work is being carried on, funded by two separate federal government agencies, who sometimes speak to each other, but there are some problems of communication horizontally. I hope I am not insulting my hosts.

S. W. WITIUK: I'd like to point out that part of the responsibility for communication may be vested with the institutions and agencies themselves. Some universities, and certain government agencies try to work together to get a job done. There are certain things that take forever in the government environment whereas universities seem to expedite certain kinds of work. We have been able to call upon both Carleton University and the University of Ottawa for assistance. I think that for the last year or two there has been a tremendous amount of momentum behind our work because it involved the universities. Now our organization is starting to make rapid progress.

C. R. EVES: I have always been under the impression that there was a fair exchange between the technical personnel of say CPIC, CNR, Bell Canada, and others working with computers, but when it comes to the data base, this is usually guarded under security restrictions under the guise of privacy protection. Could this be the reason for the lack of exchange that you suggest?

D. R. F. TAYLOR: Exchange can go on in different ways, at different levels depending on particular circumstances. Confidentiality, I sometimes feel, is too often used as an excuse to not do something you really don't want to do in the first place. Statistics Canada, for instance, is very good at telling me that data is confidential and I can't have it. It usually means either "I don't want to produce it right now" or "Don't ask me; I am too busy". Confidentiality is sometimes used as a cloak to avoid the great degree of effort needed to really cooperate. I think in technical cooperation we're a long way from being effective, even in as small an area as the National Capital Region. If you look at it on a Canada-wide basis, we are nowhere when it comes to effective exchange of experience. We need to work at this if things are going to improve.

J. R. HOPKINS: I think that I would tend to agree with you and make the point that this has to be a two-way street. During our early days when we realized that we were going to be gathering data but couldn't gather a great deal of information from manual files, the reaction of sociologists was: so what? They already knew people committed crimes and that was really all they were concerned about. There was no incentive for us to gather specific information about age groups, etc. to correlate for study purposes.

D. R. F. TAYLOR: I believe I made that point. Another point I would like to make is that a good unifier of both physical and socio-economic data is the fact that it is being collected on a spatial base. Here I see an opportunity for exchanging what used to be apples and oranges. We now have new coded geographical reference bases, and that gives us greater opportunities for exchange. Let us take the very basic step of looking at geo-coding to decide how flexible it is, so that we can ensure that ten years later we will not incur tremendous unnecessary costs when we attempt to do it then. I think that Perry Hanson's paper may indicate from a specific environment some of the difficulties of attempting to change after the event in order to merge things.

S. W. WITIUK: My own feeling is that practically any information on an individual person is confidential. Some people get upset over personal information, such as income, in computer files, but I don't know too many things that are confidential about a block or a block face, or an atom or something like that. The kinds of information we have by grid square loses all its confidentiality as soon as it is transformed spatially, and the fellow out on the street driving to a block face can learn something about what is happening in that area without having to know who is inside that house. Rather he may want some information about the likelihood of there being a dangerous situation there. He is, in other words, interacting with people in a spatial context, if he has good information about that spatial likelihood.

D. SWAN: We had a discussion at Communications Research Centre yesterday regarding radio coverage. This problem was brought up by the Department of Communications in relation to allocating radio licenses. The comment was made that in all of the Canadian government there didn't seem to be a good base of machine readable data, about X, Y and Z of the topography, that could be used to forecast coverage of radio transmitting equipment. The data referred to in the discussion was a digital terrain model to allow accurate predictions of radio stations in various locations. I cannot help but think also of the tremendous cost that is going to be borne by police forces around this country as street-to-beat files are put into computer-aided dispatch systems. I find it intriguing that there is no digital terrain model data base available in Canada covering a fairly large part of the country, at least in the cities.

D. R. F. TAYLOR: The National Capital Commission does have such data but it covers only a tiny area. There is some Z data available in digital form at Energy, Mines and Resources. Unfortunately the coverage is incomplete.

D. H. DOUGLAS: This is a classic example of the poor communications that Dr. Taylor has addressed. You obviously have a use for a digital terrain model of Canada for a specific purpose. But I am sure that none of the people that I know of who are collecting such data have the slightest idea of, or interest in, your particular need. They are tracing contours apparently for no other purpose than to scribe them on film with a drafting machine, but the data they are collecting is the

DTM you want. I am just wondering what <u>your</u> responsibility is to inform these people of your need of this data.

T.A. PORTER: I think this discussion is demonstrative of the situation of communications in Canada. Here is a gentleman who wants some data and who is not sure who has it. There are people providing such data who do not know his requirements. They have no knowledge of one another. This is a perfect illustration of the lack of communications that we have been talking about.

47423

A CRIME ANALYSIS RESEARCH PACKAGE (CARP): A STRATEGY FOR THE DISPLAY AND ANALYSIS OF SPATIALLY REFERENCED CRIME DATA

PERRY O. HANSON, III, KURT E. BRASSEL, and JACK J. UTANO

Geographic Information Systems Laboratory
State University of New York at Buffalo

1.0 Introduction

During the last decade when most larger police departments in the United States added digital computers to their arsenals in the fight against crime, the potential has evolved for executing sophisticated geographical crime analysis. For the most part, however, only rudimentary geographical analysis has been carried out--usually involving, for example, a simple plot of the locations of a crime-specific phenomenon such as residential burglary. While the advantage of improved technology in this example shows that map plots formerly done painstakingly by hand may now be done rapidly by a machine, there are a large number of sophisticated spatial, or geographical, techniques that are suited for crime analysis albeit for the most part these have been overlooked. One of the primary reasons why geographical analyses have not been used in crime analysis is that a geocoding capability is a necessary condition to assign geocodes to locations of calls for service and arrests. Presently, considerable effort is being expended to develop geocoding capabilities in police departments so that in the future most crime files will include spatially referenced crime data; yet, given the existing geocoding capability, spatially referenced crime files still remain underutilized. Thus, another problem exists: quantitative decision-aiding tools are relatively new to police departments.

Until recently, police information systems did not employ quantitative decision-aiding tools such as those used in management information systems by military and industrial users over the past two decades (Gass and Dawson, 1975). Prior to the work of the President's Commission on Law Enforcement and Administration of Justice (1968) in the U.S. the need for the use of quantitative analysis techniques in a police environment was not evident. The Commission's recommendations, coupled with the 1968 Omnibus Crime Control and Safe Streets Act, provided the impetus for research and development to assist police administrators in addressing a wide range of important police questions. Consequently, the number of computer applications reported by police departments through the United States has more than doubled since 1968 (Colton, 1973).

The increase in the use of computers represents an attempt on the part of the police 1) to help curb increases in operating costs, 2) to use modern management techniques in the resource allocation process, 3) to evaluate patrol operations, and 4) to provide the police patrol planner and the social scientist with data suitable for crime analysis. The last point has been sorely neglected. In spite of the relatively slow start in using computers and quantitative decision-making techniques nearly all police departments have adopted computing and are organizing some of their operations around its use. Thus, at the least, crime records are available in machine-readable form for larger police departments. If these records include address data related to calls for service, crime incidents, or arrests, then such records can be locationally coded and used subsequently in geographical crime analysis. The problem is that once these spatially referenced crime records are in machine-readable form, the police have not utilized the vast wealth of information housed in their crime files. Most applications have been of the administrative type for housekeeping purposes. It seems appropriate, then, to discuss a strategy for developing the full potential of these files.

The purpose of this paper is to discuss a strategy for geographical crime analysis. The objective is to show how large crime files can be accessed according to crime-specific searches, how these crime-specific data can be aggregated and integrated with census data, and how both types of information can be linked to a spatial reference file for subsequent mapping and analysis. A full discussion of how to access large crime files is provided by Hanson and Utano (1977). A complete description of the spatial reference file structure is available in a paper by Brassel and Utano (1977). At the present time the Crime Analysis Research Package (CARP) described below represents a strategy to carry out crime analysis. It is not a stand-alone system, but a set of integrated programs that are linked to other software packages like SPSS and BMD.

2.0 Background

The fundamental premise of the strategy presented is that crime analysis can be a useful tool in the effort to reduce crime and solve crimes. By identifying patterns or trends of crime, the crime analyst, or police planner, is able to present material to the police administrator that could be used in an attempt to change existing trends or patterns of crime. Furthermore, the geographic component of crime analysis can make a non-trivial contribution to crime analysis. Before turning to a discussion of the strategy used in developing the structure of CARP, an overview of the role of geographical analysis in crime analysis is presented. This is followed by a description of geocoded crime data. Finally, the advantage of geocoded crime data as a link to census data is reviewed.

2.1 Geographical Analysis

One way to approach the identification of patterns of crime is to use geographical analysis, one of the components of crime analysis (Buck, 1973, 42). For the most part, traditional geographical analyses that have been carried out in the field of crime have been unsophisticated and involve relatively simple plots of crime incidents. Although this type of mapping may be useful for identifying concentrations of a given crime, in general, the plotting of given incidents of crime is of relatively little use compared to the potential that exists for geographical analysis of crime. Other types of geographical analysis that are sometimes used in crime analysis involve generating histograms of crime incidents by patrol, beat, or precinct areas. This, too, provides little in the way of useful analysis because such areas have arbitrary boundaries that lack correspondence with other units of data collection, especially census data. In general, crime-specific planning is difficult because of our lack of knowledge of such things as "the correlations of offense types with each other and the extent to which these correlations are invariant across temporal and geographical dimensions" (Hindelang, 1973, 30-31). The geographic component of crime analysis is presently limited to simple plots and histograms. This component should be expanded to include the full range of geographical analyses. Specifically, this component should include, but not be limited to 1) simple spatial statistics including centrographic measures, 2) multivariate techniques including analysis of covariance, discriminant function analysis, and classification techniques, 3) trend surface analysis, and 4) graphic display including simple histograms, dot maps, choropleth maps, graduated circle maps, and contour maps.

There are a number of reasons that have led to the restricted use of sophisticated spatial techniques in crime analysis. Spatially referenced data--data that are locationally coded in some way --are costly and difficult to obtain. They usually require specialized hardware (a digitizer for example) and software (computer programs designed to carry out complex editing of geographic base files) for initial encoding. Display presents additional hardware and software problems. To present graphic material, appropriate output devices are required. Computational algorithms for graphic display are of considerable complexity; poor programming algorithms increase computing costs substantially for graphic display. Furthermore, crime master files including incident and arrest data for even moderately sized police departments are large for any kind of data processing. Carrying out sophisticated spatial analysis is just about impossible with the current sequential structure of most crime data bases. Thus, not only are there inherently difficult problems in dealing with initial encoding of locational codes and with display of geographically referenced crime data, but there is the added problem of obtaining computing power and a repertoire of efficient computing programs suitable for geographical analyses. In summary, the situation that has lead to the current position of geographical analysis in crime analysis is relatively straightforward. Handling geographically referenced data of any kind is difficult; handling large complex data files that are typically of any moderately-sized police department is even more difficult. No development in this area could have been possible without the introduction of the modern digital computer.

2.2 Spatially Referenced Crime Data

The process of appending a locational code, or geocode, to an existing crime record is termed geocoding. Although a considerable variation in approach is possible, DIME (Dual Independent Map Encoding) technology has been accepted by many police departments in the United States. This is true for a number of reasons, including 1) the inertia created by the development of DIME files by the United States Census

Bureau, 2) the support given to the creation of DIME files by the Bureau for major metropolitan areas in the United States, and 3) the more recent support given to the use of DIME files in policing by cooperative effort between the Geography Division of the Bureau of the Census and the IACP (1975). Furthermore, education in its use is ongoing (Stevens and Strahan, 1975). A review of and practical experience with the software that has been developed by the Geography Division in support of creating and using DIME files (more commonly called GBF/DIME files), would show, however, that the topological theory behind DIME files is relatively complicated. Thus, finding appropriately trained people to use the so-called standard "user oriented" programs is difficult. The use of DIME technology is sometimes hindered, because people are not trained in its use, because computer programs are not always suitably documented for local conditions, and because the code in which the programs are written is not always useable on a given police department computer. Nevertheless, the advantages of geocoding, however carried out, outweigh the disadvantages, and it can be safely assumed that geocoding in more or less its present form is here to stay. Police departments once exposed to the advantages of geocoding have been quick to take advantage of existing geocoding technology. The potential, at least, for geographic crime analysis is established; as long as disaggregate crime records are spatially referenced, then geographical analysis is possible.

2.3 Geocoded Crime Data: The Link to Census Type Data

If records are geocoded and if access to a user-defined subset of crime records is possible, then geographical crime analysis is possible. The exact nature of the analysis that is carried out depends on the nature of the crime type, of course. One alternative, areal analysis, is appropriate for many types of crime analysis. The advantage of areal analysis is that a number of other data sources become available that otherwise would be totally inaccessible. In particular, census data that are available at the block, block group, and tract level are extremely useful for evaluating the environmental context in which crime occurs and also for constructing crime rates based on actual population figures. Other local data could also be used depending on its availability. The particular type of spatial aggregation that would be carried out depends entirely on the problem that is defined. In general, to study crime--to carry out crime analysis--using precincts as a spatial unit of analysis is inappropriate; thus, for a given problem the particular approach from the geographical point of view could only be determined from the problem itself.

2.4 Summary

If crime analysis is to be capable of identifying patterns or trends of crime, then the role of geographic location in relation to crime must be recognized in order to show the distribution or pattern of crime over space. Furthermore, these trends of crime over space should not be studied in isolation since they are usually related to a number of other variables including the spatial distribution of other crimes. The problem, then, is to devise a strategy that permits a flexible entry to large, disaggregate crime files, to census data, and to relevant spatial reference files. This strategy is discussed in the next section.

3.0 A Geographically Oriented Crime Analysis Research Package

A strategy to carry out geographic crime analysis requires the integration of a number of large base files. Furthermore, these files must be structured to permit rapid and flexible access so that the various base files can be integrated if required or structured to allow a variety of research questions to be addressed to them. The CARP structure provides a data organization that provides flexible and rapid access to crime and census data and a direct link to a spatial reference file for mapping. User defined data subsets may be generated directly from large crime or census files and used in disaggregate analysis. These data subsets in turn may be integrated with the spatial reference file for mapping. To link census data with crime data a data aggregation routine is used; thus, crime analysis may be carried out according to user specifications that integrate crime and census data through a common locational identifier. It is the flexibility of access to the several data files that gives power to the CARP structure. The strategy for geographic crime analysis is described below. A brief review of other approaches is outlined first to provide a basis against which the CARP structure may be evaluated. For the most part alternative structures involve using the same basic data files as CARP. However, the files used in alternative structures are usually not integrated.

3.1 The Use of Crime and Census Data in Crime Analysis

Analyses using crime and census data have usually been undertaken along separate and distinct research lines. Census data have been used in a variety of studies by geographers. Typically, these studies use existing census data without any link to crime data. Factorial ecologies, for example, often involve fifty to sixty variables related to socio-economic status, family status, and race. Crime analysis, too, has been carried out in isolation from the contextual milieu in which crime occurs. Thus, analyses of crime data often only include variables such as the timing and locations of crime occurrences. Very few studies have attempted to evaluate a crime-specific phenomenon in the context in which it occurs. The study by Schmid (1960) does link crime and census data and is excellent; this type of study is not duplicated frequently, however, because of the obvious costs involved in developing an appropriate data base for analyses.

Figure 1 shows the typical analysis paths that have been followed by urban analysts and crime analysts. Analyses have been done using crime data, census data, or crime and census data together. The latter analysis type has required considerable effort to put both kinds of data together in one table and thus has been carried out infrequently. Lacking geographic base files, mapping too has been done infrequently. Often the crime path leads to mapping that may involve a simple plot of locations of a crime-specific phenomenon. The census path leads to choropleth mapping of census variables. The crime and census path leads to choropleth mapping of such values as factor scores. In each case problems arise because no efficient means have been established to access specific data subsets from either crime or census data or to organize crime and census data into one file for subsequent analysis. These strategies are discussed next.

3.2 Census Access and Analysis

Various approaches have been developed to access large census files efficiently. One of these approaches is called CAPS (Census Access Program System) and was developed by Brothers and Rens (1972). The CAPS system permits the user to specify an identification code for a given census variable, which is then used to retrieve all the values associated with the given variable for different levels of census aggregation. Once the appropriate data are selected from the base file, mapping and geographical or statistical analysis may be carried out on the census specific data. This structure provides a flexible and rapid access to census data. Figure 2 shows the typical paths through such a structure.

3.3 Crime Access and Analysis

The problem of accessing crime-specific data efficiently is similar to the census-specific data problem; there is, however, a major difference--typical police files are much larger than census files because they are composed of disaggregate records since police files usually are organized by calls for service, offenses known to the police, and arrests. Furthermore, it is not always clear when crime data should be aggregated by a given areal unit or when they should be available for disaggregate analysis. Figure 3 shows the various paths through a crime oriented structure. Once data are retrieved from the large police files, they may be used directly for disaggregate analysis or, after aggregation, for aggregate analysis.

3.4 Crime and Census Data

For sophisticated crime analysis both crime and census data are needed. To obtain crime rates, for example, population counts are necessary. When crime and census data are linked, then a number indices may be generated that relate crime to associated contextual variables. To accomplish the link between crime and census data, the crime and census specific data are stored together within one data table. To implement mapping and analysis the data table is developed and subsequently accessed according to the needs of the user. Of course, mapping requires the use of the appropriate spatial reference file. Figure 4 shows the overview of the census and crime data organization.

3.5 The CARP Structure

The relation among the data files and routines in the CARP structure is shown in Figure 5. Census data, crime records, and spatial reference files are interfaced through a set of computer routines. Programs handle data organization and storage. Processing includes data analysis and display. Display is implemented through use of the spatial reference data, including geometrical indices such as census block group boundaries. The three key files: crime, census and topological are the

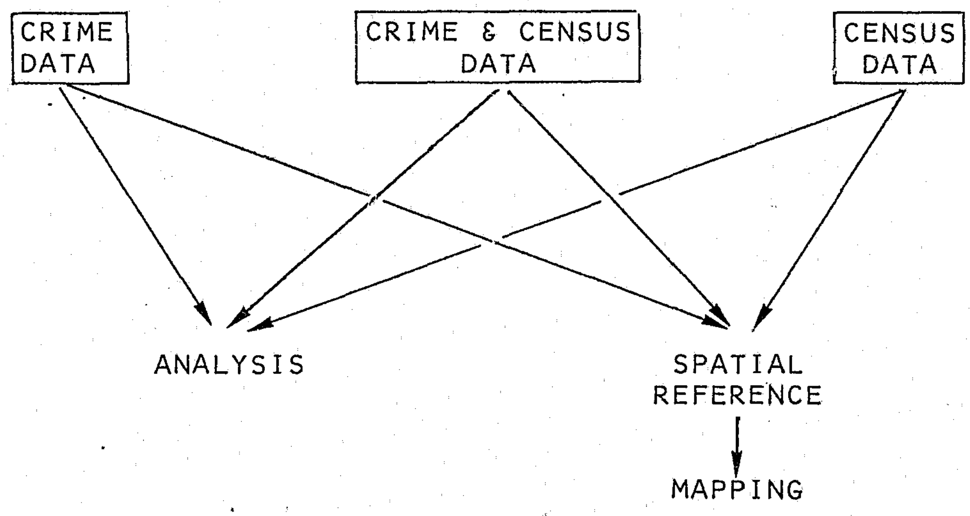


Figure 1. Typical Analysis Paths by Urban Analysts and Crime Analysts.

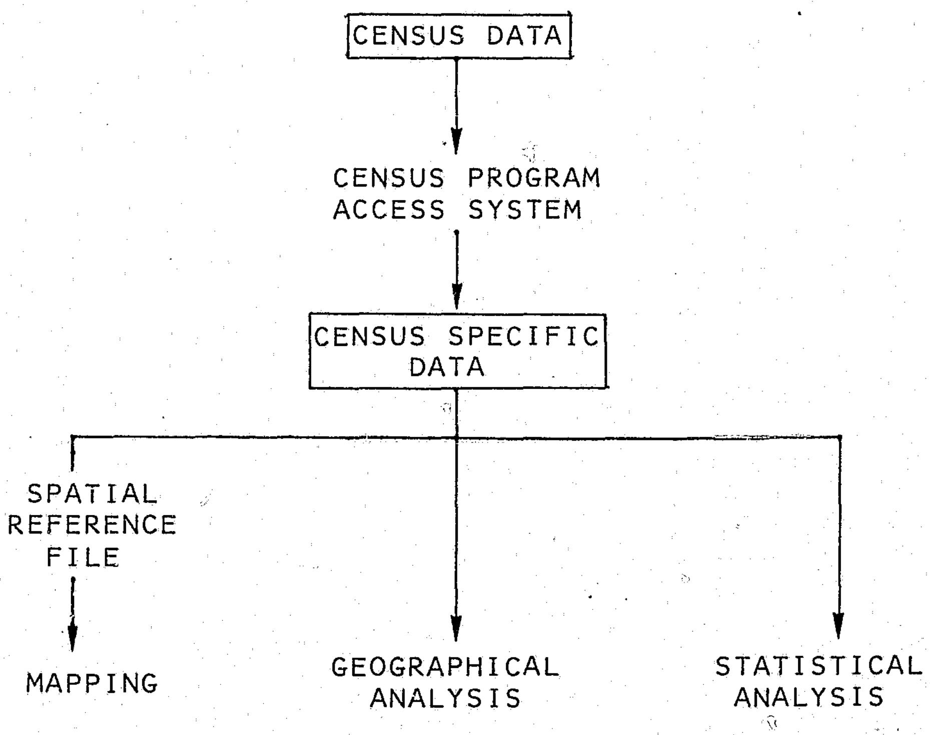


Figure 2. Obtaining a Census Specific Data Set for Subsequent Analysis.

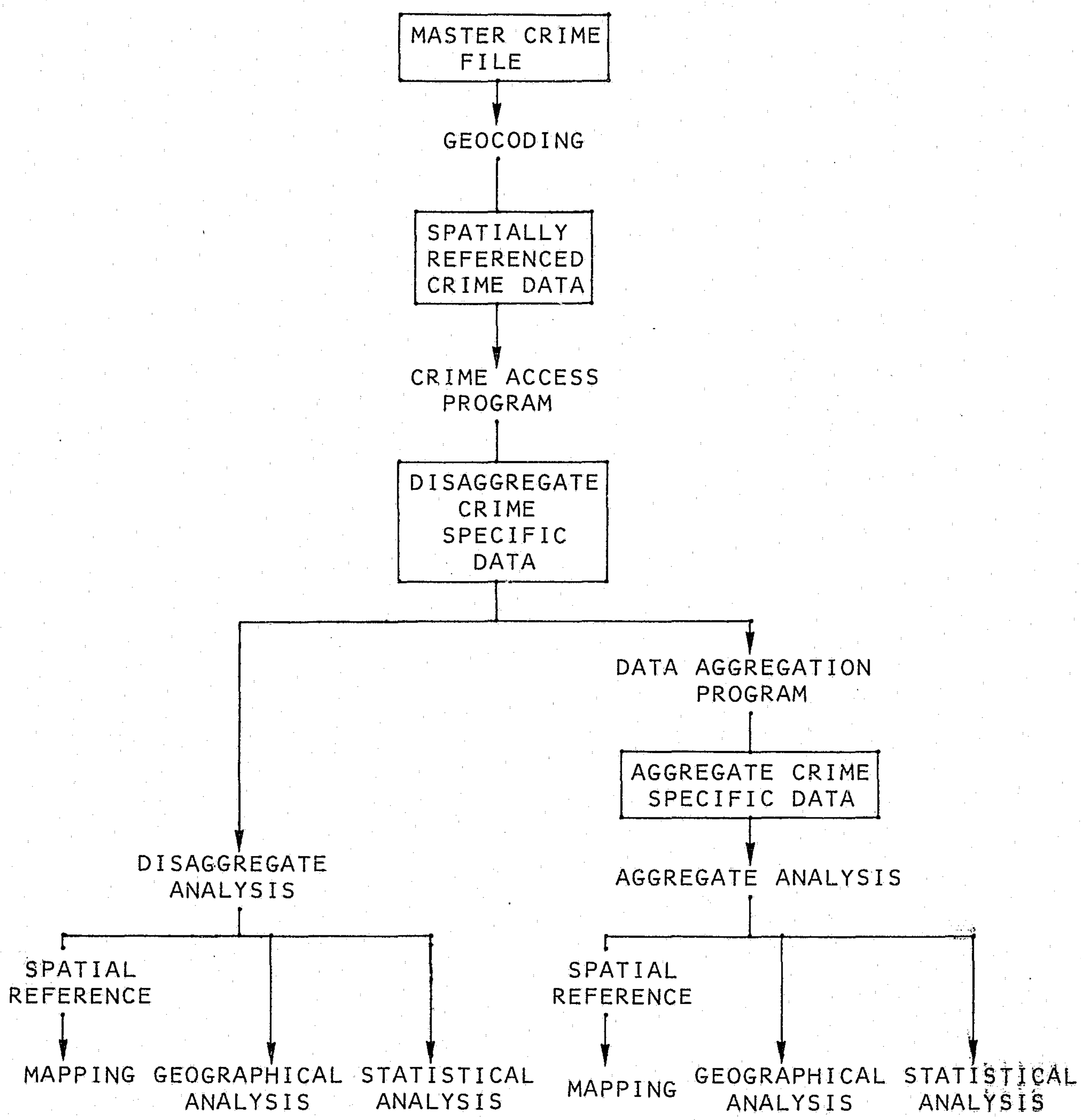


Figure 3. Obtaining a Crime-Specific Data Set for Subsequent Analysis.

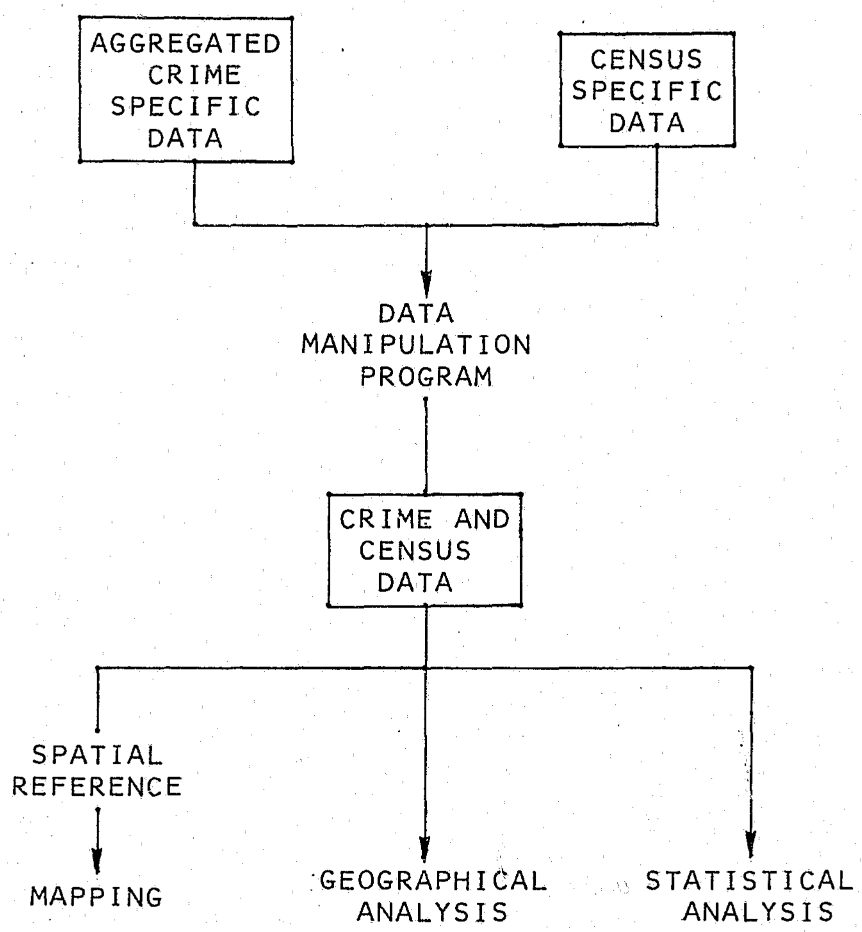


Figure 4. Crime and Census Data.

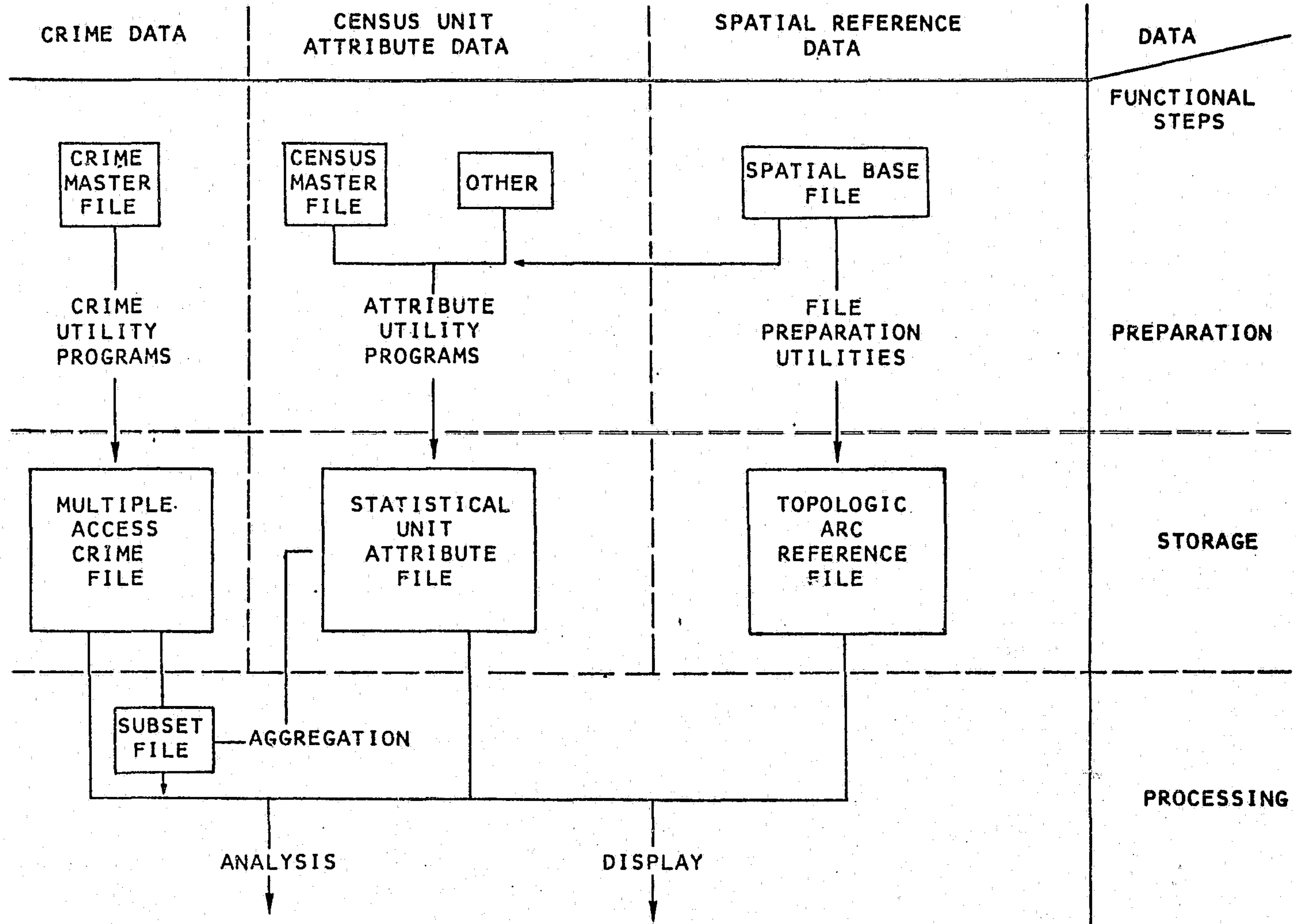


Figure 5. The CARP Structure.

heart of the structure. These are organized in either random access or index sequential mode. The three files are integrated in this way. Crime-specific data are retrieved from the crime master file, which is modified to allow rapid retrieval of records on a single or multiple key structure. To interface crime data with census data, crime data are aggregated to corresponding census defined areal units, and then both crime and census data are entered in one data table, called a Statistical Unit Attribute File (SUAF). SUAF is then manipulated according to the needs of the user. For statistical analysis a new data table, which contains selected crime and census variables is created. For mapping, SUAF is interfaced with the topological arc reference file, which contains the polygon boundaries for the various census areal units.

An important aspect of the structure of the SUAF file is that data entries corresponding to two variables, for example, number of females arrested for shoplifting and number of males arrested for shoplifting, may be added together creating a new variable number of people arrested for shoplifting. The new variable in turn may then be standardized by a third variable, total population. Thus, the specific variables abstracted from the crime data or from the census data are determined by the user in every case.

At the present time CARP is implemented on a large, research oriented, digital computer. While it is not reasonable to expect police departments routinely to have access to this type of computer, it is hoped that the conceptual approach that has been developed can be implemented on a mini-computer. Preliminary work has begun to study the feasibility of implementing a CARP type structure on a mini-computer.

4.0 Conclusion

In an age when mini-computers and micro-processors are beginning to dominate all phases of data processing, a discussion of a batch oriented data processing system may seem archaic. Furthermore, a structure that has been implemented on a large, research oriented digital computer hardly seems appropriate for many police departments. Two points are appropriate here. First of all, the authors have started to evaluate the problems of implementing a CARP type structure on a mini-computer and at the present time see no overwhelming problems. The approach requires large amounts of disk space, but not excessive amounts of core. Secondly, the batch environment has provided a laboratory for experimenting with a conceptual approach to geographically oriented crime analysis research. To date it appears that the capability of creating a data table that contains crime and census data and that is linked to a spatial reference file provides promise because problems of access to large, cumbersome data files are overcome.

The success of the CARP structure is that according to user specifications any crime-specific phenomenon may be retrieved from a large data base and in a similar fashion any census variable may be retrieved. Depending on the needs of the user the two types of data may be used separately in disaggregate analysis or integrated in a data table in a way that permits aggregate analysis. Where mapping is called for, the data are interfaced directly with appropriate spatial reference files, which include appropriate data structures to allow for mapping.

Thus, the CARP structure attempts to overcome some of the problems of the dealing with large files. By providing to the crime analyst or police planner flexible and rapid access to a complex data structure, a variety of analysis and display options are possible.

REFERENCES

Brassel, K. and J. Utano. 1977. The Buffalo Crime Mapping System. Research Report, Geographic Information Systems Laboratory, State University of New York at Buffalo.

Brothers, D. and F. Rens. 1972. CAPS: A Census Access Program System. Dept. of Social and Preventative Medicine, State University of New York at Buffalo, Buffalo, New York.

Buck, George A. 1973. Police Crime Analysis Unit Handbook. U.S. Department of Justice, Law Enforcement Assistance Administration, National Institute of Law Enforcement and Criminal Justice, Washington, D.C.

Colton, K.W. 1972. "Computers and Police: Patterns of Success and Failure", Journal of the ACM, pp. 4-13.

Gass, S. and J. Dawson. 1975. "Evaluation of Police Protection Research", paper presented at the Joint TIMS/ORSA Conference.

Hanson, P. and J. Utano. 1977. "The Utilization of Police Information Systems - A Research Strategy", Review of Public Data Use.

Hindelang, Michael J. 1973. "The Utilization of Criminal Justice Statistics", Review of Public Data Use, pp. 29-33.

International Association of Chiefs of Police. 1975. Geographic Base Files for Law Enforcement. Gaithersburg, Maryland.

President's Commission on Law Enforcement and Administration of Justice. 1968. The Challenge of Crime in a Free Society, Washington, D.C.

Schmid, C.F. 1960. "Urban Crime Areas". American Sociological Review, 25: 527-542, 655-678.

Stevens, J. and B. Strahan. 1975. "Geo-processing Systems and Their Impact on Crime Analysis and Manpower Allocation", paper presented at the Second National Symposium on Information Systems for Police Service, Crime Control, and Community Planning, St. Louis, Missouri.

DISCUSSION

S. W. WITIUK: You have been telling us how mapping techniques can be used for post-facto analysis of crime. Have you been able to use them to predict crime, or to make associations between crime occurrence, socio-economic traits, etc., and then extrapolate to indicate where patrolmen might look for a crime to occur?

P. O. HANSON: I began working that way but I got more involved in questions about the role of police officer distribution. We have looked at many different types of crime and certain patterns have become evident. For instance, the number of arrests seems to increase on one side of the main street, in the wealthy white middle class areas, and also for other types of crime at the interface between the Polish side of the city and the black side of the city, where the black ghettos extend toward the Polish area. So I can make predictions easily by going to those interfaces.

J. G. ARNOLD: I didn't like the graphics. I thought they were very difficult to read. Our approach is to allow someone to sit at the console of a minicomputer and say: "Give me this, give me that", and to have things integrated with a CADRE type system, displayed in real time. Then we can do practical analysis on the way to the scene of a crime, and perhaps have a list of every related incident in, say the last two or eight hours.

W. J. BROWN: What is the optimum turn-around time for providing this type of information?

P. O. HANSON: It depends upon the type of crime you are dealing with. If you are dealing with burglary, you might use two minutes or three minutes, or more. If you are looking for a certain kind of pattern, for example a gang that is working out of the city in the suburbs, it could take six months to catch them. So other events take much more time.

W. J. BROWN: Perhaps I did not make my point clear. In order to offer field personnel data to hit the hot spots, or to suppress certain areas of activity, I think one should know the maximum age of data before it's no longer valid, or of no further use.

D. R. F. TAYLOR: Now that you have been working with the Buffalo police, has your research revealed anything to them of crime patterns in the cities that they didn't know before?

P. O. HANSON: We have had no impact at all on the operation of the

Police Department. Some of the best sergeants I have talked to are convinced that they know where all the action is and that there is nothing we can do.

K. W. COLTON: I would say that the reaction you got is not uncommon. In fact in St. Louis that was exactly the case, where the computer mapping and modeling had been undertaken for a couple of years and then put aside. The reaction was: "I know where the crime is and you are not telling me anything that I didn't know, and besides that you are really after the fact. What I would really like to know is what is going to happen in the future". This is not a research tool from the social science aspect, so much as a tool for the police officer. I think there are still some questions to answer first.

P. O. HANSON: As I see it, we are interfacing to provide them with data of a certain kind and calibre they can use in their reports and PR work. We hope we can get them interested that way.

W. H. BRODHECKER: The computer phenomenon is still very young. You have to realize that when it came on the police scene 16 years ago, people did not think that it would change our society the way it has. There is a whole process of education. You are not talking about a time framework of two or three years. It is 10, 20, or 50 years away, or even 60 years away, in terms of application. We should realize that some of these things aren't going to be directly applicable to police work at all.

P. O. HANSON: My only comment is that the structure we came up with is good for subsequent processing and nothing else. We cannot, for example, look after reports by precincts or by time of day. That is of no use to me or you, yet that's where all the money is spent.

W. H. BRODHECKER: Where does your data base come from?

P. O. HANSON: For our research. We are only using what they call the 1191 and the 1192: offences known to police.

W. H. BRODHECKER: How large is your data base?

P. O. HANSON: Once we do our aggregation and reduce it to what I call a "data table", we are down to a matrix of perhaps 500 times the number of census tracts.

47424

GEOGRAPHICALLY BASED INTERACTIVE CRIME ANALYSIS

J. G. ARNOLD and F. R. LIPSETT

NATIONAL RESEARCH COUNCIL, OTTAWA

INTRODUCTION:

"While the geographic display of data is often times deemed trivial by the non-spatially oriented researcher, he soon learns to respect the power of doing it automatically after completing his first map coloring exercise". (JPL, 1976)

For the past four years my colleague Dr. F.Lipsett and I have been working in the field of Police Science. I will not talk about our past work in simulation but instead will talk about a tool we have been thinking about for some time - an interactive analysis package.

Anyone who has done an analysis of patrol activity in a police department will sympathize with the view it's a long and tedious task. I do not intend to give you a package that will entirely eliminate this work but rather an approach to help the officer responsible for patrol to better allocate his manpower. Usually, the first step, the gathering of the data is very frustrating. Fortunately, today with the arrival of mini computers in police stations around the country this task should become easier.

OBJECTIVES:

What are our major objectives in this package? They are

(1) To create graphic displays using automated techniques.
(2) To facilitate the analysis of calls for service.
(3) To summarize and simplify the data and its presentation.
(4) To produce a statistical summary of the data.

WHAT IS NEEDED:

What is needed for an urban police department to use a concept like the one I will describe?

(1) You need a geographical system that you can use to classify your data. We are using a street span system with visual centroids at the center

of each police atom. An atom is a police defined area. The city of Ottawa has 579 atoms.

(2) You need a computer system to provide the data as well as to run the package. We are using a PDP 11/55 with 2 disks, a tape drive, an alphanumeric terminal and a vector display. The package is divided into two sections:
map creation and interactive analysis.

The package is written in Fortran IV Plus which is an extended Fortran that is used by DEC (Digital Equipment Corporation). The system it runs under is RSX-11 M.

MAP CREATION:

The first section creates the maps used in the analysis. First a data set of uniquely numbered points is digitized from a map. These points are then inputed to the program and the analyst starts making his map.

SLIDE 1 (arrangement of terminals)

Here we see the general arrangement. On the left is the vector display (VT-11) with the video alphanumeric terminal on the right.

The interaction in the setup we currently have is through the light pen and alphanumeric keyboard. When one is defining a polygon it would be much better to use either a graphics tablet, tracker ball or joystick rather than the light pen. The light pen is difficult to point with the accuracy that one needs to draw a polygon.

The idea of building up a map in this way may seem like a trivial exercise but for those who have done it may appreciate the ease at which it is done. Let us look at how to build a simplified street map.

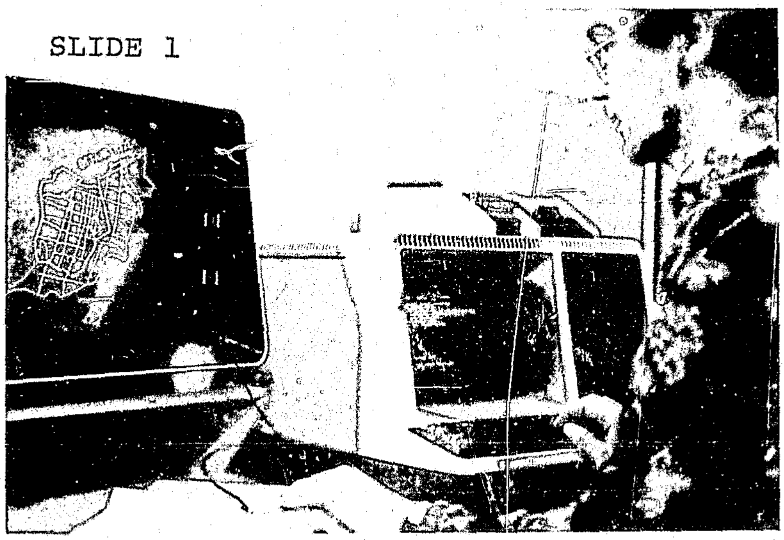
SLIDE 2 (Outline of Ottawa District 1)

Here is the border of district 1. This was drawn by keying in a range of numbers and then keying in the first number again to close the border.

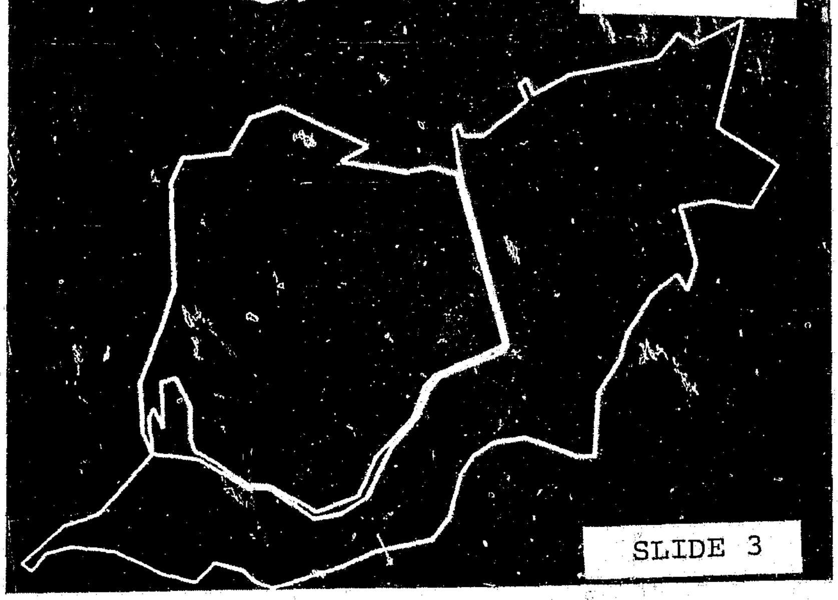
SLIDE 3 (Canal and Dows Lake)

Here we have indicated the points that make up the Rideau canal and Dow's Lake.

SLIDE 1



SLIDE 2



SLIDE 3

SLIDE 4 (Streets - Bank, Queensway etc.)

One keys in the streets one at a time to build up the map.

SLIDE 5 (Instructions on terminal)

Here we see the set of instructions used to build the map up to this point.

SLIDE 6 (Complete simplified street map)

One continues until one has a complete map which takes in the order of 15 minutes to create and use in the analysis of police data.

One also builds a centroid file that will be used to display our information. You will notice that we are not displaying our atoms on this map. The reasons we are not are twofold. First, we are working with the VT-11 which is a refreshed vector display so as one keeps adding more information the display buffer becomes used up and the picture eventually flickers becoming very hard on the eyes. This of course could be rectified by the use of a storage tube. The second reason is SIMPLICITY. We are displaying information and in order to aggregate it we have defined arbitrary polygons. To keep it simple we decided to eliminate these polygon boundaries and show the basic map with only the data that is present.

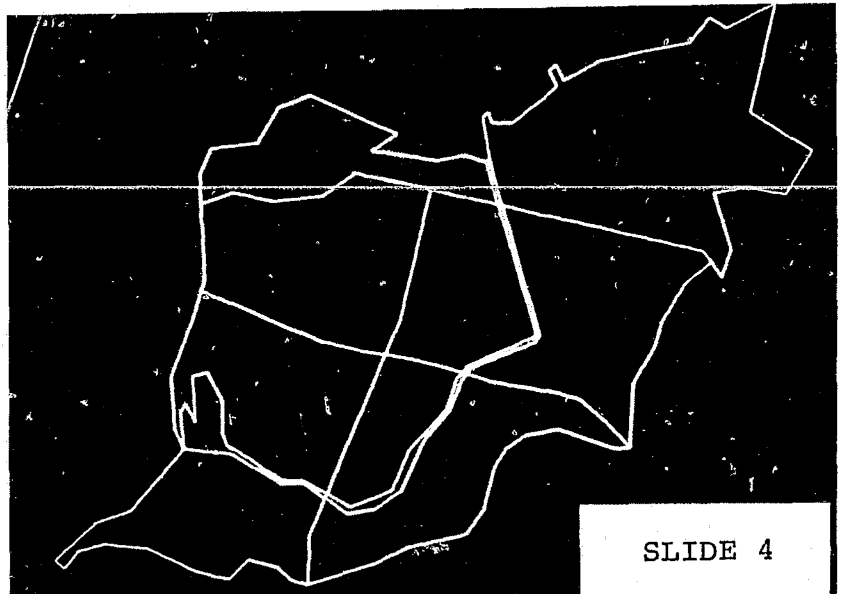
SLIDE 7 (Atom Boundaries drawn in 22)

Here as a contrast we see the atom boundaries all drawn.

INTERACTIVE SECTION:

The interactive section takes the map that was created and allows the user many alternatives.

1. An online edit of the map adding and changing various features at will. (For example, correcting digitizing errors).
2. To shade in user defined polygons.
3. To add or delete text.
4. To draw the map at various scales.
5. To display information in the form of pillars at the centroids of the atoms or also being able to shade in user defined areas.



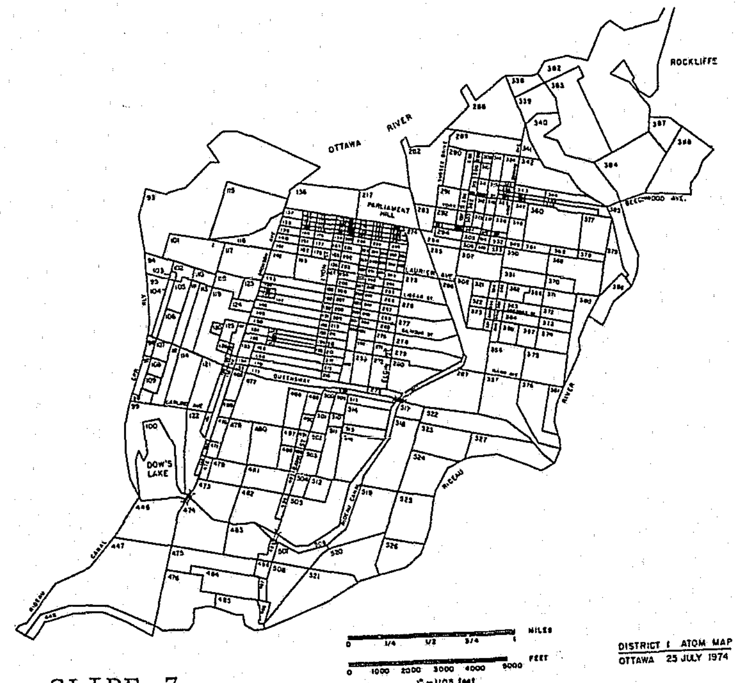
SLIDE 4

```
TYPE <CR> TO EXIT

>REM MAPEDI
>INS DK!\!\1:CRDAF
>RUN CRDAF
ENTER INPUT AND D.A. OUTPUT FILE NUMBERS:
>7,8
THERE WERE 185 POINTS IN FILE FOR007.DAT
DO YOU WANT DATA PLOTTED (Y/N)? Y
ENTER C TO CREATE CENTROID FILE,<CR> TO CREATE MAP FILE
ENTER NUMBER OF ASSOCIATED CENTROID D/A FILE: 9
ENTER E TO END, <CR> TO CONTINUE:
LINE   1 OF THIS GROUP:1 -63,1 /
ENTER E TO END, <CR> TO CONTINUE:60,64 -75,\,57- 46,06
LINE   2 OF THIS GROUP:60,64 -75,46,76 -95,60 /
ENTER E TO END, <CR> TO CONTINUE:
LINE   3 OF THIS GROUP:120 -122,10 /
ENTER E TO END, <CR> TO CONTINUE:
LINE   4 OF THIS GROUP:25,145,112,146 -149 /
ENTER E TO END, <CR> TO CONTINUE:
LINE   5 OF THIS GROUP:20,162 -164,134,133,165,119,166 -167 /
ENTER E TO END, <CR> TO CONTINUE:_
```

SLIDE 5

SLIDE 6



SLIDE 7

6. To produce a statistical summary of the calls for service data.

The calls for service data is accumulated on a magnetic tape. Here, I am mounting a tape with seven weeks of calls for service data (18,000 calls) obtained from the Ottawa Police Force. The data is in the following form:

SLIDE 8 (Data used in analysis)

The record starts with the year, month and day. Next the four times, T1-T4, where T1 is the time the call was received, T2 the time the car was dispatched, T3 the time the car arrived and T4 the time the car finished the call. Next comes the car number, the 10 code designation, (10-34 a break and enter) in atom 401 (our geographical referenced location) and a 600 code which in this case was a residential break and enter in progress.

Sitting at the consul one then interrogates the tape for a particular time period in question. A sample interrogation could look like this.

SLIDE 9 (Data for interrogation)

Here we key in the title of the session followed by the actual time period. Next the number of months to look at, the month, number of days and dates follow. Here we are looking at the entire month of March 1976 the time period is for the whole day 0000 hours to 2400 hours.

The program searches the tape for this particular time and tabulates 25 variables by atom as shown on the following slide

SLIDE 10 (Variables)

This data is all keyed to the atom so that we can produce a map with any one, several or combinations of the parameters. Here we have the number of calls to each atom, dispatch delay, travel time, service time, utilization and the calculated averages. When we initially started analysis of patrol operations we looked at the number of calls for service but it is probably more appropriate to look at the utilization time (time the officer is

YEAR	MONTH	DAY	T1	T2	T3	T4	CAR #	10 CODE	ATOM NOS	600 CODE
75	07	28	0159	0205	0211	0230	105	34	401	611

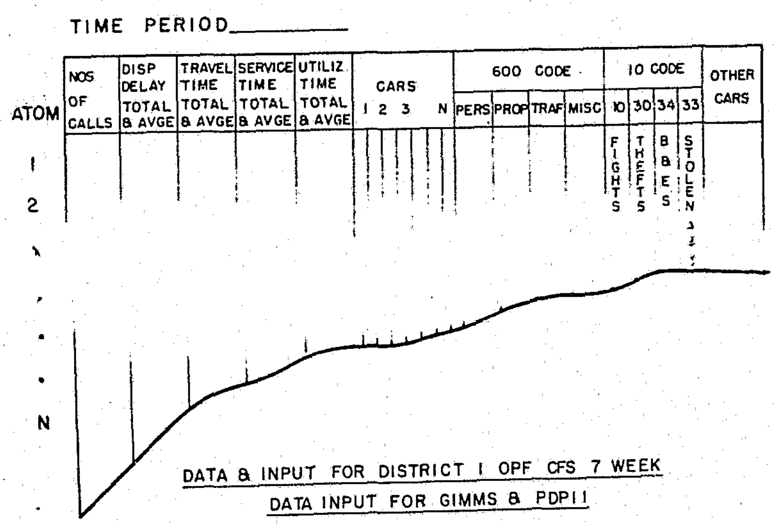
DATA USED IN ANALYSIS SLIDE 8

DATA FOR INTERACTIVE ANALYSIS

B&E'S RES MARCH 1976	←TITLE
0000 2400	TIME PERIOD
1	NUMBER OF MONTHS
3 31	MONTH, NOS. OF DAYS
1,2,3,4,5,6,7,8,9,10,	ACTUAL DATES

----------30,31.	

SLIDE 9



SLIDE 10

on a call for service) of the police officer as this is the resource being consumed. Also we keep track of where the zone cars went - that is which atom they went to. As mentioned earlier a 600 code is used to identify incidents. These have been broken down into 4 broader categories - crimes against persons, property, traffic and miscellaneous. These 4 major groupings give an overall look at what is happening where. If one wants to get specific we can put in specific 10 codes to cover such events as disorderly disturbances, break and enters, thefts, and stolen autos as shown here. One reason we have arranged the data in this way is to input it into the GIMMS (Geographical Mapping and Manipulation System) system at Carleton University. We are going to do an evaluation of GIMMS in the next month or so to see if it can help in the analysis of calls for service.

One now is able to display this data on the simplified street map by means of pillars.

SLIDE 11 (Pillars)

The display we see here is for break and enters for March 1976. The length of the pillar corresponds to the number of B and E's. There is a facility to shade in user defined polygons. This is very helpful when one is looking at workloads and equalization of the same.

SLIDE 12 (Shaded in) New.

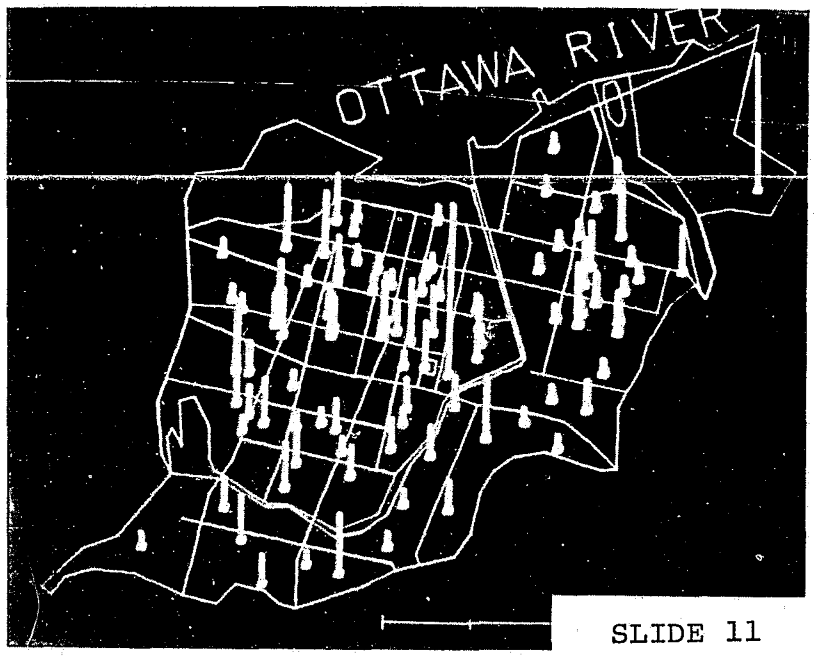
These polygons were defined with the light pen and reflect the amount of activity generated within their boundaries.

SLIDE 13 (Terminal for showing percentage)

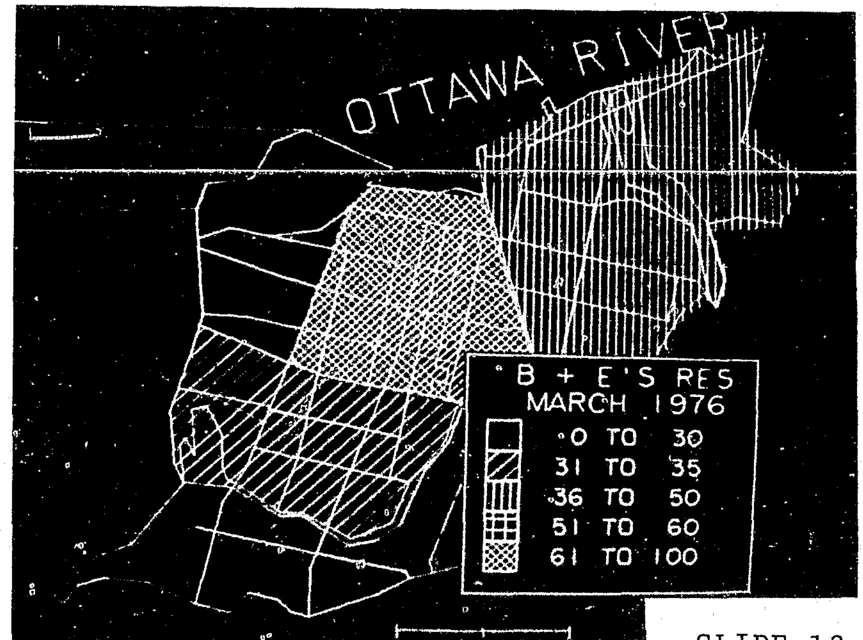
The terminal then shows the results of the interaction with the total number of B & E's and their percentages.

STATISTICAL SUMMARY:

For each session a statistical summary is provided. Distributions of DISPATCH DELAY, TRAVEL TIME, SERVICE TIME and UTILIZATION TIME are automatically determined along with appropriate averages.



SLIDE 11



SLIDE 12

```
MORE POLYGONS TO BE DEFINED (Y/N)? Y
E
MORE POLYGONS TO BE DEFINED (Y/N)? Y
E
MORE POLYGONS TO BE DEFINED (Y/N)? N
MAPEDI-ENTER KEY: 10
ENTER INPUT DATA FILE NAME: DATA.DAT
PLOT PILLARS (Y/N)? N
DO YOU WANT AREAS SHADED? (Y/N): Y
ENTER TITLE (2 LINES): B & E'S RES
MARCH 1976
ENTER UPPER LIMITS ON RANGES (5 MAX), <CR> TO END:
30
35
50
60
100
POLYGON  0 HAD   0 OR   0.00% OF TOTAL.
POLYGON  1 HAD  14 OR   7.37% OF TOTAL.
POLYGON  2 HAD  67 OR  35.26% OF TOTAL.
POLYGON  3 HAD  49 OR  25.79% OF TOTAL.
POLYGON  4 HAD  33 OR  17.37% OF TOTAL.
POLYGON  5 HAD  27 OR  14.21% OF TOTAL.
ENTER SAVE FILE NAME OR <CR> TO RETURN:
```

SLIDE 13

Workloads are calculated for each car zone. They are also calculated for each car since it may answer calls outside its own zone.

How many times each car went out of its zone to answer a call for service is tabulated. The calls for service types are broken down by percentages into the four main headings of Personal, Property, Traffic and Miscellaneous. The number of 10 code events such as fights, thefts, break and enters or stolen automobiles and their respective percentages are tabulated. And finally the total number of calls for service are tabulated. The use of an interactive package as I have described should make the police planner's job a lot easier.

References

1. International Association of Chiefs of Police. (IACP), 1976, Geographical Base Files for Law Enforcement - Workshop Notes, Research Division, 11 Firstfield Road, Gaithersburg, Maryland, 20760.

2. Jet Propulsion Laboratory (JPL), 1976, Lumis Interactive Graphics Operating Instructions and System Specification, JPL-SP-43-31,NTIS N76-30821, 101 pages.

DISCUSSION

D.H. DOUGLAS: What kind of data structure are you using to define the polygons?

J.G. ARNOLD: The ones we are using from a computer simulation we obtained from MIT. We adopted the algorithm from the simulation, basically for finding points within the polygons.

D.H. DOUGLAS: So you digitize the segments.

J.G. ARNOLD: No, we digitize the atom boundaries and the vertices.

D.H. DOUGLAS: Is each polygon separate?

J.G. ARNOLD: Yes.

S.K. CHANG: Is that system operational in your police force now?

J.G. ARNOLD: No, it's not. It's in the research stage right now. We've been working on it since last fall. We are looking forward to using it when CADRE comes up. We hope they will be able to file their calls for service on magnetic tape and that we will be able to do an analysis of the tape with this package. The officer in charge of a patrol should be able to interrogate the tape and look at various shifts. He could look at morning rush hour, for instance.

W.J. BROWN: Do you have a manual or an automatic logging system?

J.G. ARNOLD: The data that I showed you was partly written and partly punched on a card by a time clock. We had to edit and get it key punched. It relies on the officer to report the arrival time and on the dispatcher to stamp it. We hope this will be automatic in the future.

W.J. BROWN: What problems are involved in getting people's views on this type of information?

J.G. ARNOLD: We haven't really approached police officers on this. We have shown the patrol commander what we have been doing but we don't feel that it's reached a point where we could invite him to use the system. There are quite a few problems yet, as you saw on the slides. When we reach a point where the system is more or less complete we will attempt to get user opinions on it. The patrol commander hasn't worked with the interactive maps yet.

W.J. BROWN: Do you think an educational process will be required before this type of technology will be accepted by police and management?

J.G. ARNOLD: Most definitely.

W.J. BROWN: What sort of person do you require to set up this educational program?

J.G. ARNOLD: We are not sure of that yet.

D.G. LYON: I presented colour maps on house break and enters to the heads of the force and they are very excited about being able to look at the number of house-breaks that occur in the atoms of the city. Now, unfortunately, we have been unable to supply maps to them on a continuing basis because our facilities are not adequate.

S.W. WITIUK: What steps have been taken towards expanding the data collection?

J.G. ARNOLD: As you are aware I am not happy with the spatial unit of the atom. That came out of the simulation system we got from Richard Larson of MIT. What has happened, of course, is that the Ottawa Police Force didn't have a geographical reference location system before, so when the atom came along they immediately adopted it. We are now going to have to look further. Workshop material that the IACP put out last year says we should give the street address. That is a decision that will have to be made but as Fraser Taylor said, you'd better make sure that whatever choice you make is right, so that ten years later it doesn't have to be changed.

S.W. WITIUK: Following up on that comment regarding the recording of the spatial element, isn't there an implicit assumption that links the location of the crime to the residence of the criminal that, in fact, is likely false? According to the formats that we see, the link with the other data is not possible in a spatial context because you will be getting information only about the demographic characteristics of a place in which the crimes are occurring, rather than the demographic location of the process that is causing the crime to emerge. I think one could map the atom over the census information, for instance.

J. LECOMPTE: Can you say a few words on the structure of the atom. For instance would you mix a residential area with a commercial area or a park area?

J.G. ARNOLD: We would probably make a park into one atom. Similarly we wouldn't break apart a shopping centre. Rivers, of course, are well defined boundaries as are railroad tracks. In Burnaby we asked the zone commander who handled the patrol cars to break his area down, rather than telling him how to break it down.

J. LECOMPTE: Using the same logic you would not include a low income area with a high income area around it, would you?

J.G. ARNOLD: No. We broke out low rental areas and got interesting results by looking around those areas.

K.R. COCKE: Would the package available to police be written in Fortran IV Plus and thus be transferrable to those using DEC equipment?

J.G. ARNOLD: Anything we have is available to the police departments.

W.J. BROWN: What is the alternative to the atom system? Is it a segment system with actual addresses?

J.G. ARNOLD: That's right.

W.J. BROWN: Does that mean that systems that presently use the atom system will have to be redone?

J. G. ARNOLD: It's quite possible. There is a big problem here. A mini-computer can handle atoms very well, for example 579 atoms for Ottawa. But I am worried about trying to get a mini to do that sort of data processing with, say 100,000 addresses, not to mention streets. I don't think that the technology is advanced enough yet.

F.R. LIPSETT: This is a fundamental question that we have never resolved to our own satisfaction. I think Victor Davis from Atlanta has resolution to the nearest lot. Most police forces utilizing geocoding use block faces for their resolution. I don't think anybody has decided what resolution is required for police work or for related sociological studies.

S.W. WITIUK: You really need the coordinates for the event. It may not be economic yet, but if you have point locations whatever structure you build in the future will have the necessary resolution.

4/14/25

INTELLIGENT TERMINALS IN AN POLICE INFORMATION NETWORK

RON A. K. MEYER

Canadian Police Information Centre
Royal Canadian Mounted Police

Micro-processor based terminals are now available in sufficient quanity and diversity, and at a sufficiently low cost, to be used in large computer networks. As a manager in such a network, I believe that the introduction of intelligent terminals promises to impact large networks more than any single technical advance made in the past ten years. The potential aspects of this impact, both positive and negative, will be discussed.

Micro Processor Based Terminals vs Intelligent Terminals

Many different interpretations exist and are used when referring to intelligent terminals. The term is used to cover a very broad range of structures and abilities, fr from a 'soft-wired' conventional terminal through a full scale mini-computer system. For the purposes of this paper, a boundary will be defined to separate these into two categories.

The term 'micro-processor based terminals' will be used to describe those 'soft-wired' devices that implement conventional terminal characteristics using a micro-processor and ROM (read-only memory) and/or PROM (programmable read-only memory). Strap options, board variations, etc. are handled with memory changes. This approach will likely supplant all 'hard-wired' terminals developed during the next five years and represent the low cost line of 'dumb' terminals. The primary reason for this conviction on my part is the economics of the terminal market.

The micro-processor based terminal will be more economical to build, to test, to customize for an application and to maintain. Because of the inherent adaptability of the micro-processor, the terminal can be altered at a reasonable cost to react to an evolving application, or it can be reprogrammed for installation at another customer site. Carriers and customers can purchase this equipment with greater confidence that it will have a ten year or better service or revenue-generating life. Common test equipment and technician training can cover a variety of apparently different terminals. Much of the logic testing can be done with an appropriate diagnostic PROM. Economically, the days of the hard-wired terminals are numbered just as certainly as they are for mechanical terminals. It will just be too expensive to keep them.

The 'intelligent' terminal is distinguished by having user-programmable RAM(random access memory). It is essentially an extremely flexible device. It too has a micro-processor, more likely several micro-processors and offers support for many devices. A single basic terminal may look like a data-entry sub-system, a stand-alone mini computer system, an RJE (remote job entry) sub-system, a text-editing sub-system, or a highly tailored terminal system. Essentially, the intelligent terminal is viewed as an inexpensive mini-computer!

The intelligent terminal will normally have a network function in that it distributes significant processing to the nodes of a network. A central or 'host' computer will be noticeably relieved of processing functions.

The intelligent terminal will also consequently require significant software support, quite probably on the part of the customer and certainly on the part of the supplier. While the microprocessor based terminal can continue to be designed by engineers and tailored by technicians, the intelligent terminal application will have to be designed, implemented and supported by software programmers. Therein lies both the strength and the weakness of intelligent terminals.

Large Network Constraints

Adaptability

A large network, one with more than 200 terminals distributed over a broad geographic area is vitally concerned with standards. Inevitably many people are involved in the maintenance and operation of such a netowrk and often the people are employed by many different organizations. Such a network will have selected a restricted number of interface and protocol standards which will be supported on the network. The standards may be supplier standards, industry standards, de facto standards, or customer developed standards. However, standards must exist. Migration or extension to support new facilities, new equipment or new services will pose the problem of phasing the resulting new interface and protocol standards into the existing network. There are many disincentives to the manager who would consider doing it by duplicating facilities (installing separate lines, concentrators, communications controllers and host hardware support); the primary one being the very high cost. It is improbable that the manager of a large network will attempt a total conversion to a new terminal (weekend panic). Many terminal users likely prefer their existing terminal system and are averse to major disruption. The geographic spread makes such a project a very risky one. Evolution offers more promise than revolution.

The most attractive approach for a network manager is to introduce the new offering slowly, and adapt it to run on the existing network. Over a period of time, the network protocol can be progressively (and safely) altered to utilize and support the protocol and features of the new terminal inboard the network. The intelligent terminal permits the designer to selectively emulate the old protocol while offering many of the features of the new terminal to the terminal operator. The ability of the terminal to do code conversion, segmentation, control character substitution and to generate the sequences needed by the network are vital to this approach. Intelligent terminals offer the first viable and attractive solution to the problem of network adaptability.

Reliability

Terminal networks are used to provide on-line computer support directly to a labor force. On-line systems augment the productivity of operational people and operational units and permit the provision of a higher level of service to the clientele. Terminals rapidly become a vital part of the procedures utilized by front-line personnel to do their jobs. Because of this, the terminal and the service it provides must sustain a level of reliability comparable to that provided by the telephone network. If the system is not reliable, the staff won't rely on it. If they do not rely on it, they will not use it. If the system is not used, it is a failure and the money it cost was wasted! Therefore, reliability and integrity or accuracy are probably the most critical objectives of an on-line system, and are also the most technically complex to achieve.

Reliability is achieved by careful design, good specifications, redundant equipment, diagnostic procedures and great amounts of testing. Reliability is sustained by avoiding cataclysmic change and carefully controlling all changes of hardware or software. Change of any sort dramatically increases the vulnerability of the system to down time. However, change is inevitable. Requirements change and components of the system must be changed to reflect this. Workloads increase and equipment capacity is exceeded, resulting in change for more capacity. New applications are required. Therefore, any successful on-line terminal network must already have the methodology to deal with change.

The application of intelligent terminals can distinctly aid the manager in his pursuit of reliability. As identified earlier, they provide the ability to mask incremental change by isolating changes to a sub-system. The diagnostic ability of the intelligent terminal can be used to diagnose other failures of the system (lines, concentrators, etc.) and the re-try ability permits the system to recover gracefully from short duration failures. Achieving reliability is an evolutionary process. The adaptability offered by the intelligent terminal presents the opportunity to eliminate identified vulnerabilities and thus increase reliability.

Intelligent terminals could, however, also be used in a way that would reduce reliability. They offer the ability to very easily tailor each terminal individually. The term 'user programmable' could be literally interpreted. If many people are simultaneously programming the terminal, changes will not be controlled, testing will not be adequately done, and the impacted terminal users will experience an unreliable system as certainly as if a data base processor had failed. It may be necessary to restrict programming capability of the intelligent terminals to just one terminal in the network or to the host processor as IBM does. In that case, the terminal user would not see the terminal as a programmable device. Only the system designer and the network manager would be able to take advantage of the programmability offered by an intelligent terminal.

Training

Large terminal networks pose an operator training problem hitherto unknown to EDP managers. Suddenly, hundreds, possibly thousands, of people are directly interacting with the computer system. They may be distributed across a continent. Training and documentation needs assume massive proportions.

Most large computer networks deal with this problem in a similar fashion. They use the computer terminal to augment the training process. A workbook, a training data base, and a series of well-planned exercises or drills enable the new operator to walk through the necessary sequences and become familiar with operating procedures.

It must be noted that this approach merely uses the computer as a tool to 'drill' the novice operator. The technique has proven to be effective for training dedicated operators when staff turn-over is kept to a reasonable level. However, when a terminal is being used by a number of occasional or casual operators, the necessary time is rarely taken to become thoroughly proficient using this type of training. In the latter case, something more akin to Computer Aided Instruction (CAI) is required. This would involve a dialogue between the computer system and the operator. The terminal must selectively prompt the operator to ensure that the correct information is entered. If this interactive prompting is done from the central computer, the communications network must handle a significantly higher load, since each transaction may result in ten to twenty-five messages being processed through the network in each direction.

An intelligent terminal would be capable of being programmed to provide the interactive prompting required by the casual operator locally, while restricting the data communications workload to the same volume as experienced in a non-interactive network. It can do the interactive prompting by field with a near instant response time, something that cannot be economically provided without local processing capability. Intelligent terminals will truly permit transient or occasional users to effectively and economically use a computer based information system.

Networking

Several characteristics of computer systems which tend to discourage the continued centralization of data-base applications on one computer complex have been identified in recent years. These are:

- the sheer processing limitations of a single system;
- the vulnerability of a single system;
- the needless inter-dependencies which just 'happen' to be created when a single system is used with the resulting impact on maintenance cost and reliability;
- the data to be accessed crosses several jurisdictional levels;
- geographic distribution of the community of interest;
- varying levels of security and access rights. This can be handled most safely with independent systems;
- economies of scale in a large network do not always hold true, and in fact, sometimes invert;
- improved communication facilities encourage distribution of data base components.

However, any given terminal on the network may have access to all of the distributed processsing power. Whether the network link uses a message switch at the centre of a star, node to node addressing, a 'hot potato' loop, or a custom or commercial packet switching service to link a terminal with a processing host, some amount of intelligence is required from such a terminal. Selective addressing is certainly required, as is some ability to distinguish which host a message was received from. Considerable intelligence at the terminal permits maximum flexibility and thus maximum cost optimization to be achieved in network design. Commercial packet switching virtually demands an intelligent terminal to permit effective use. Large networks linking many data bases become operationally and economically practical only when intelligent terminals are used. They permit a single consistent view to be presented to the operator of many different, separately-developed data bases.

The intelligent terminal, '<u>if used intelligently</u>', can provide the vehicle to establish the large multi-faceted networks of the next decade.

<u>The Canadian Police Information Centre Network</u>

The CPIC system was established to collect, store and disseminate operational police information to all accredited police agencies in Canada. The objectives of the system are:

- INTEGRITY
- RELIABILITY
- EASE OF USE
- PERFORMANCE
- ECONOMY

The network technique employed is a modified 'STAR' network, the modification being the concentrator nodes implemented for reasons of economy and control. Fig. 1 pictorially illustrates the network structure. The network presently supports some 870 terminals located in every Province and Territory of Canada. Each terminal operates as if it had a dedicated line to the centre of the STAR. No polling, selecting or multi-droppign is implemented.

The initial system supported a single terminal type, the Texas Instrument Silent 700 series. This is a hard-logic machine which produces a single hard copy on a thermal printer. It is operated in the network at 10, 15 or 30 characters per second, depending upon line costs and workload. Approximately 30% of the terminals operate at 30 cps. Input buffering, backspace and error correction, and line monitoring are provided for each terminal by the concentrator node (DSX), an Interdata mini-computer. The DSX also terminates synchronous lines carrying a character interleaved stream from a second level concentrator, in this case a TIMEPLEX MC 70 TDM.

The concentrator (DSC) and the front-end computer (also an Interdata mini-computer) operate as 'hot potato' packet switches. They do not have secondary storage. Therefore they packetize incoming bit streams in buffers, segment messages and get rid of these segments as fast as they can. The front end groups segments together for processing by the host computer.

The first segment is passed to the front-end as soon as the message has been processed. Subsequent segments of a message are forwarded upon request by a DSX. This technique has proven to be effective. Under heavy usage, the transit time through the network is less than ½ second in either direction.

A new communications system design is currently under development. While most of the fundamental principles of the original design are retained in the new design, modifications are being effected to reflect advanced technology, provide more logical system separation, remove interdependence between the computer sub-systems, and to provide greater flexibility and adaptability. The new system is scheduled to become operational during 1978. It will provide limited disk storage at the DSX for program storage, check-point/restart, and extended buffering during short duration, downstream failures. Considerable disk storage will be provided at the front-end to handle traffic switching without involving the host processor. The host processor will become network transparent, essentially a data base processor.

The facility will be incorporated to support a second front-end complex, remotely sited from the host coupled by a 50 kb circuit. Two objectives exist for this change. First, an economical warm back-up can be provided which would sustain inter-system communications in the event of a fire or similar destructive occurrence at the host site. Secondly, the front-end can connect to any similar sized IBM 370 where emergency back-up can be arranged. This also will facilitate testing and conversion to any subsequent replacement host (data base) processor.

The communications function and the data base function are being deliberately separated into different systems. Changes to the communications system are generally initiated by events which have no impact on data base processing, and vice-versa. Better user insulation from disruption can be provided if only one of these systems (hardware or software) is changed at one time. It is also my observation that no computer supplier has equal ability or superiority in both of these areas. An impartial observer might also draw the conclusion that technical ability in these two areas is

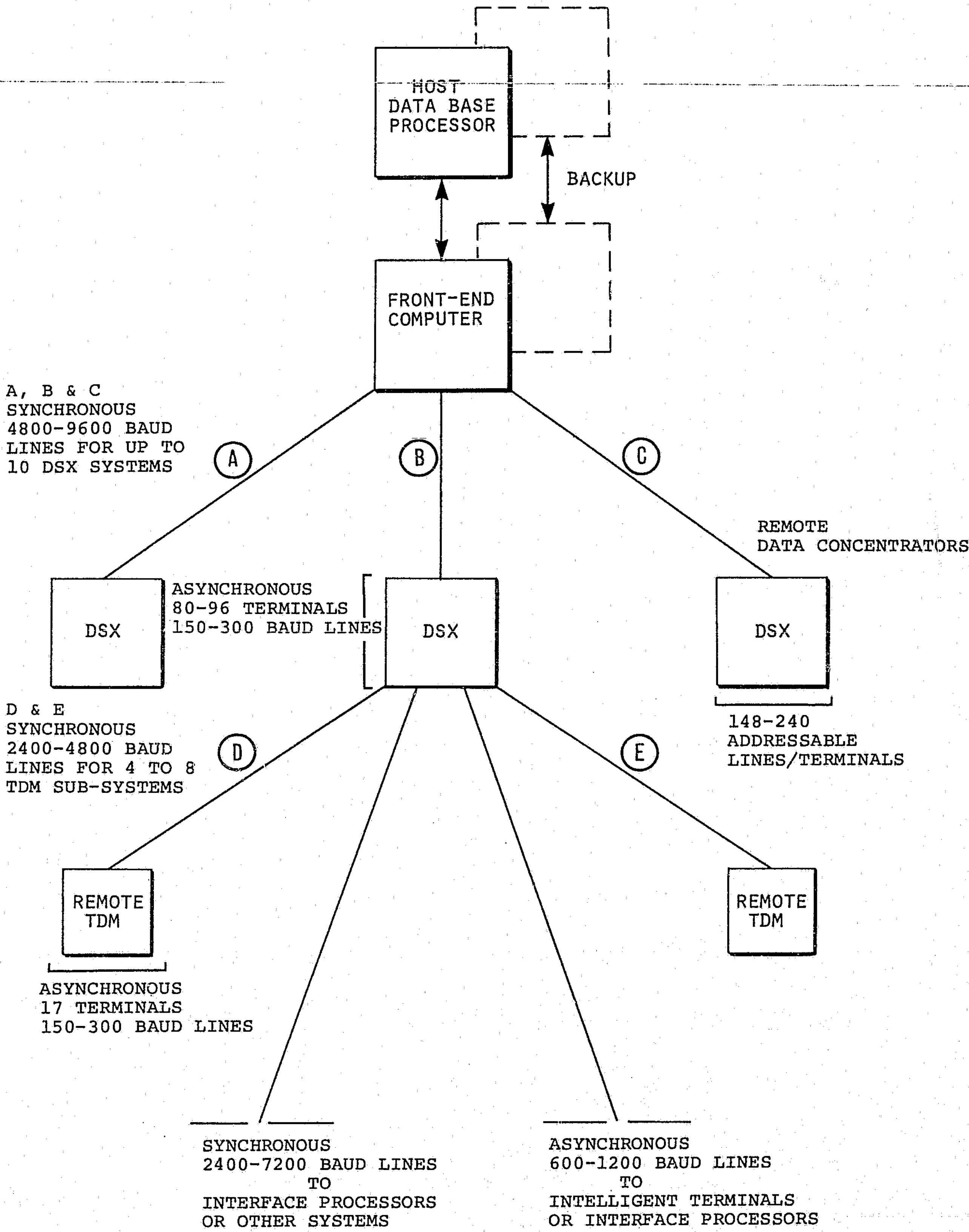

HOST
DATA BASE
PROCESSOR
BACKUP
FRONT-END
COMPUTER
A, B & C
SYNCHRONOUS
4800-9600 BAUD
LINES FOR UP TO
10 DSX SYSTEMS
A
B
C
REMOTE
DATA CONCENTRATORS
DSX
ASYNCHRONOUS
80-96 TERMINALS
150-300 BAUD LINES
DSX
DSX
148-240
ADDRESSABLE
LINES/TERMINALS
D & E
SYNCHRONOUS
2400-4800 BAUD
LINES FOR 4 TO 8
TDM SUB-SYSTEMS
D
E
REMOTE
TDM
REMOTE
TDM
ASYNCHRONOUS
17 TERMINALS
150-300 BAUD LINES
SYNCHRONOUS
2400-7200 BAUD LINES
TO
INTERFACE PROCESSORS
OR OTHER SYSTEMS
ASYNCHRONOUS
600-1200 BAUD LINES
TO
INTELLIGENT TERMINALS
OR INTERFACE PROCESSORS

FIGURE 1

mutually exclusive!

The current system is meeting most objectives adequately. The mean response time at the terminal is less than three seconds 90% of the time. System availability is being sustained at better than 99% or,put another way, less than 80 minutes of down time per week as viewed from the terminal. The 'average' terminal is located 1300 kilometers from the host computer and costs less than $400.00 per month for access to the host, including the cost of the terminal, modems, lines, TDMS, DSX, etc. Integrity of records has been maintained. Stable on-line systems are vulnerable to compromises of integrity only as a result of combination of hardware, human and software errors. To cope with such a threat, on-the-fly audit routines are being implemented to provide instant detection, thus limiting damage and consequently repair time.

Ease of use, however, has been more difficult to achieve. The first applications installed were comparatively simple to understand and use, and during the first year of operation, there were fewer than 100 terminals involved covering a limited geographic area. The first operators were thoroughly trained in classrooms and were installed. Each subsequent application tended to be more complex, and also interacted with the previous applications with a net effect that the system became more complex to understand and use each year.

Today, approximately 4,000 police personnel use the CPIC system as part of their regular duties. New staff, turnover and application refinements have combined to make the initial classroom training obsolete. The number of people involved, the geographic distribution and turnover rate of operators dictate that terminal operator training is done on-the-job almost exclusively, using a terminal set in the training mode and following established exercises. Training mode uses training data bases rather than operational data bases. Intelligent terminals will permit a third mode of terminal operation, 'novice' mode. In this mode, operational data bases would be manipulated, but the terminal program would interactively 'walk' the operator through the transaction preparation sequences. This will permit newly assigned operators and occasional users to utilize the terminal effectively, albeit slowly. The intelligent terminal would, in effect, automate the vital portions of the Reference Manual in an interactive manner.

Other Intelligent Terminal Applications

It was identified earlier that a single terminal type was supported on the system, from which it could be inferred that a single user community was to be served. That is, alas, not so. A number of user communities have always existed and were recognized in the original design. However, their divergent requirements were partially met by building in software variations to support the different methods of operation represented. Neither time nor money was available to provide each community with the 'ideal' terminal to suit the environment. Different terminals demanded different protocol and inter-action sequences and we could not afford that in the late sixties when the system was being designed. Intelligent terminals have changed that.

We now recognize four other user communities, beyond the user of the TI #720.

The 'novice' or specialist squad or occasional user requirement was defined earlier. An intelligent terminal with adequate storage for programs, formats, and data assembly would satisfy this requirement.

The second user community is the communications centre environment. This community handles a high volume of narrative traffic and is concerned with broadcast of messages, delivery of messages, re-direction of messages and storage of traffic. Communications centres often also handle file inquiries but rarely do any file maintenance.

The third user community exists in large metropolitan centres with a requirement to satisfy the information requests from a number of patrol dispatchers. The requirement of this community is to support a number of stations and provide a 'shorthand' ability to enter file enquiries. The goals of a device for this community would be to increase the throughput of each dispatcher while reducing the line and port demands of the cluster of terminals.

The fourth user community operate large record centres and have four or more terminals dedicated to file maintenance. Again, the objective of a new device would be to increase the productivity of each operator in order to reduce costs. If possible, some fundamental field editing should also be done to ensure the accuracy of the transaction prior to transmission since this would help newly-hired operators.

In fact, a fifth category is being implemented and can best be called 'other networks'. This involves the development of custom interfaces to other networks and other data bases. In virtually every case, there is a requirement to convert protocols, codes and control characters and to translate message formats from both systems. Our intent is to use an 'interface mini-computer' to effect these interfaces. It is quite likely that an intelligent terminal capable of satisfying the previously defined requirements would also be capable of acting as an interface computer.

In satisfying these requirements, every effort will be made to adhere to existing protocol, link standards and methods of operation. This philosophy of one transaction out in response to each transaction in, will still prevail. This will minimize the amount of unique documentation and training needed. Further, we will attempt to customize a terminal for each of these communities based upon the same terminal device. Intelligent terminals will likely permit this goal to be recognized.

A device with potential to satisfy these requirements must:

- be programmable, from a reasonably large memory;
- have secondary storage;
- have a very flexible line interface unit;
- be capable of simultaneously supporting more than one line;
- support up to 16 satellite keyboard displays;
- have ten or more function keys at each keyboard display.

The device must have a basic threshold operating cost comparable to the current terminal ($160 /month including 24 hour, 7 day maintenance coverage). Yet it must be field expandable to the size of a key-to-disk data entry mini-computer.

Fig. 2 illustrates the configurations needed.

A terminal which appears to meet these requirements is currently under investigation, and it is expected that many such devices will be available in the near future: The most significant breakthrough in the past two years has been made in the area of cost. While terminal systems with similar capabilities have been available for 4 or 5 years, it is only recently that they have been offered at prices comparable to the cost of hard logic terminals.

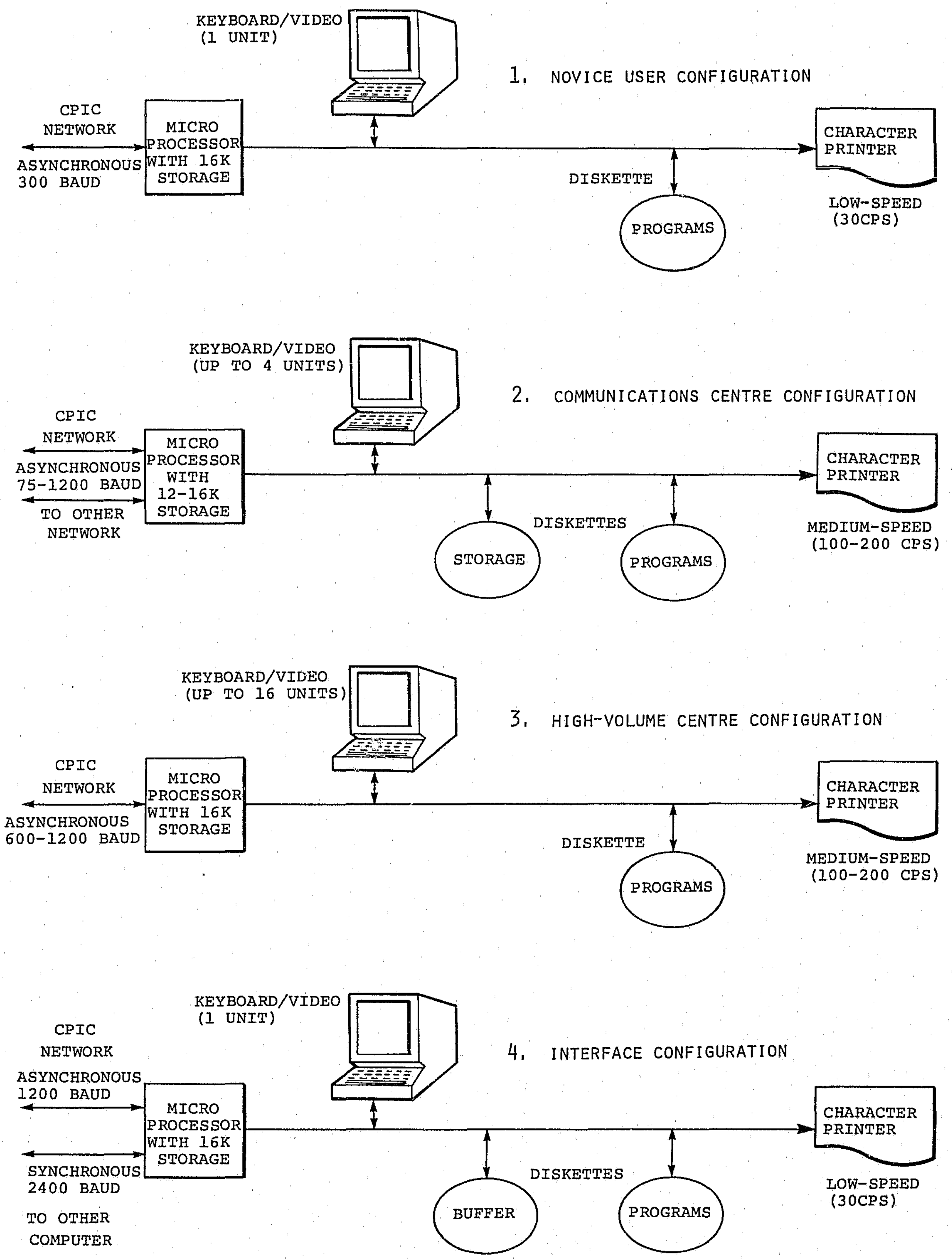

KEYBOARD/VIDEO
(1 UNIT)
1. NOVICE USER CONFIGURATION
CPIC
NETWORK
ASYNCHRONOUS
300 BAUD
MICRO
PROCESSOR
WITH 16K
STORAGE
DISKETTE
PROGRAMS
CHARACTER
PRINTER
LOW-SPEED
(30CPS)
KEYBOARD/VIDEO
(UP TO 4 UNITS)
2. COMMUNICATIONS CENTRE CONFIGURATION
CPIC
NETWORK
ASYNCHRONOUS
75-1200 BAUD
TO OTHER
NETWORK
MICRO
PROCESSOR
WITH
12-16K
STORAGE
DISKETTES
STORAGE
PROGRAMS
CHARACTER
PRINTER
MEDIUM-SPEED
(100-200 CPS)
KEYBOARD/VIDEO
(UP TO 16 UNITS)
3. HIGH-VOLUME CENTRE CONFIGURATION
CPIC
NETWORK
ASYNCHRONOUS
600-1200 BAUD
MICRO
PROCESSOR
WITH 16K
STORAGE
DISKETTE
PROGRAMS
CHARACTER
PRINTER
MEDIUM-SPEED
(100-200 CPS)
KEYBOARD/VIDEO
(1 UNIT)
4. INTERFACE CONFIGURATION
CPIC
NETWORK
ASYNCHRONOUS
1200 BAUD
SYNCHRONOUS
2400 BAUD
TO OTHER
COMPUTER
MICRO
PROCESSOR
WITH 16K
STORAGE
DISKETTES
BUFFER
PROGRAMS
CHARACTER
PRINTER
LOW-SPEED
(30CPS)

FIGURE 2

The introduction of a programmable terminal whose programs may correspond to host application programs introduces another complex level of programming support. Every time an input message format is added or changed, or the editing rules change, some of the intelligent terminal programs will change. Support software currently available for intelligent terminals is quite primitive, hence development and testing effort will be increased. The process of releasing new levels is complicated in that the terminal programs will have to be updated in concert with the release of a new host system level. A number of options are available when the process of updating terminal programs is considered.

The most attractive approach at this time is to permit 'down-line' loading of terminal programs from a specific control terminal address. The control terminal would 'broadcast' the message containg the new program to all programmable terminals. Upon recognition of a 'load module message', each terminal would modify its disk storage program with the new load module, and acknowledge the modification back to the control terminal.

This approach ensures that only properly tested programs are used in intelligent terminals; that they are loaded at the correct time, and that each program that should have been modified in fact was modified.

Conclusion

Intelligent terminals will play an increasing and vital role in the CPIC police information network. In every case, the role will have to be justified financially, primarily by increasing operator throughput, thus saving operator time, and reducing manpower cost.

Bearing in mind that most terminals are operated by three to four operators on different shifts, the cost differential between our standard terminal and an average intelligent terminal can be compensated for by a 5% productivity increase of a police-man or an 8% productivity increase of a civilian operator. Such gains are readily achievable with the current state-of-the-art in intelligent terminals.

DEVELOPING A COMPATIBLE SYSTEM OF POLICE GEOFILES IN THE UNITED STATES

ALLEN L. PEARSON II and SAMSON K. CHANG

International Association of Chiefs of Police, Inc.

Introduction

This paper deals with the establishment of a nationwide system of police geofiles in the United States based on compatible coordinate systems. Due to the interlinkage resulting from shared coordinate bases, data from various localities over wide areas can be collected and merged to perform spatial and aspatial analysis. The values of this system are discussed both from the standpoint of desirability in application in the United States as well as the implications of such an effort to Canadian application in computer mapping of police data. A background is given concerning the development effort on geobase files of police by the International Association of Chiefs of Police in the United States on a national scale. Current implementation policies and successes are addressed as well as their transferability to other nations.

This paper uses the term "compatible coordinates" which refers to the three sets of X, Y coordinates currently available through the GBF/DIME File as developed by the U. S. Bureau of the Census. These three sets are:

Map Set Miles. Two six-digit coordinates expressed in miles and thousandths of a mile measured from an arbitrary point at the lower left of the Metropolitan Map Series coverage for each SMSA. The decimal point is implied between the third and fourth digits.

Latitude, Longitude. Six and seven-digit coordinates, respectively, expressed in degrees and ten thousandths of a degree. The decimal is implied between the second and third digits for latitude and between the third and fourth digits for longitude. Latitude is defined as the angular distance north or south from the earth's equator measured through 90 degrees. Longitude is defined as the arc or portion of the earth's equator intersected between the meridian of a given place and the prime meridian.

State Plane. Two seven-digit coordinates expressed in feet relative to the State plane system assigned to the area.

These coordinates can be developed from each other based on relative interpretive calculations. A digited file (with X, Y coordinates) is the basis for all programs mentioned for the generation of local geobase files.

Background

Law enforcement agencies have had an increasing need in recent years to establish management information systems. The quick and accurate information processing used by law enforcement agencies has been identified as an important tool to be applied in law enforcement for many areas such as planning, administrative and operational purposes. Massive research efforts have been undertaken to study methods of improving the operational effectiveness of an agency as well as the reliability of the data used in management decision-making. For example, computer assisted dispatch, crime analysis and resource allocation systems have been developed to equalize the patrol units' workload, and to reduce police response time.

Almost any police management study will require summary spatial statistics as well as temporal information of uniform officer units' activities. Therefore, a geographic base file (GBF) system is needed in order to code the location information of police incident records.

A geographic base file is a description file which duplicates, in computer readable form, the information found on a street map. This information is used to cross-reference street addresses with geographic areas and allows the coding of information with a street address to geographic areas by using the computer. This coding of location information is called geocoding.

GBF-Project 1

With the availability of DIME (Dual Independent Map Encoding) which was developed by the U. S. Bureau of the Census, a growing number of agencies are taking steps individually and independently to develop and implement computerized geographic base file(s) system for law enforcement applications. Beginning 1974, the IACP recognized the needs of law enforcement agencies for GBF systems, the benefits of minimizing duplicated efforts, and the significance of providing a less expensive method of GBF development and implementation.

The first project was a joint effort between the Technical Research Services Division of the IACP and the Geography Division of the U. S. Bureau of the Census supported by Law Enforcement Assistance Administration of the U. S. Department of Justice. The major objectives of the first GBF project were (1) to determine the extent of GBF development and use in law enforcement agencies, and (2) to provide a uniform basis for comprehensive systems development. To accomplish these objectives, an advisory committee was formed, which included criminal justice planners, police administrators, GBF theorists and other people with experience in police information systems. Under the guidance of the GBF Advisory Committee, the research activities were organized into three major phases.

Phase I. This phase dealt primarily with gathering information on current and planned law enforcement development of geographic base files and their applications. The Geographic Base Files for Law Enforcement: Descriptive Report, released in September, 1975, describes geographic base files and associated support systems in eight cities visited by the staff: Dallas, Texas; Long Beach, Huntington Beach, San Francisco, and San Jose, California; Kansas City, St. Louis, Missouri, and Jacksonville, Florida. Research was also undertaken on a number of issues dealing with administrative policy, and the subject of privacy as it relates to geographic base files.

Phase II. Phase II focused on the study of geographic base file system requirements and system design alternatives. Because geographic base files may contain various types of information which support a variety of law enforcement applications, the operational differences between various base file designs were considered. Alternative file structures and formats were designed to support the various on-line or batch applications that a police department might wish to implement.

Phase III. The findings of this research effort and the importance of the programs being developed to support law enforcement have demonstrated the need for wide dissemination of information on current developments. To provide for this type of support, during Phase III, the IACP and the Census Bureau communicated with law enforcement agencies through publication of findings, presentation of workshops, and provision for technical assistance.

The publication of findings was primarily provided through the Geographic Base Files for Law Enforcement: Descriptive Report which is available from the IACP. The extensive report provides detailed descriptions of eight cities studied during the course of the project including applications, file structure and content, and computer hardware configurations. Additional papers and short publications on geographic base file systems development were made available during the second project.

The workshops scheduled for dissemination of findings to law enforcement agencies were conducted between February and June of 1976. Ten workshops were scheduled in various sections of the United States and were limited to participants who had a direct need for information and training on the subject. These workshops included information of both a general and technical nature and supplied participants with an extensive notebook of materials for use during systems development and implementation within their agencies.

GBF - Project II

The current Law Enforcement Assistance Administration-funded, IACP project entitled "Geographic Base Files for Law Enforcement: Technical Assistance and Services," is an outgrowth and expansion of the previous GBF project conducted jointly by IACP and the U. S. Bureau of the Census. The National Advisory Committee on Geographic Base Files for Law Enforcement strongly recommended that the IACP continue to assist law enforcement practitioners and other criminal justice personnel in creating geographic base files in local agencies, further refining programs and implementation strategies developed during the initial project, and disseminating materials on the concept of geographic base files.

GBF Workshops

GBF Workshops. During 1976-1977, the IACP will conduct a series of six, tuition-free workshops on Law Enforcement Geographic Base Files in the cities of Tampa, Florida; Santa Ana, California; Columbus, Ohio; Rochester, New York; St. Paul, Minnesota; and Oakland, California.

The course is designed for police personnel with administrative or operational experience in agency operations related to geographic base file applications (e.g., communications, resource/manpower allocation, crime analysis, data processing or planning).

Program Testing. A major task under the current GBF project is the testing of software packages developed by the U. S. Bureau of the Census under the previous grant. The IACP prepared and distributed to major U. S. law enforcement agencies a brochure soliciting interest in this testing. The IACP, after considering these and other evaluation items, selected St. Louis, Missouri, and Tucson, Arizona, as test sites. The tests were made on site using local systems support with continual IACP monitoring of the experiences of local personnel in implementing the GBF packages.

Based on the experiences encountered in implementing the programs in an operational environment, the IACP will document the procedures regarding programs, installation and operation. This documentation will include a discussion of administrative systems design and hardware/software techniques used in the implementation process. The report, which will be made available to law enforcement and criminal justice agencies upon request, will enable other departments to implement the package more easily.

The following computer software package is being tested at the above sites and supports the concept of the GBF/DIME system as a national generic base from which a geographic base file tailored to local requirements may be derived. The program will allow localities to enter local geocodes, and/or reformat the GBF/DIME File into a derivative law enforcement geographic base file designed to meet local needs. (If the local agency uses a non-DIME File, the file should be reformatted so that it will have a similar record layout to the standard GBF/DIME File.)

The package includes the following eight major programs:

Polygon. A system which allows the user to add local geocodes to the file with the proper code. The user identifies the boundary segments (using x-y coordinates or node points off the Metropolitan Map Series Maps) for each geocode. The program uses this information to define the boundary and identify which segments inside the boundary should receive the geocode identifier.

Intersect. A program which creates an intersection file from the GBF/DIME File. It consists of seven computer programs. The intersections are determined for street and non-street physical features using the same Map-Tract-Node configurations as the match key.

Strip Dime. A program which will allow the user to selectively remove data fields from the GBF/DIME File to create a reduced content geographic base file. It will also remove codes from a GBF/DIME File which has local geocodes attached (i.e., an output file from the Polygon program). Substantial reductions in file content are possible with this program.

Strip Intersect. A program which operates in a similar manner to Strip Dime and produces intersection level elements.

Index Dime. A program which creates an index file system primarily for on-line applications. The user selects appropriate codes off the geographic base file, removes them to a subfile and replaces the code with a pointer. Pointers may be created between the master file and the subfile or vice versa. This program may be used with the GBF/DIME File to integrate local user files for common place or street name abbreviations and misspellings.

Index Intersect. A program which operates in a similar manner to the Index Dime and generates an index for the local intersection file.

Header Record. A program which is used to reduce redundancy by creating a variable record length file with an initial header record containing information to be duplicated on succeeding records. Normally this program is used to reduce the redundancy of the street name file by listing the street name once and following this listing with succeeding records of the same name.

Poly-Guide. A program which creates a street span system by using either a GBF/DIME File or GBF/DIME with local geocodes attached. The system accepts parameter card input and will produce span records for the geographic district indicated by the user. A secondary district with overlapping boundaries may also be indicated to produce additional segmentation of the GBF.

Technical Aid. The IACP is instituting a three-part technical assistance program consisting of: (1) on-site technical assistance to a maximum of ten agencies, (2) a nationwide clearinghouse system through which a system directory will be developed and distributed, and (3) an inquiry-response service for agencies desiring information on geographic base file systems.

On-Site Technical Assistance. IACP staff is selecting agencies to assist in implementing the software package developed during the initial GBF project. IACP staff will offer assistance in defining applications requirements, resolving operational difficulties, debugging systems problems, and correcting other problems as they occur.

Directory on Law Enforcement Geographic Base Files. The IACP is preparing a directory of systems and applications. Based on a systems inventory survey, the directory identifies and describes, in detail, geographic base file systems currently used by municipal, county, and state police agencies across the nation and will present comparative data on current and planned GBF applications. The directory will be published and disseminated to police agencies to promote an information exchange among GBF users and to serve as a practical reference guide concerning law enforcement geographic base file technology.

Telephone Reference Services. The IACP has initiated a new inquiry-response service to provide technical assistance to law enforcement agencies considering or operating GBF systems. Agencies are encouraged to contact GBF staff concerning the design and implementation of geographic base files. The IACP is operating a clearinghouse to distribute GBF reference publications. Special toll-free lines are available for telephone inquiries.

Geostatistics. To encourage the successful use of geocoded statistics in a variety of applications the IACP is preparing a manual concerning uses of geographic data in police agencies. The systems inventory survey will be used to acquire information on how geocoded data are used in law enforcement. The results of this survey will be used to identify potential research sites which IACP staff will visit to acquire in-depth information on the use of geocoded data. Subsequent to these field visits, the IACP will develop a manual on the use of geocoded statistics in law enforcement. The manual will include sections on procedures for aggregating raw data, transferring data output to operational personnel, and updating systems. The manual will be distributed upon request to law enforcement and other criminal justice agencies currently using geocoded data.

Users Groups. To further provide an exchange of technical information among GBF users, the IACP will conduct two users group meetings to be attended by various law enforcement practitioners using geographic base file applications. The users group will meet to discuss common GBF issues, and reports on users group meetings will be prepared and distributed through the IACP GBF Clearinghouse. These meetings are scheduled for May 23-24, and August 15-16, 1977.

Benefits of a Nationwide System

As a result of these two projects, the following are the expected benefits: (1) a reduction in unnecessary duplication in law enforcement geographic base files design; (2) a reduction in costs to police agencies when developing geographic base files; (3) a more efficient and effective use made of geocoded statistics in law enforcement, and (4) increasing compatability of multiagency data.

(1) Reduction in Design Duplication. The first main benefit of the system is that the multiplicity of geographic base file designs has been reduced. The computer programs supplied by the IACP

to help agencies derive local geofiles contain standard defaults to which the program reverts if there are not specific overrides. Therefore, if the local agency does not have major reasons for selecting a unique format, the standard default will be produced. The past proliferation of geobase file designs and structures within the law enforcement community of the United States greatly inhibits the adaptability and transferability of generalized geobase programs, applications, and interaction. In the preliminary studies undertaken in the initial GBF project, of the eight initial sites analyzed which were considered "state-of-the-art" agencies, six different basic approaches were being undertaken. This general pattern was discerned in further studies of other law enforcement agencies.

(2) Reduction in Costs of Development. Another major finding in our earlier research was that massive amounts of resources, including time, funds, and equipment, were utilized in each agency's development effort; these independent research and development efforts each produced various geographic base file generation programs which were costly, yet used by only that agency and only a few times. Because of the disparity of geobase designs. the various generation and maintenance programs were not compatible with the other current systems, and these programs were not used on a national scale. The diffusion of the various type of files resulted in the following: Long Beach begat New Orleans which begat Birmingham; Huntington Beach begat San Diego which begat (again) Huntington Beach, and so on.

Through the efforts of the Geographic Base Files Project, a major reduction in GBF development costs to law enforcement agencies has been realized. The eight major developmental programs previously described are available from IACP at a minimal cost to any interested agency. Through the use of these programs a multitude of geographic base files formats can be developed, all from the same genuine base, and with the basic compatable coordinates referred to on page 119.

(3) More Efficient Use of Statistics. The increased use of geocoded statistics and mapping capabilities has been a major benefit of this endeavor. Key personnel in approximately 245 different United States' law enforcement agencies have been trained in use of geographic base file applications. Many agencies have indicated that although they would continue efforts to develop a local geographic base file and could not wait for the completion of this project, the IACP's suggestions for GBF design and use would be incorporated into the local designs. The recommended application and suggested use for mapping programs have been an important portion of the workshops, and the increased uses and standardization of uses within the law enforcement community will greatly enhance the efficient and effective use of geocoded data.

(4) Increased Compatibility of Multi-Agency Data. The basis for developing the local geographic base file in the IACP program is the use of one of three standard and easily cross-generated coordinate

systems. Each local file contains or has as its basis a coordinate system which is compatible with few modifications with any other local system developed with our programs. The geocoded data from Agency A, based on latitude and longitude coordinates, can be mapped with and compared to other data from Agency B in the same or other states because the coordinate systems are compatible and easily interpolated. Regional mapping is becoming a recognized possibility on countywide or large area in several areas of the country; Southern California primarily. Since as many as 30 different jurisdictions and agencies would comprise an area each with a separate data file and no one overall coordinating agency, the use of base files with coordinates of compatible elements allows this multi-agency use on a county, region, or multi-state area to become a reality. This is a major benefit of the Geographic Base File for Law Enforcement Program.

International Transferability

The preceding benefits can also accrue to other nations such as Canada, which follow the methodology described above. The methods can be adapted for use by the Canadian government to establish and develop a nation coordinate base system. This system could be used not only for law enforcement but also other research activities in the fields of social welfare, housing, and transportation planning. The use of a DIME type national base system has many advantages. Its techniques for manual development have been well established and documented by the United States. Data coding forms as well as guides for various staff members are available for use by any area wishing to manually develop a DIME-type base file. Therefore, assuming localities nationwide in Canada can develop DIME-type base files for various uses, the above methodology represents an approach which will (1) impress upon law enforcement administrators the value of geocoded statistics and mapping and (2) give the widest dispersal to available software programs for development and use of the geocode files.

A series of workshops such as those held by the IACP could be presented by a Canadian organization on a regional or area basis. Workshop material such as papers, slide presentations, and practical exercises can be obtained from the IACP and adapted for use with Canadian audiences. Police administrators, technicians, and planners could be acquainted with the product and its application. The national clearinghouse concept can be used to support GBF interest as well as fill the informational gap between workshops and onsite technical assistance. The Canadian clearinghouse can build on those documents and programs gathered by the IACP in its clearinghouse operation; the operation can be modified and expanded to fit the needs of Canadian law enforcement.

On-site technical assistance can be offered to local law enforcement agencies to stimulate development as well as solve problems which may be unique to a given area or agency. This assistance could be provided by a core of national staff with the aid of special consultants as required. Specialized documents concerning the use of geocoded statistics, types of computer mapping and executive overviews could be developed for the Canadian law enforcement community to answer administrative and technical questions as well as stimulate interest in development of regional data analysis approaches. Finally, the current IACP project could supply basic training materials, documents, and other products which could be used in whole, or in part, in such a Canadian effort. Any request for such assistance would receive favorable response from the IACP.

The potential effects for Canada are the same as those for the United States, initially, they are: (1) a reduction in unnecessary duplication in law enforcement geographic base files design; (2) a reduction in costs to police agencies when developing geographic base files; (3) a more efficient and effective use made of geocoded statistics in law enforcement, and (4) ease in use of multi-agency data. In addition, there would develop the capability of international mapping of crime trends in border areas such as Windsor-Detroit or Vancouver-Bellingham. This new capability could prove to be most valuable.

Conclusion

Why should other nations consider the transfer of the methodology, rather than be concerned with individual technological advancements in the field of computer mapping? The true question is one of impact over time. A technological change of an individual nature has an "osmotic" effect on its community. Initially starting in one cell, it affects those other surrounding cells slowly, as they acquire the professional and technical competence to manipulate and interpret the tool. To have a wide effect, a massive overall improvement of the state of law enforcement data processing must be achieved as well as major "seeding" operations of creating operational sites in all regions to help simulate the desire to effect the change. The methodology suggested in this paper has a much different effect and approach, rather that like osmosis, it simulates a shotgun blast. The basic approach to geographic base files mapping and utility is shown nationwide over a short period of time, give "immediate" value recognition in the localities. Secondly, the technological tools needed for development are available at the same time; therefore, individual agencies across the country can immediately pick up the use of new technology, thus accomplishing the same result as that of the osmotic effect, but in a much shorter time.

Both approaches are valuable, and each has its place; the preceding approach for developing a national system of compatible geographic base files of police mapping is one that should be considered.

DISCUSSION

D.R.F. TAYLOR: I would like to thank Mr. Chang for his excellent presentation of the DIME system and ask him whether he is aware of the Canadian System, which was developed at about the same time as the DIME system and is in full operation at Statistics Canada.

S.K. CHANG: No. I had been trying to find out if a similar system to DIME is used in Canada but I learned about it only yesterday.

D.R.F. TAYLOR: The Geographically Referenced Data Storage and Retrieval System (GRDSR) of Statistics Canada was developed between 1967 and 1972 (Witiuk 1976). It is based on a two-level referenced hierarchy of spatial building blocks and has the ability to study micro area data within Canadian urban centres. Although the system is technically not a segment system, it has a segment capability. It has not yet been used by Canadian Police Forces. I was very impressed by the advantages that you mentioned in relation to the DIME. I wonder if you would like to discuss some of the disadvantages of the utilization of DIME File in the United States, as there are lots of them.

S.K. CHANG: To me it seems that there is only one critical problem or major disadvantage of DIME File, and that is maintaining and updating the file. My interpretation is that one does not have to worry if, for example, the street names are changed because that can easily be accommodated. But if a change of street pattern is caused by the building of a freeway, a park, or something like that, then one has to digitize the new features. The real problem is how to update the file with the digitized XY coordinates. The user should have programs for correcting, updating and extending files.

Right now the Bureau of Census has Joint Statistical Areas Programs, or JSA programs. They are encouraging local agencies to use their programs in connection with the 1980 census by offering support funds in a 75 percent federal to 25 percent local ratio.

D.R.F. TAYLOR: May I draw your attention to a paper by C.E. Barb (1975) which gives a fairly detailed history and description of the development of DIME Files from a much less positive viewpoint than the one we have heard this morning.

S.K. CHANG: Well, I guess there are different opinions about the DIME File. I sometimes hear comments by local governments or local police departments about slow processing or slow responses from the Census Bureau. Other than that, I think the DIME File is good because it is relatively cheap. The programs are free.

J.G. ARNOLD: I am very impressed with your methodology and the ways in which you are going to educate your police forces. I would like an idea about the size of your staff and the IACP, and about the projected size of the staff.

S.K. CHANG: On the current project we have four staff members: myself (I am responsible for all technical matters), a senior staff analyst, a research assistant, and a full-time secretary.

J. G. ARNOLD: Do you develop your own programming?

S. K. CHANG: No. All the programs were developed by the Census Bureau.

J. G. ARNOLD: I realize that the DIME File is a block face oriented file. Is it intended to implement a parcel approach?

S. K. CHANG: No. When trying to implement different approaches one is confronted with disadvantages caused by the historical development of the file. This is an involved issue that requires a lengthy explanation.

J. GONGOS: I assume that the IACP got into this particular situation by virtue of a requirement for information by law enforcement authorities.

S. K. CHANG: Quite true. The project is funded by the Law Enforcement Assistance Administration (LEAA).

J. GONGOS: Who were involved in the workshops that you conducted across the United States? Was it primarily law enforcement personnel or were there other representatives?

S. K. CHANG: About 90 percent of the participants were from city data processing departments. They were mainly interested in the improvement of communication between the police department and other departments in city hall.

D. R. F. TAYLOR: You talked about compatibility, and your efforts in developing the interaction between three specific agencies. What do you see as an interaction with the other departments or organizations that have similar requirements?

S. K. CHANG: Since DIME File was not developed for police application only, it can be used for interaction with other organizations. We classify the programs that I mentioned as "reformat" programs that allow manipulation of the DIME File.

D. R. F. TAYLOR: Is the DIME File the U. S. Census file, developed by the U. S. Census Bureau for census purposes?

S. K. CHANG: Basically yes. We deal with the law enforcement community only, so we concentrate on law enforcement applications. However, the DIME File can be used for all urban planning work.

REFERENCES

Barb, C.E. 1975. Congruence between U.S. Census DIME technology and observed local operating agency geography interests and needs. Auto-Carto II. Proceedings of the International Symposium on Computer Assisted Cartography, 21-25 September 1975. U.S. Dept. of Commerce, Bureau of Census and American Congress of Surveys and Mapping, pp. 499-504.

Witiuk, S. 1976. The geographically referenced data storage and retrieval system of Statistics Canada: Yesterday and Today. Proceedings of the Symposium on Geographic Information Processing, Carleton University, Ottawa, January 1976, pp. 46-58.

41427

THE GEORGIA COMPUTER MAPPING PROGRAM

Victor M. Davis, Jr.

City of Atlanta

The Georgia Computer Mapping Program is a coordinated joint effort involving the City of Atlanta, the Georgia Power Company, the Atlanta Gas Light Company, the Southern Bell Telephone and Telegraph Company and the Georgia Department of Transportation. It involves aerial photography of the areas involved, followed by the making of orthophotographs into computer-readable data, and the subsequent plotter drawing of planimetric maps from this computer data base.

An additional involvement is the agreement in the jointly-executed contract for the City of Atlanta to continually update this computer data base. The City has also contracted with its partners in this project to furnish them with updated planimetric maps from its data base at the cost of reproduction.

Within City government, the Bureau of Information Systems functions under the director of finance. Under this bureau, the Systems and Programming Division functions to provide systems analysis and computer programming services for all departments, bureaus, and divisions of the city which require data processing services. As a Senior Systems Analyst in the Systems and Programming Division, I was appointed Project Leader for the Special Project Team in January, 1973. The primary assigned function of this team was computer plotting and drafting. As the project developed, the team was renamed the Geocoding Project Team, and still later the Graphics Project Team. Serving as the Project Leader of this team, I interfaced as a member of the *ad hoc* committee formed by the partners mentioned earlier.

The City of Atlanta's first involvement with computer mapping came about as a result primarily of two police applications. The first of these was a requirement to plot the crimes along each block in the city of Atlanta for use as part of a submission for LEAA Impact Program grant funds. The statistics were easily obtainable from our uniform crime report master file. However, the manual searching of city directories to determine which addresses fell in which blocks was a tedious and backbreaking manual effort.

The second project was also in connection with other phases of this Impact Program. When the Atlanta Regional Commission began monitoring results from the program, they required all statistics to be expressed in terms of census tract and census block. Since we did not record crimes in this fashion, sorting these crimes by the geographic units which comprised census blocks and tracts became very tedious. and difficult.

Because of these two requirements, we began investigating computer mapping and geocoding techniques in general. During our investigation it became obvious that several interests were involved in this area. One of these interests was the Georgia Power Company, who had been for some time attempting to find a way of accurately updating its maps. In this enterprise, Georgia Power had been working on involving other utilities who might have a similar need to locate underground plant facilities. The consensus of the utilities other than the City of Atlanta (which provides water and sewer service for a large area of Metropolitan Atlanta), was that the State Plane Coordinate grid was the system they desired.

We set up a rather loose committee system which had numerous persons from each interested party involved in the program. If I may, I will skip over a number of subsequent transactions and get to the point at which the Georgia State Department of Transportation became involved. Their involvment was due to the fact that all of the concerned parties were being bombarded with various allegations by photogrammetrists engaged in the commercial production of orthophotographs. Of the whole group, the State had the only qualified photogrammetrists available. Consequently, the parties attached to this group decided to request the assistance of the State Department of Transportation in giving some background in photogrammetry and evaluating some of the proposals. As a result of this request, the State became interested in the joint project and asked that they be allowed to enter it as an equal partner.

The most significant thing which was accomplished in the early stages of the City's and the utilities' efforts (before the entry of the State into the project) was the establishment of a responsible representative for each interested potential participant. The primary problem which was encountered earlier was that committee meetings were attended by twenty eight to forty supposedly interested individual participants, but they were in most cases not the same participants as attended the previous meeting. When we agreed to have each potentially interested participant organization designate one specific individual who could speak for his company or group, we began to make progress. Once this significant step was achieved.

the parties involved could discuss on a one-to-one basis the potential compromises which they might make on behalf of their individual participating companies or governments.

After that we were able to make several significant compromises. For example, all parties were able to agree on the use of the State Plane Coordinate grid system. Significant compromises were also made having to do with the acceptance of the scale to which the original photographs were to be made. The final decision was to use a scale of one to twelve hundred (or 1"=100'). Once this decision was made, it appeared that work would rapidly proceed toward the production of the orthophotographs and the digitizing.

However, after this compromise was finally agreed upon by all of the participating companies and/or governments, it was determined that there still was some difficulty with the technical method used to make the orthophotographs and to digitize them. For instance, there was a disagreement over the lens focal length and the eventual negative scale of the original orthophotographic negative which was also resolved. There were further compromises on color versus black and white photography, whether to digitize directly from the stereo model or the finished orthophotograph, and who was to keep the system updated after it had been computerized to a data base, etc.

The area involved includes only the incorporated city limit boundaries of the City of Atlanta. However, all of the partners involved, including the City of Atlanta, have interests which extend beyond this area. The City, for example, furnishes sewage services within the Peachtree basin and the unincorporated area of Fulton and DeKalb Counties. We also furnish Fire services to the unincorporated areas of Fulton County. The Georgia Power Company and the Atlanta Gas Light Company serve the entire state of Georgia. The Georgia Department of Transportation is also interested in the entire state. The Southern Bell Telephone and Telegraph Company encompasses four southeastern states. Therefore, the area encompassed by the present contracts is considered as a pilot project for the overall program.

The funding of this program was accomplished in various ways by the different partners. In the case of the utility companies involved and the Georgia Department of Transportation, the funds were diverted from existing funds for various mapping projects. In the case of City government, the project was established as a one-time special project, including the purchase of the computer hardware neccessary to keep the data base updated and to plot the planimetric maps from the data base.

A particularly interesting feature of this system is that centroids of addresses and intersections are also being contracted. This will permit the City or any of the other participants to relate any file, including crime reports, which they may presently hold in a computerized format to the geographic location involved by an interplay between the address in the existing file and the relationship of the geographic centroid of the building or intersection involved. We were led into this approach by the nature of the police applications which initially led us into computer mapping and it has proven invaluable.

One of the things which has become apparent to those involved with the Georgia Computer Mapping Program is the absolute neccessity of local government involvement. This is due to the requirement of keeping maps accurately updated in as near a "real-time" fashion as possible. All of the records neccessary to perform this update are a matter of public record and could theoretically be obtained from a service bureau operation directly interfaced with the local government involved. However, the accuracy of these computer updated records is liable to be considerably greater if the local government has a vested interest in the accuracy of these records.

In view of the foregoing remarks, it is also of interest to take a look at what the desirability of maintaining these records in an accurate fashion might be to a local government. Of primary interest to most governments is the fact that they are all involved in some utility-type operation (i.e., sewer, water, electric and/or telephone utility). In view of these operations, it is of extreme interest to them to obtain the updated maps. Also all governments are engaged in the abandonment and dedication of streets which comprise the majority of the travel-ways upon which this program is based.

Also of local government interest is the field of traffic engineering. The participating organizations may input plans of maintenance and/or construction. The obvious areas of conflict may then be graphically presented for all to see.

This planning data from the geographically coded data base can also be presented on alpha-numeric printers, terminals or whatever medium is desired. By undertaking an operation like this, a local government can afford to work out with the utilities the underground plant requirements for some significant period of time, such as five years. The plans of the participating parties to request the local government to close down streets, reroute traffic, and redesign one-way throughfares may now be coordinated to occur only once during the planning period.

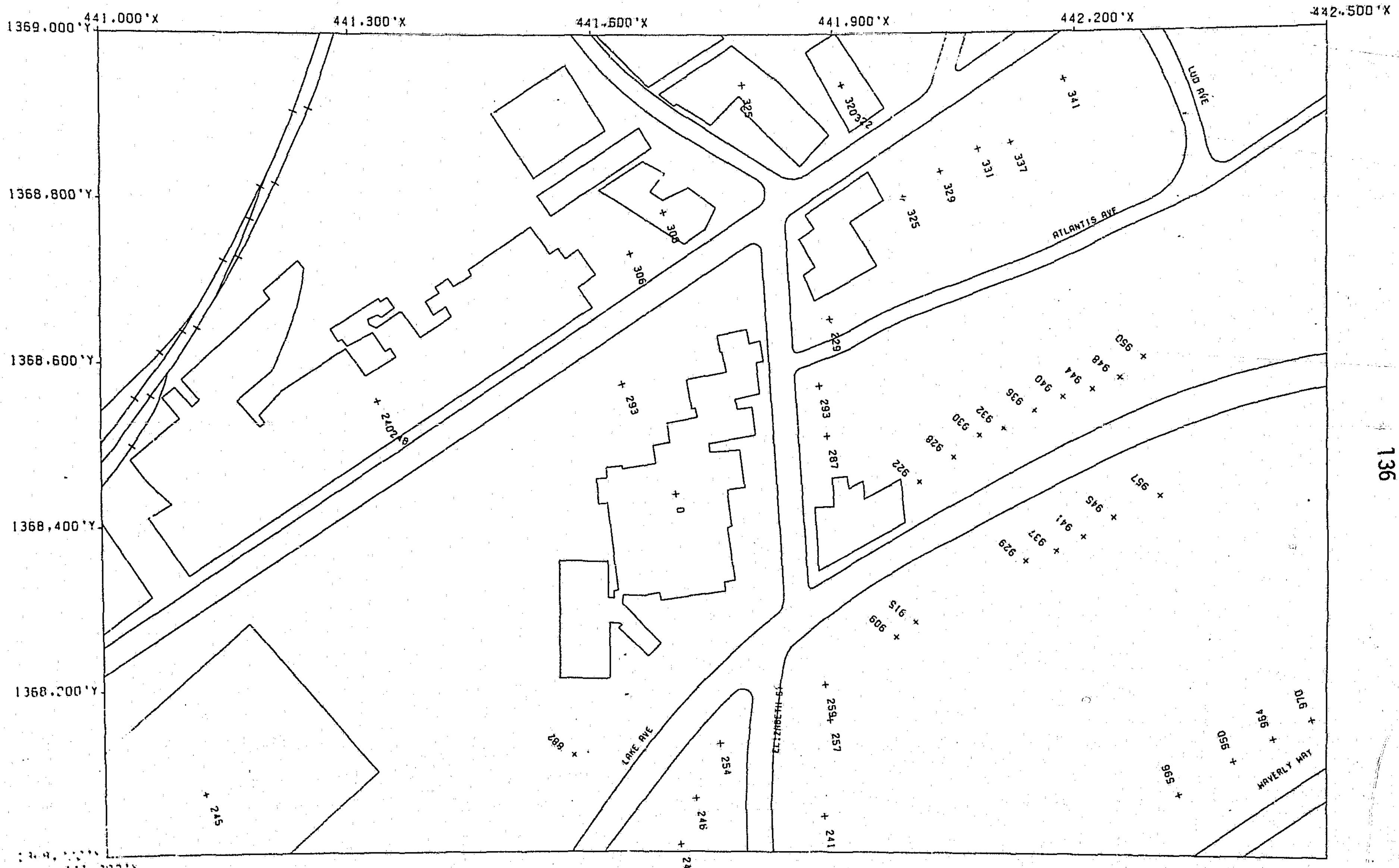
While I feel that all of the foregoing remarks have a great deal of validity, both in determining the historical background of our program and in examining the many other sources that might be called upon to assist in bearing the cost of an accurate data base and the hardware associated with its manipulation, it is now time to look at some of the actual applications through which this data base is being put for use in police work.

The very first of these, of course, are the initial application areas which put the City into this business. The map which I have brought is of what the Atlanta Police Department calls Zone Five, or the downtown zone covered by the Police Department. It graphically depicts with different symbols and different colors of ink the number of robberies, larcenies, assaults and burglaries. These were the initial crimes selected for representation as they were the so-called "stranger-to-stranger" crimes which the Impact Program was supposed to reduce. Obviously, they could have been any other crimes and they could have been for the previous month, or for the previous month during the evening watch period, or any other breakdown on which we maintain data in our master crime report file.

While this is a very interesting graphic representation of events in this area, it does not have to be graphic to be useful. Since we also have centroids of intersections recorded, we can record any polygonal area and sort out all events within this area which are of interest. The beautiful thing about this approach is its flexibility. If you want it by 1970 census tracts, we can sort out within those polygons. If, on the other hand, 1980 census tract data is desired, again we can sort geographically within the defined polygon. More appropriately might be a sort like the one shown on this map, possibly with an additional sort by watch and month to get a better grasp on resource allocation.

Another very important application, not only for police, but for any emergency vehicle dispatching, such as ambulance or fire, is the capability of giving a dispatcher fast access to a large number of relatively detailed maps showing actual centroids and addresses of the buildings along the street. From a very few microfiche we can locate any address in the City and direct the emergency vehicle to the correct address. It is possible, at some point, that we will even have microfiche readers in our fire apparatus.

We do not have the computer output to microfilm equipment installed yet and we still have one little programming problem with the way we handle the addresses. However, the approach is sound and has gained quick acceptance. Eventually we would hope to have this system on line instantly through a graphic CRT in the dispatchers areas.



ROOUCED BY: CITY OF ATLANTA - FINANCE DEPT.
BUREAU OF MANAGEMENT SYSTEMS

SCALE 1"=50'   ZONE X Y WO.5-441.0-1368.0

136

CONCLUSIONS

(1) A cooperative mapping effort between various parties with similar yet diverse interests has been proven to be entirely feasible.

(2) For purposes of updating the data base, participation of the local government with jurisdiction of the area involved is highly desirable, if not essential.

(3) The economic advantages of a joint effort are considerable, but the advantage of having a common grid out-weighs even the economic advantages.

(4) While the advantages to other partners involved in a project such as the one described above are great, it is probable that the local government has the most to gain in such a project.

(5) Such a program can have significant effect on computer aided dispatch and resource allocation systems.

DISCUSSION

D.H. DOUGLAS: A very important aspect you did not mention is the need for manipulation of information that cannot be identified by address, for example street intersections and traffic lights.

V.M. DAVIS: Yes, that was a major factor for having also coded the centroid of every intersection and every street coming into that intersection.

S.W. WITIUK: May I make a couple of comments? What types of coding or geocoding are best depends on needs and implementation. What is put into a file, whether it be a parcel or the centroid of a house will be a function of scale. Our census tracts are defined in cooperation with the municipalities.

We would like to have census coverage for all Canada. We already cover fifty percent of the population, mostly in urban areas, but the costs for 100 percent coverage would be proportionally very much greater. Some municipalities can justify parcel coding and it is always possible to go from the parcel to the centroid and work up in scale. But there is no single agency that can justify the cost of parcel coding the whole of Canada for its own purposes.

V.M. DAVIS: The City of Atlanta has a good survey project going right now. But we have three contractors and each one is making his own topographic map from the slides. I can't emphasize too strongly that we should design a system that is useful to anyone, including the private sector.

D. SWAN: How does the telephone company use the system?

V.M. DAVIS: I am glad and I am sorry that you asked. The utilities hope to get out of this project a common grid which would enable them to easily determine the presence of their installations at a particular location, in case somebody wants to dig at that location. It is worth noting that 80 percent of all disruptions of utilities are caused by digging.

Right now all the utilities have their own maps. It is much better than what they had before, and I am not belittling that, but it is so primitive in view of modern technology. A message about a potential dig at a particular location is teletyped to all three utilities and to the city. On the next day they teletype back their answers and the contractor is instructed by phone to start the work or to wait until one of the companies finds its underground facility.

47428

CANADIAN POLICE COMPUTER USAGE - AN HISTORICAL SURVEY, COMPARISONS & LESSONS

David H. Mead, Ministry of the Attorney-General
Vancouver, B.C.

Acknowledgements

The assistance of Staff Inspector Cocke, Vancouver Police Department; Assistant Commissioner J. Gongos and Mr. R. K. Meyer, both of the Royal Canadian Mounted Police, C.P.I.C. Directorate, is acknowledged with thanks. In additionthe unpublished data on Canadian Police Strength and Expenditures as compiled by the National Task Force of the Canadian Attorney-General has been of considerable benefit.

Purpose of This Paper

If the conference on "Mapping and Other Applications of Computers to Canadian Police Work" is to achieve its stated purposes then it will be appropriate to spend some time becoming aware of the actual state of the application of the art in Canadian Police work. Hopefully this paper will be one way of closing the gap between the possible and the attainable in terms of actual police implementation of the subjects and concepts considered at this conference.

The following therefore are the primary objectives of the paper:

1. To ascertain in as economical a manner as possible the actual level of application in computer technology both individually and collectively among Canadian Police Forces excluding C.P.I.C. usage.

2. To obtain additonal data and draw appropriate conclusions likely to be a benefit to the technical liason committee (TLC) of the NRC/CACP should they elect to pursue the idea of further and continued work in this field.

There were two subsidiary objectives of the writer which should be explicit:

a) As Chairman of the technical committee on information systems for the Canadian Court Administrators Association which has a similar project underway to that which might be undertaken by the TLC, he has a considerable interest both in becoming aware of the actual state of affairs in the police component of the justice system; both for its own sake and for the reason of cross system implications. Court systems are nourished by police systems.

b) In the past ten years the writer has been actively involved in the development of police computer applications and has seen a number of myths and assumptions arise concerning these. The preparation of this paper has given an opportunity to examine some of these untested assumptions. The results in some cases were revealing.

Scope of the Paper

The paper concentrates upon Municipal Policing. Regional forces were deemed to fit in that category. Information was sought from provincial forces for comparative purposes but was excluded from calculations made. Likewise the R.C.M.P. as a Federal force, as a contract Provincial force, or as the operators of CPIC, were excluded although Mr. Ron Meyer, Deputy Director of CPIC was a very considerable help in giving an overview of CPIC development. On the otherhand, R.C.M.P. forces acting as contract municipal forces were included. The reasons were:
First The R.C.M.P. contribution to the development of police computer applications warrants a separate paper in itself and there are a number of excellent papers from members of the force being given at this conference.
Second and more important in terms of development, administration, and financing, the R.C.M.P. operate in an environment so different from that of municipal forces that comparisons become difficult if not meaningless except in the context of a contract municipal force.

An Opening Clarification

Whenever two Canadian Justice Systems people happen to meet their conversation soon turns to one or both of two standard themes. One is to regret the absence of the Canadian equivalent of the pot of gold called LEAA. The other is to deplore the actual level of Canadian technical performance. Both are inappropriate. Quite apart from what our U.S. friends could tell us about the use of LEAA funds, it is a fact of Canadian life that we spend more than twice LEAA's annual budget to aid underdeveloped countries. Whatever our personal views may be we have to live with fact of this national priority. Secondly, Canada has made contibutions to justice technology of which it may be justly proud: the CPIC system, the simulation models of court and correction systems as reported in the recent Rand study, and automated legal research are examples in point. Canada certainly has its share of triumphs to compensate for its shortcomings imagined or otherwise.

The Method Used

In February 1977 a questionnaire was sent to all municipal forces throughout the country likely to be using computers in police work other than for CPIC purposes. The term "Automated Data Processing" was used in the hopes of identifying applications which might not strictly speaking be regarded as computerized, e.g. unit record or mechanical devices. No such methods were disclosed by respondents. The questionnaire did not make a distinction to having access to a computer and using a computer - a very necessary distinction in the current state of technology - as it was felt likely to cause confusion to the non-technical mind. In any event information about both was desired. However only two such cases of access rather than use were disclosed both which involved motor vehicle files. However in the province of Ontario there is a likelihood of several other such applications through the PARIS system.

The Responses:

Eighty-two percent replies were received. Many showed a very positive interest in the topic plus a desire to be made aware of the outcome and further developments of this conference.

The results were that some form of computer usage (other than CPIC) was identified in municipal forces having 58.5% of the total municipal sworn police strength in the country. Allowing for returns promised but not yet received this should eventually reach about 63%.

Incorporating provincial responses into the data and again allowing for returns pending we have some computer usage other than CPIC in about 65% (on a strength basis) of all non-Federal policing.

The following sections now describe briefly the results obtained. In commenting hereon the author would acknowledge his tendency perhaps to draw upon experiences during a lengthy association with the Vancouver Police Department to illustrate the subject.

How Long Have Municipal Police Forces Being Using Computers?

Almost all Municipal usage commenced in the late 60's or early 70's. All but three respondents had their computer system operational in at least some form prior to the advent of CPIC. In other words while the CPIC has met very basic and important needs for modern police management it has not been such as to apparently develop local applications in other fields.

What Are The Applications of Municipal Forces?

Generally they are batch-oriented, aggregative after the fact housekeeping types of applications or ones which have a high visibility in terms of public involvement. For example; traffic ticket processing. Some analytic work was noticed as in call load recording and in dispatch analysis. However very limited UCR applications or related statistical uses were discovered.

Interestingly enough despite a seven to eight year span for the average installation there appeared to be very little progress between the initial applications and those currently installed. Questions were asked along the lines, What did you start with?; What do you have now?; What do you expect to have in the near future? A general conclusion was that the imaginative sophisticated approach apparent in the CPIC network did not appear to have been transfered to the day by day type of applications in use by the average municipal force. Little growth conceptually was seen likewise in plans for future uses. In most cases they were discreet applications addressing local needs. With very few exceptions integrated management or comprehensive analytic systems were not proposed. In the case of one or two large urban forces some excellent work appeared on the horizon.

Why Has There Been Such A Limited Growth?

Several reasons can be advanced for the fairly pedestrian state of local data processing. The following are the conclusions reached from the questionnaire although they may not in fact be the sum total of the reasons that could be advanced. Firstly, there is the matter of use and control of hardware and resources. With few exceptions hardware was in no way under police control. Apparently in most cases police forces were not able to influence the direction of municipal data applications. A very static set of relations appears to be the norm.

Secondly, a look at the budget available for municipal police data processing indicates that the limitation is equally because of the lack of resources budgeted by police departments for this purpose. The data obtained refers only to that contained in municipal police budgets and therefore must be read with caution because the majority of municipalities do not have a charge back system for individual using departments. Likewise time of serving policemen who would appear in the traditional line budget may not be included in police data processing costs.

Reading the following figures with this limitation in mind, the following dollar costs per sworn officer for reporting police forces were disclosed.

The highest was $340.00 per sworn officer. The lowest $13.00. The average was $208.00 or less than 1% of the annual cost of a policeman.

Excluding capital costs and development expenditure as reported by two large forces; the average would be reduced to $104.00 per sworn officer or somewhere less than 1% of the cost annually of a policeman.

Even if unrecorded costs double this amount or 1% is reflected as the annual expenditure on data processing, this compares very unfavourably with usual expenditures in government and industry of at least 3%. Figures supplied to me by Mr. R. K. Meyer suggest that for the average police force, given its highly labour intensive nature, to reflect the average expenditures in other branches of government, somewhere the order of 6 to 8% of a police budget would be the appropriate figure.

Against this should be compared the estimated operating costs of the CPIC system which would be in the order of say $300.00 per sworn member for all levels of policing Federal, Provincial and Municipal expenditures we are still faced with a considerably lower usage of resources than elsewhere.

Thirdly, the use of human and technical resources within departments is extremely low. On the basis of returns the equivalent of twelve full time police members and 94 civilian staff or 106 people in all were reported. These figures should be compared against an estimated 16,3500 sworn municipal policemen throughout the country and a civilian strength of 2,840. These figures may be modified to a small extent because of data entry functions performed at a central data processing pool within a municipality but do not significantly alter the percentage.

Fourthly, the technical resources available for computer systems development are extremely limited. Only fifty technical, that is systems analysis, programming, etc., positions were identified within municipal forces. While some usage of municipal based staff and some very limited use of outside consultants was reported it would appear that there is a distinct shortage of qualified technical persons available for both conceptual development and implementation duties.

<u>The Reasons For The Limited Resources:</u>

A number of reasons can be advanced from general knowledge of the municipal scene of police vis a vis municipal budgeting processes. Firstly, a police force would argue strongly in comparison say with additional manpower, more radio equipment, vehicles, etc. There are some exceptions, one municipal force is known to have been extremely aggressive in the use of industrial engineering and methods study resources available from a central city pool. This however is very much of an exception. Other reasons are that municipal police agencies are not strongly represented on any planning group that is likely to exist within a municipality for determining its own priorities. Finally in terms of perceived needs by city administrators, money for the administration of justice has to compete with many other conflicting demands.

Training and Orientation:

The response generally revealed that training and orientation was limited strictly to immediate requirements and given only to those having direct involvement with the application concerned. For example, it was hard to determine whether general levels of NCO's had been given any orientation as to the power of the computer as a tool in law enforcement. An exception to the general rule would be the approach of the City of Vancouver in 1968 when as a first step towards its plans for the introduction of computer applications it conducted a week long training seminar at which every NCO of the rank of corporal and above plus all officers attended. Experts were brought in from all over the continent and temporary connections made to several then existing systems in order that a direct feel for the type of application which would occur some years ahead could be obtained by all decision makers in the force.

Likewise the training and orientation given to the executive of municipal police forces is extremely limited. Although a number of forces acknowledged the use of IBM equipment, for example;no reference was made to the attendance of any officers at the Law Enforcement Executive Programs conducted by that company for senior police administrators.

Planning:

Some questions were asked as to what plans existed for future development and it would be fair to say that formal planning in the accepted sense was not apparent in almost all cases reported. Three respondents indicated that much work had gone into the development of a long range strategy for meeting their informational needs through the use of computer facilities but these were by far the exception. In most cases it would be correct to describe statements as being hopes rather than plans.

The Nature of Planned Applications:

In general applications forseen by respondents tended to be an extension of those already in existence. That is after the fact, batch-oriented, aggregative collections of data about general police activities. The reasons for this may be ascribed to those which were given to the lack of resources available at the present time for police computer usage. In as much as few police forces were involved in the general planning of municipal computer facilities, nor did they receive anything like a reasonable share of budget resources for the purpose. It is appropriate to expect that they would not forsee any major change in the near future.

The Use of Computers For Mapping and Other Techniques:

A series of eight questions endeavoured to obtain as much information as possible as would be of interest to this conference on the use of computing in management science and related applications. In almost all cases there is no activity to report upon. Even in the municipalities which were known to have engaged in programs with the National Research Council these programs were not reported by the municipal forces and upon enquiring in one case I was told that this was deemed to be a National Research project not a local police one. On the other hand questionnaires were generally answered by the police officer responsible for records, communications, etc. and in certain known examples though the planning and research agency within a police department has engaged in some applications of interest to this conference these were not reported upon. However these constitute a minority.

In the case of mapping the only reported application was that of the City of Vancouver which in 1971 for some time produced maps giving the distribution of groups of crimes throughout the city. These maps utilized the then equipment of the city an IBM/360 model 30 with 64K; hardly an adequate facility for any sophisticated work. In consequence the maps were not of a great benefit because the data had to be highly centralized and the time lag between the events upon which they reported and the distribution of the maps was too long for an operationally oriented police officer. Perhaps more important in retrospect would be the fact that insufficient explanation of the use to which such maps could be put was given. For these reasons the experiment terminated after approximately six months. In another application in the city however a single dramatic use of mapping was highly successful and serves to illustrate a use to which it can be put. In as much as mapping is dealing with aggregates in a spatial relationship it is necessary to remind oneself that mapping deals not so much with the response of police to requests for service or dealing with current situations but rather with the steps that it can take in preventing events from occuring. The following description of its use in a juvenile study will illustrate this point.

The information available as to where an event occurs is often of considerable benefit in looking for evidence that will lead to its solution. The best example being that frequently of stolen automobiles where the place a vehicle is recovered from is likely to give an indication of the residence of the person who stole the vehicle in the first place. Using this concept the City of Vancouver proceeded over a twelve month period to plot the location of the residences of juveniles who committed offences and lived within the City of Vancouver. (Note: not where the offences occured but where the offenders came from). The City of Vancouver's geographic based system enabled easily the determination of a co-ordinate reference for every known address in the City. It soon became apparent that there were a series of areas from which juvenile offenders apparently congregated or were domiciled. In certain cases these were readily identified as group homes, etc. It could be argued that all that had been done was to give in another form what was already well known to any experienced policeman. This of course is often one of the strengths of computer mapping; it does give formal confirmation of conventional wisdom and enables an independant collection of the data to confirm or disprove what experience and intuition has led the police officer to believe.

This plotting of the locations of groups of offenders led to an analysis of the offenders themselves and their known associates. Using sociogram and similar sociometric techniques it was possible to come up with diagrams illustrating the relationship of juveniles one to another and therefrom leadership patterns to be identified. In short some twelve key juveniles were identified as being the leaders of groups or themselves the perpetrators of a substantial proportion of juvenile crime within the City of Vancouver.

In terms of simulation no applications were reported upon other than those of the City of Vancouver which has embarked upon several discreet models for beat allocation, vehicle replacement and manpower deployment projects. Again it must be stressed that there may have been other applications used by planning and research groups within police departments which were not reported. One continuing application is that of the City of Vancouver's traffic analysis.

For over ten years all traffic accidents have been plotted on the City's geographic base files with many benefits. One important one has been the fact that consistency of data and agreement between municipal engineering traffic branches has been obtained. Equally the systems design achieved substantial economies in related systems and procedures.

What Would You Like To Have?

Questions were put to respondents asking them in the absence of budget or other restraints to indicate the applications of their preference. Almost all of them indicated a need to have indexing retrieval systems which would enable speedy recovery of information at a level below that which is currently entered on the CPIC network. Two provinces namely Ontario and B.C. have active projects in this area, but the need was felt in almost all areas of the country. Interestingly enough these needs do not seem to be in keeping with those which are perceived by certain Federal agencies who are sponsoring national projects.

Cooperative Efforts:

It was asked if respondents could visualize cooperative efforts to produce systems of broad application which would enable repetitive work to be eliminated and in almost all cases the answer was that such concepts were strongly supported.

Training and Development:

All forces expressed great desire for further training and development not only of line members but of executives and the use of the Canadian Police College in its executive development courses was mentioned. Doubtless there are other means of meeting these needs as well which do not involve travel to a centre location.

Conclusion:

The conclusions of the study, final details of which will be reported to CACP, are as follows:

1. There appear to be many fruitful areas for further development on behalf of CACP, NRC and others in a presently limited field of application.

2. That the application of standards for levels of systems would be a stimulating and very necessary program. Under a grant from the

Donner Foundation certain studies in standards for various parts of the Criminal Justice System presently underway it is not known however whether in the police area any consideration is being given to appropriate standards for technical levels of information systems.

3. It would appear that policing systems are operating entirely in a vacuum. The fact that they generate data which is of use to respondents in many other parts of the justice system has not been considered and the relationship of police computer usage and information generated therefrom as being of benefit to courts, corrections, prosecutors, etc. is worthy of considerable study.

49429

PRIVACY AND SECURITY OF DATA BANKS

R.J. Friesen
Research Consultant, Security Systems Branch,
"P" Directorate, RCMP, Ottawa

This is a cursory look at the concept of personal privacy and its relationship to security in automated information systems.

Personal privacy and security of information are both subjects which, in themselves, could be discussed in great length and not be covered completely. In fact, the concerns for privacy are still changing and developing. In Canada, legislation is now before the House of Commons dealing with discrimination and the protection of personal privacy respecting personal information in federal information systems and this will have far-reaching significance on how we will look at the protection of privacy respecting personal information and its uses.

The concern for personal privacy and automated information systems began about 1965 when the Social Science Research Council in the USA proposed a central repository for all socio-economic data. Some apprehension arose that this would result in dossiers being created on everyone with great risk of misuse and privacy violation[1].

Some of the first legislative proposals in the USA in the early 1970's were directed toward computerized information banks, where the threat was thought to be, rather than manually operated systems. Today, however, there are good indications that privacy protection could be made easier if information was stored in a central repository where it would be easier to control and protect and where it might provide an individual with easier access to information about himself. This is somewhat of a reversal of the earlier thinking and is perhaps an illustration of the changing and developing views of how privacy, respecting personal information, might be protected.

Because of the concern for security of information that is now being processed in automated systems, security is also being looked at differently and is becoming sophisticated.

1 "Concepts for Privacy of Federal Records", Robert H. Courtney. The Social Science Research Council (Ruggles, 1965)

The concepts of personal privacy and information security, and the relationship between the two, continue to evolve as our understanding of both progresses.

There is a story about a hairy prehistoric man standing near the edge of a forest early one evening. The mist shrouded the horizon as the moon began to rise above the trees. The prehistoric man looked at it, seemingly not too far above the tree branches, and decided it would be a good idea if he were to bring it down, examine it closely and find out what it was. So he climbed up the tallest tree but soon found he was still a long way from being able to take the moon into his grasp. He then looked down to the ground and observed that although he hadn't yet reached his objective, his project was at least off the ground[2].

This is not unlike our present situation with respect to our understanding and analysis of personal privacy. We are making progress but we have a long way to go before we know what personal privacy really is and what the long-term solution will be in protecting it, if it can be protected at all.

Attempts have been made to define personal privacy, and then to draft legislation that would prevent any conduct that would violate that definition of privacy. This approach fails because of our failure to be able to define personal privacy. A person may want to protect certain information about himself from exposure at one time and want the same data exposed at another time. At one time in a woman's life, for example, she would object strongly to her age being made known. Later, when she comes near to qualifying for old age pension, she may become quite happy to reveal her age.

A person may feel that revealing certain critical parts of his personal file would violate his personal privacy, but at the same time he would be quite happy to see some of the good things made known.

What is private to a person at one time may be something he is anxious to reveal at some other time and vice versa. That sort of thing varies from person to person from one time to another. There is no static definition of privacy under these circumstances.

---

2 Adapted from a story by Willis H. Ware, The Rand Corporation, in his paper "State of the Privacy Act: An Overview of Technological and Social Science Developments", November 1976.

Attempts have been made also to decide who owns the information and from this, declare what is private and should not be used by anyone else. Presumably if the person is considered to be the owner of all personal facts about him then no one else can have that information without his consent.

There are attractive aspects of this "ownership" approach except that information is intangible and its ownership is not controllable like the ownership of a car, a lawnmower or a book. We cannot control the use of information about one person that another person can obtain simply by observing it himself in everyday life, such as who he is, who he works for, how he spends his money and his spare time, what other people think of him, what his boss thinks of him and an almost endless list of such personal items.

The only way in which some measure of enforceable control is possible over personal information is to restrict access to it and limit the use of information to authorized persons only. As soon as we speak of restricting access to information, we are talking about security.

There is a common expression "...you cannot protect privacy unless you have information security - but just because you have good information security does not mean that you will be able to protect personal privacy". Privacy can be protected by adequate security while personal information is contained within a secure data bank. Information, however, is collected for the purpose of being used and it must be disseminated to various users to serve its purpose. It must, therefore, leave the secure environment where controls cannot be enforced. This might be illustrated in Figure 1.

Protecting privacy while data is held within the EDP environment could be called the technical aspects of privacy protection. The social aspects of privacy protection apply after the data is distributed to users.

Security in an EDP environment involves all aspects of physical security plus several more. This might best be explained by a "ring" concept illustrated in Figure 2.

<u>Administrative and Organizational Security</u>

This includes:

- the organization of security personnel and their appointment to administer the regulations,
- the development and dissemination of security regulations,

- the development of clearly defined reporting channels to proper authority levels and a security awareness and responsibility at all levels,
- determining the sensitivity of the information, the threat to that information, and the appropriate security measures required to counter those threats.

Personnel Security

This includes:

- implementing a thorough personnel security program including a security awareness program for personnel at all levels,
- personnel security clearance procedures (where applicable),
- formal identification of personnel,
- authorization for access to sensitive, classified or personal data only by persons with a need-to-know,
- oaths of allegiance and secrecy,
- personal protection where applicable.

Physical and Environmental Security

This includes perimeter barriers, access controls, locking devices, alarm systems, guard staff, power supply, air conditioning, back-up storage, environmental threats such as water damage, flood, fire and vandalism. The security measures implemented must be consistent with the assets to be protected, the threat posed to those assets and their vulnerabilities.

Communications Security

This is a concern when data is transmitted over telecommunication lines into and out of a data base whether it is a manual or an automated system.

These first four "layers" of security are basic to a secure environment for all types of facilities and must be effective before it is practical to implement the technical aspects of security required by automated systems.

Hardware, Software, Operations and Data

These are the added aspects of security that are required where EDP systems are involved. Hardware, of course, is the equipment, software the instructions, operations are the procedures, and data is whatever it is that holds the data. Firmware is a new descriptive term for what is neither hardware nor software such as a sensor card that can be changed but not with something like a pencil.

DATA SECURITY AND PRIVACY PROTECTION

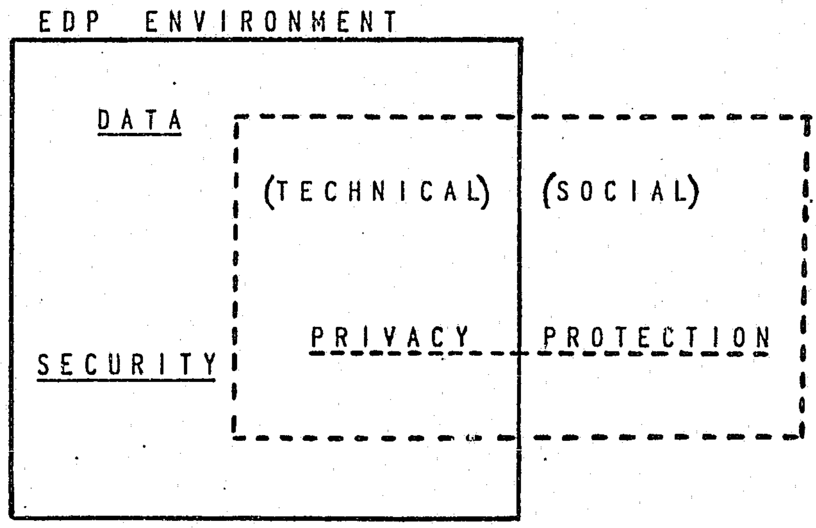


Figure 1

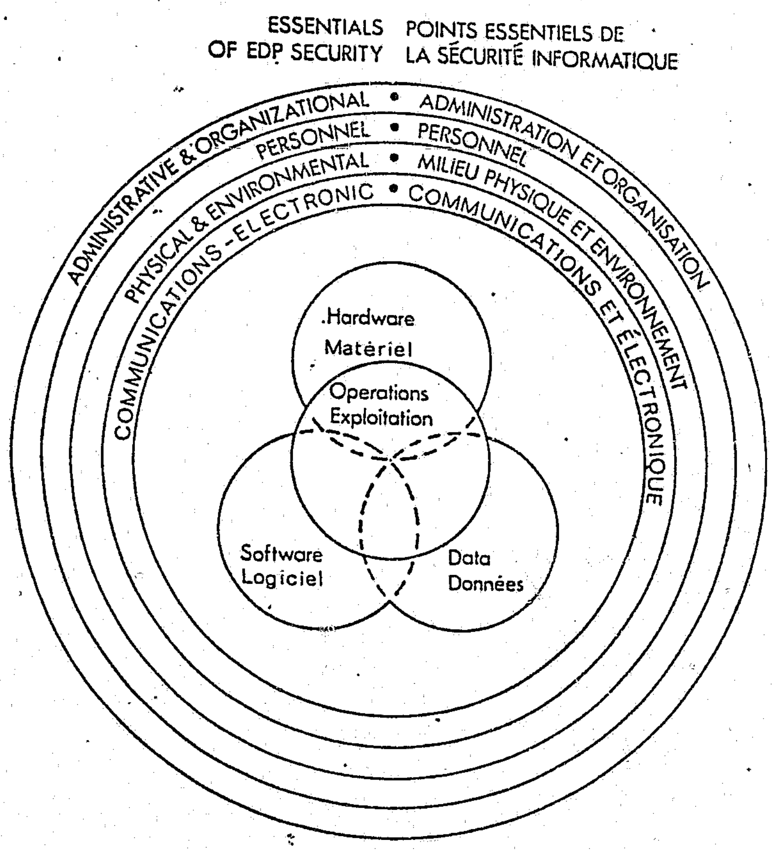


Figure 2

What a system can do or what people can make it do or avoid doing must be controlled and audited to ensure that the data is being used properly and legitimately and by authorized terminals.

When remote terminals have input and output capacity, and particularly where they can alter or purge data, the EDP environment and the security controls must extend to include those terminals and the personnel at remote locations.

All of this takes place within the EDP environment. When it is done appropriately and effectively the information in the system should be protected and be accessible only by authorized personnel. Personal privacy, as it pertains to the personal data within the system, should then be protected. This is the technical aspect of security. It is largely recognizable and controllable.

These physical and technical security controls, however, do not necessarily protect the information, nor the privacy of individuals to whom it relates, after the information leaves the secure EDP environment. When data is distributed to user departments it is out of the EDP environment and into what can be called the social aspects of privacy protection. In this area our approach and understanding of privacy protection is not very precise.

There are probably two aspects of protecting personal privacy at that stage. One is the legislative approach, the other is the ethical or a privacy-principles approach. Neither provide all the answers to protecting personal privacy just as security alone does not ensure the protection of privacy.

Bill C-25, the Canadian Human Rights Act, has passed second reading and is now being studied by the Justice and Legal Affairs Committee. This Bill deals with discrimination and establishing a federal Human Rights Commission. PART IV establishes access rights, for individuals, to personal information about them in federal information systems. See Figure 3. There are certain exemptions from access which are based upon a judgement as to the detrimental affect of such access.

The name of every federal information bank will have to be published in a central index so the public is aware of what exists.

The approach here is to make it possible for individuals to know what information there is about them in federal government departments and how it is being used. In this way, presumably, individuals will have some control over this information and the

C-25

Second Session, Thirtieth Parliament,
25 Elizabeth II, 1976

THE HOUSE OF COMMONS OF CANADA

BILL C-25

An Act to extend the present laws in Canada that proscribe discrimination and that protect the privacy of individuals

Access to and Use of Records

Entitlement of individuals

52. (1) Every individual is entitled to

(*a*) ascertain what records concerning that individual are contained in federal information banks named or otherwise identified in the publication referred to in subsection 51(1);

(*b*) ascertain the uses to which such records have been put since the coming into force of this Part;

(*c*) examine each such record or a copy thereof whether or not that individual provided all or any of the information contained in the record;

(*d*) request correction of the contents of any such record where that individual believes there is an error or omission therein; and

(*e*) require a notation on any such record of a requested correction therein where the contents of such record are not amended to reflect the requested correction.

Where individual to be consulted

(2) Every individual is entitled to be consulted and must consent before personal information concerning that individual that was provided by that individual to a government institution for a particular purpose is used or made available for use for any non-derivative use for an administrative purpose unless the use of that information for that non-derivative use is authorized by or pursuant to law.

C-25

Second Session, Thirtieth Parliament,
25 Elizabeth II, 1976

THE HOUSE OF COMMONS OF CANADA

BILL C-25

Exemption from access

54. The appropriate Minister in relation to a government institution that has control of a federal information bank may provide that subsection 52(1) or any provision thereof specified by him does not apply in respect of a record or part thereof concerning an individual in the information bank where, in the opinion of the Minister, knowledge of the existence of the record or of information contained therein

(*a*) might be injurious to international relations, national defence or security or federal-provincial relations;

(*b*) would disclose a confidence of the Queen's Privy Council for Canada;

(*c*) would be likely to disclose information obtained or prepared by any government institution or part of a government institution that is an investigative body

(i) in relation to national security,

(ii) in the course of investigations pertaining to the detection or suppression of crime generally, or

(iii) in the course of investigations pertaining to the administration or enforcement of any Act of Parliament;

(*d*) would be detrimental to the proper custody, control or supervision of persons under sentence for an offence against any Act of Parliament;

(*e*) might reveal personal information concerning another individual;

(*f*) might impede the functioning of a court of law, or a quasi-judicial board, commission or other tribunal or any inquiry established under the *Inquiries Act*; or

(*g*) might disclose legal opinions or advice provided to a government institution or privileged communications between lawyer and client in a matter of government business.

Figure 3

protection of their own personal privacy. No attempt is made in the legislation to define privacy and no specific conduct or use of information is prohibited on the grounds of privacy violation.

There are two federal Acts in the USA that are already in effect that are intended to make information accessible to individuals. The Privacy Act deals with personal information in federal information systems and the Freedom of Information Act deals with all other types of information in federal information systems. A third Bill, the Koch-Goldwater Bill, HR 1984, will probably be studied by Congress in 1977. This deals with access to information in private-sector agencies. Comparison of the legislation in the USA and Canada would be as set out in Figure 4.

In the USA the involing of an exemption can be challenged in a district court. In Canada a refusal by a department to release information to a person could be taken to the Human Rights Commission which could then investigate the matter. Invoking the exemption by a federal government department may have to be endorsed by the Minister of that Department. If the Minister denies access, that would end the matter; however, the Human Rights Commission will have to submit a report annually on its activities to the House of Commons. The Minister's decisions to invoke an exemption from access could presumably come under question in the House.

The effectiveness of the whole approach of access by individuals, the exemptions possible by institutions and the challenging of those exemptions, as a way of protecting personal privacy, is yet to be demonstrated in Canada.

The collection and use of personal information is increasing. The aggregation of personal information makes it more likely that the records of individuals and their activities will become more detailed. Automated information storage has begun to affect everyone; not just systems like credit reporting agency information, automated police information systems or tax returns. Computers are everywhere, processing such things as motor vehicle registration numbers, purchases, credit accounts, payroll data, personnel records and airline ticket purchases. All of us are recorded in some way in several automated information processing systems and just around the corner there is the electronic funds transfer system, or the cashless society.

All of this aims at the same thing; data capture, processing and use of information by one or more departments. We must surely have to question whether or not legislation will give individuals any real control over this tidal wave of information processing. We are moving headlong into an "information era" with no clear-cut

PRIVACY LEGISLATION

CANADA - U.S.A.

	Access to Personal information within Federal Government Records	Access to Information within Federal Government Records	Access to Information-Public Private, Industrial, Commercial.
UNITED STATES	PRIVACY ACT	FREEDOM OF INFORMATION ACT	H.R. 1984 Koch-Goldwater Bill - Congress to study in '77.
CANADA	CANADIAN HUMAN RIGHTS ACT Part IV	-ACCESS TO FED. DOCUMENTS ACT (PCO study) -Private member's FOI BILL.	---

Figure 4

PRIVACY PRINCIPLES

1. Security within information systems should permit access to data by authorized persons, for authorized uses only.

2. Security should provide protection at a level that is in direct relation to the sensitivity, or the consequences of loss, or misuse of the data.

3. Data should be accurate, complete and current.

4. There should be a commitment to efficiency, (the less information there is, the less there is to protect.)

5. The identity of individuals should be separated from the data, wherever possible.

6. The data subject should have access to information about himself to see, copy and correct unless there is an overriding need within society to prevent this by way of exemptions.

7. Value judgements should not be based solely on information extracted from an information system.

8. There should be an outside monitoring capacity.

Figure 5

CONTINUED

2 OF 3

answers to how we can protect personal privacy in the process. We have seen that while security is necessary to protect privacy, it does not provide the whole answer. Legislation to provide access by individuals to information about them is also a necessary part of protecting personal privacy but if we look to the future and the uncontrollable expansion of automated information processing systems, we can see that legislation will not likely provide the whole answer either. Something else is needed. As with every aspect of society there must be responsible, accountable conduct and some manner of ethics. How we use information and how we prevent the misuse of information must be addressed. As information becomes more accessible, custodians must become more accountable for how that information is distributed and used. A better defined commitment to protecting personal privacy is probably developing as a result of society's present concern for personal privacy. If there is such a thing as honesty, fair trade practices and business ethics we should be able to develop a set of privacy principles in the processing and use of personal information.

An element of morale suasion must develop to augment the security aspects and the legislative approach to privacy protection. We are just arriving at this approach of ethics or privacy principles as a set of obligations in protecting personal privacy. The Younger Committee on Privacy in the United Kingdom proposed certain principles for handling personal information[3]. Principles such as these parallel some of the elements embodied in existing legislation. A framework for this ethical or privacy-principle approach might be as set out in Figure 5.

As our understanding of personal privacy evolves, the ways in which it might be protected requires continuing analysis. Neither security, nor privacy legislation, nor ethical conduct in themselves will ensure that personal privacy in the processing of personal information will be protected. For the present, the combination of the three is all we have.

---

3 "Computers and Privacy in the Post Office" (Britain), Data Processing Service.
© The Post Office - 1975

DISCUSSION

S. W. WITIUK: Does the act differentiate between confidentiality and privacy?

R. J. FRIESEN: Neither the Canadian nor the American act attempts to define privacy or confidentiality. The approach has been to consider accessibility by individuals, so this distinction has not been made. I would like somebody to give a definition for privacy or confidentiality that would hold up in all cases.

S. W. WITIUK: I think this may be a definition. Confidentiality concerns the right of access to information already collected. Privacy means the right of individuals to refuse to supply data. In other words none of you might view it as a violation of privacy if someone asked your age. But I might consider that to be a violation of privacy, so it's partly subjective.

R. J. FRIESEN: I agree. One is subjective and another is objective. A woman doesn't usually want to reveal her age. That is a violation of her privacy. Later on, when she wants to collect her old age pension, she will be quite happy to tell her age. Then it's not private any more. So one may definitely be subjective.

T. A. PORTER: I notice the progression from the federal government to the private sector in the United States. Why not involve all government levels?

R. J. FRIESEN: The approach in both Canada and the United States has been towards federal information banks. The approach in the United States now seems to be to look to the private sector, and to require them to reveal information, but there is no mention of any other level of government. In Canada we are moving towards federal-provincial cooperation and are considering information that is in federal systems but which originated in provincial systems. The federal Act will affect the information when it's in the federal systems, but not before, and provindial departments will certainly be interested in knowing how the information will be affected when they give it to a federal department.

D. R. F. TAYLOR: Isn't it also a question of cost? Experience from other countries, in particular Sweden, has shown that when a new service of supplying information to individuals on request was provided the cost was enormous. I think in the Swedish case it increased by 40 percent to 50 percent. I wonder if in Canada anybody had given any thought to the impact of this on existing federal agencies and what it is going to cost the Canadian taxpayer.

R. J. FRIESEN: It's just now being addressed, and not too soon. It should have been done long ago because it is a new application that the system was not designed for. Certainly there's going to be a cost factor, and added personnel. It can be coped with. The technicians will look after that. Each department will have to see how it affects them, since they will be faced with requests for information. Not all departments will have this problem. Certainly some police departments, CPIC, and the RCMP will be concerned. Treasury Board has already assigned a group to examine the impact of this legislation on federal government departments. They are trying to establish common concerns and costs.

D.R.F. TAYLOR: I hope it goes down to the people who will actually build the data banks, because the implications of that type of structure will be enormous.

R.J. FRIESEN: Absolutely.

T.A. PORTER: I wonder if there is an exemption for data such as Statistics Canada holds, since it has data on individuals that are used not for administrative purposes, but for statistical purposes.

R.J. FRIESEN: If it does not identify the individual, I would suppose there is no restriction.

T.A. PORTER: What if it does identify the individual?

R.J. FRIESEN: Then, according to a section of the act, you would have to contact the individual and say you intended using the information for another purpose and he would have to consent to its use. The section would be quite restrictive for secondary uses.

D. SWAN: What procedures would an individual follow in dealing with departments or in legal actions against government agencies?

R.J. FRIESEN: You are getting to the implementation of the act. That will be covered by regulations which have not yet been enacted. Presumably the regulations will establish procedures for persons dealing with a department. I assume that the contact would be directly between the individual and the department.

47430

THE USE OF COMPUTERS FOR LONG RANGE PLANNING IN THE CRIMINAL JUSTICE SYSTEM

R.G. CASSIDY*+ and M.A. LANIEL*

* Ministry of the Solicitor General, Government of Canada and
+ Queen's University, Kingston, Ontario, Canada

Introduction

In addressing the subject of long range planning in criminal justice and in particular, the use of computers in that area, it is necessary to spend a brief amount of time on the definition of the terms involved. In both an era and a subject area which are fraught with jargon and the careless use of abstract terminology, it is necessary to first, in laymen's terms, define the area which will be addressed by the paper.

The long range planning context which we are addressing here is ten years plus into the future. In other terms, it is beyond the normal budgetary cycle considered by most police and criminal justice agencies, but is sufficiently close to the near future that it should have some operational impact upon activities which are contemplated.

The meaning of planning is by no means in the authors' expertise to define. However, by planning we shall mean assistance to senior level decision makers within a criminal justice agency, particularly at the policy level, in attempting to cope with, and perhaps shape the long term future in which their agency will exist. This means that they must both look at alternative scenarios which are possible in the future, the strategies which their agency might undertake and not only the direct effects of such strategies, but side effects on other administrative agencies, particularly those in the criminal justice system. We shall assume that it is the objective of any decision maker within the criminal justice system to attempt to make his agency more effective and in a better position not simply to cope with crime, but to "proactively" deal with more effective strategies in the future.

It would be extremely easy to immediately jump to a specific example on the subject of planning and the use of computers, and attempt in a general and philosophical manner, to draw conclusions. However, before examining the specifics of computer use, we feel there are a number of caveats and/or conditions which must hold for any discussion of this subject to be useful.

First, in looking at the subject of planning, particularly for the criminal justice system and the police, it is important to emphasize that the criminal justice system in Canada is primarily a human system. This goes well beyond the fact that offenders are arrested, processed in the court, and incarcerated in our institutions. The major part of the "humanness" of the system is the fact that one of the major resources which are employed is people. Current estimates for the Canadian criminal justice system hover around 80,000 people employed, and over $2 billion of direct expenditures annually. This of course ignores many of the indirect expenditures by Welfare, Health, and other public and private agencies, as well as many people employed on a volunteer basis or in related criminal justice activities in the public and private sectors.[1] As such, the "humanness" of the criminal justice system, both in the activities which are undertaken as well as in the implementation of many new policy planning initiatives, must not simply be an implicit part of strategies to be assessed, but an explicit part of any considerations (see paper, "Adaptation and Social Policy", for further development of this theme).

It would be held then as a point of view by the authors that as such, computer use in any sense, but particularly in planning and evaluation for the police and the criminal justice system, differs both in degree and kind from the application of the computer to many physical and technical systems such as water resource problems, traffic problems, electrical circuit problems, etc. This is not to say that technology transfer and the lessons which have been learned elsewhere may not be applied to the criminal justice system, rather that it requires a healthy amount of common-pragmatic sense, if such applications are going to be useful rather than dysfunctional in the area of planning and evaluation for criminal justice.

As an example, there is a significant number of persons in both public and private life who would undoubtedly like to formalize such parts of the criminal justice process as police discretion in order to better estimate, for example, the training needs for policemen (if it is indeed true that only 5%-10% of police time is spent in directly related criminal justice activities, this might imply a very different type of training program). In addition, they might argue that it would assist in making better allocation of resources, since they argue quite correctly, ..."If we have a better idea of the decisions being made and the rationale for these decisions, we will be better able to allocate the correct amount of resources to these different activities." This is shown by these same people to be analogous to the measurement of traffic flow to better estimate how new routes should be established for better traffic flow within an urban area.

However, there is good reason to believe that such a formalization in measurement would fundamentally change police discretion. It doesn't take a great deal of common sense to realize that once a person understands that his actions are being monitored or measured, he will be more careful to rationalize (in "externally" valid ways) the activity which he is undertaking. There is good reason to believe that discretion in many areas would change; whether indeed it will become greater or lesser is a subject for much argument, but there is probably no question that in many cases, discretion will decrease so that the exercise of the policeman's judgment would be less easily subject to criticism.

---

[1] To understand the scope of such a consideration, it is sufficient to realize that current estimates in Ontario suggest that the size of the private police force (including such functions as Commissionaires) is about three private policemen for every public policeman.

The importance of this point and of this particular example is not to say the computers are not to be used in planning an evaluation or in adjusting resource allocation, or that there is not a transfer of technology from physical and technical systems. Rather it is to say that such transfer and the use of highly structured models or logical machines must be done carefully and must be done with the intention of taking into account the views and needs of the persons involved. Thus, it is fundamentally important to be aware of the adaptive nature of the personnel working in and working with the criminal justice system, if computer use is to be done correctly and have more than simply a noneffect on the criminal justice system.[2]

A second factor which must be kept in mind is the open systems nature of the criminal justice system and particularly of the police subsystem. The whole milieu of social services and the multiple factors which affect crime (see for example, Wilson) mean that the analysis and the use of structured devices such as computers in planning must take into account many relevant factors which could have significant impact. The introduction of new types of crimes, such as sophisticated white collar crime and the escalation of organized crime in new and different ways, is a factor, which although difficult to estimate, must be included if we are to make realistic plans for the future in the criminal justice system.

In particular, the effect of the courts and corrections subsystems on the police subsystem must not be overlooked. The old adage of the police catching criminals, courts convicting, and corrections releasing them, although having some validity obviously oversimplifies. Indeed, there is increasing evidence (see Cassidy and Turner; and Blumstein and Nagin, for evidence of this) that for some crime types, there is indeed adaptive behavior in the criminal justice system, such that police charging behavior or prosecuting behavior seem to be a function, not simply of the level of criminal activity but also of the processing of criminal cases by judges and the corrections system. If indeed, this is happening in the criminal justice system, there is a real need for the police in particular to be aware of the activities of the courts and corrections.

This is not to say that the law enforcement activities of the police should be modified directly as a result of this, but certainly there are areas in which activities in courts and corrections should be estimated and accounted for. For example, the number of offenders who will be released on the street (the recent article by Shinar and Shinar suggests this may have a significant effect on crime rate), the general deterrence effect of courts and corrections (see "Worth of the Panel on Deterrence" of the National Academy of Science of the United States), and more directly the training needs for police would seem to depend directly on activities undertaken within courts

---

[2]This point gains importance simply because computers by their very nature must have a structured and logical situation with which to deal. While there are many areas of the criminal justice system which might be termed structured and logical, there is no reason to believe that they are likely to remain so over a long period of time (or at least with the same structure).

and corrections. Moreover, if there are, as we expect, very limited resources in these other two subsystems, then there needs to be increased effectiveness in the use of these resources by the police if the maximum potential is to be achieved for criminal justice resource allocations. Moreover, it is important to take into account the truly systemic nature of the criminal justice system not just of other justice agencies but of other factors affecting crime and crime control.

A third factor which must be accommodated in using computers in planning and evaluation processes is the basic constraint that such management tools must <u>assist the decision maker</u> but not take over the decision maker's function. The whole set of decisions faced by senior management in an agency, particularly the police, are extremely multidimensional and the use of computers must be made in such a way as to accommodate this multidimensionality and assist in better informing senior managers of possible outcomes and possible strategies which are feasible. This, as will be seen, has some direct implications for feasible implementation of computer usage.

Fourthly, it must be assumed that we are not talking about normal administrative and management use of computers for such things as management information systems (or even regularized scientific operational problem solving). Although these uses of computers are clearly fundamental to long range planning and indeed such planning must be built upon them, we will not devote a lot of attention to these areas. They are areas in their own rights which are well-known and where there are, I am sure, far more competent people than we to address.

The above then are some of the major considerations which would appear to be critical in discussing the use of computers in planning and evaluation. In order to discuss the subject of computer usage, we will in the next section describe a possible long range planning process and from this, in the third section, talk about the general subject of computer usage as well as a specific model for using computers in long range planning which we have developed. The final section of the paper draws some conclusions about the future for computers in long range planning, and some of their benefits and costs.

Basic Long Range Planning Process

Clearly, in discussing a long range planning and evaluation, there are many different possibilities for undertaking and indeed structuring the process. Objectives and goals particularly in the use of Management by Objectives (MBO) and even in Planned Program Budgeting Systems (PPBS) have always been seen as fundamental. It is pointed out by many authors such as Baker and Wildavsky, that without some normative idea of where the organization should go, it is impossible to give any intermediate directions as to what it might undertake. While we would certainly not argue with this point of view, it is clear that many objectives, particularly for social services such as criminal justice or police, are so motherhood in nature that they are neither measurable nor do they serve as great direct motivation for those involved in the operational activities. An objective such as enforcing the law, while undoubtedly telling a great deal about the activities which might be undertaken, does not give great insights as to which activities should be undertaken or indeed are being undertaken. Previous papers by Cassidy and Laniel (1975, 1976) point out the different types of possible processes which have been tried for planning and evaluation and some of their advantages and disadvantages. It is not the intent of this paper to look at many of these different processes. Rather we will suggest one type of process which uses basically an issue orientation or scenarios (combining objectives and present activities) in order to describe the planning process.

In the following planning process, it must be emphasized that most of the detailed steps identified (see Figure I) are not as such new and as such have been used by senior decision makers and line managers for several (if not many) years. The difference is that this process makes the steps slightly more explicit, and thereby may be used as a checklist to ensure that many of the steps, often viewed as necessary, have been undertaken.

Secondly, we feel very strongly that such a process for planning (and the commensurate use of computers within this process) should not as such increase the workload. That is, if there is a significant increase in workload, it may lead one to believe that the planning activity itself has become the goal, rather than assisting the organization in meeting the future. Moreover, the process should be flexible and adapt to:

a) political realities;
b) emerging problems in crime control;
c) ongoing programs and policies; and
d) resource availability.

Without having such a process adapt to these particular factors, it can be safely said that whatever has developed will be, if not irrelevant, certainly unimplementable in the agency.

The difficulty of presenting such a process is that describing it in the abstract leaves large parts of it uncertain. While it is undoubtedly true that these steps can be undertaken, it is often necessary to have actual operational examples to see how effective such a process might be. Although we will only talk here about the abstract steps in such a process, see Cassidy and Laniel (1976) for more detailed description as well as some of the issues which have been developed through this process and some of the effects of this development.

The first step shown in Figure I is that of identifying a problem area. Clearly, there are many possible criteria which might be be used in identifying a problem area such as those which are shown in Figure II. Such a set of criteria depends on the objectives for the particular agency involved. A significant risk here is that almost any problem area or strategies could be included in such a process. Obviously, the weighting and assessment of probabilities, is an extremely important part of any such exercise and must be done by senior decision makers if the process is to have any validity. Figure I also shows several possible mechanisms by which problem areas could be identified.

The second step in the policy planning process is that of the definition of the problem area. This may contain such factors as an assessment of the socioeconomic parameters, an assessment of the impact of the possible criminal behavior being analyzed, and the relationship with the objectives for the agency which is involved. It is here that some computer models may be useful in analyzing the impact of the possible strategies to be used in addressing the problem area. In this way, a feasible problem area can be defined for impact by the agency itself.

The third step in the policy planning process is that of developing the policy statement itself. In this case, a number of possible activities need to be undertaken, including:

a) underlying criminal justice philosophy defined;
b) objectives relating to the problem refined;
c) assessment of connected policies and programs; and
d) broad policy statement for the agency involvement.

Once again, at this stage, computers can be used in a modeling framework to make some preliminary or pre-evaluative assessment of the possible impact. As will be seen in the following section, a computer model was used to make such assessments in order to ascertain the effect of alternative policies.

The fourth stage of the policy planning process is the definition of alternative strategies and goals. This should incorporate implicitly an assessment of the opportunities for crime control, as well as the cost benefit of alternative approaches. The strategies themselves could cover such possibilities as further research, pilot projects, or operational strategies. These strategies obviously should be coordinated to involve other agencies and to coordinate the effort with provincial and local agencies and the private sector. Once specific goals have been defined for the strategies and broad performance indicators have been developed, it is possible to move to the next stage of the development of programs and operational policies themselves.

It is important to emphasize that throughout such a process there must be the direct involvement of senior agency personnel (see paper, "Policy Evaluation" for more detail). Otherwise, developments which are made will either be irrelevant or untimely with respect to the actual policies of the agency itself.

The fifth stage in the development of programs and operational policies would see any strategies approved by senior agency personnel and specific operational policy, goals, and programs developed to support the policy. Once again, the use of the computer, particularly models, in assessing the possible impact of any new strategies can be invaluable. However, ensuring relevance of such computer models to the policy planning and evaluation process is extremely important and will be addressed in the next section.

The sixth stage is the actual resource allocation which normally in most agencies takes place as a part of the annual budgetary cycle. It may not be necessary to fit the budgetary cycle to the planning process but it certainly is important that the two be directly interrelated. It is only by doing this that it will be possible to ensure that the program forecast and budgetary allocations are in line with current priority policy issues which have been developed in the planning process. It

FIGURE 1

POSSIBLE PLANNING AND EVALUATION PROCESS

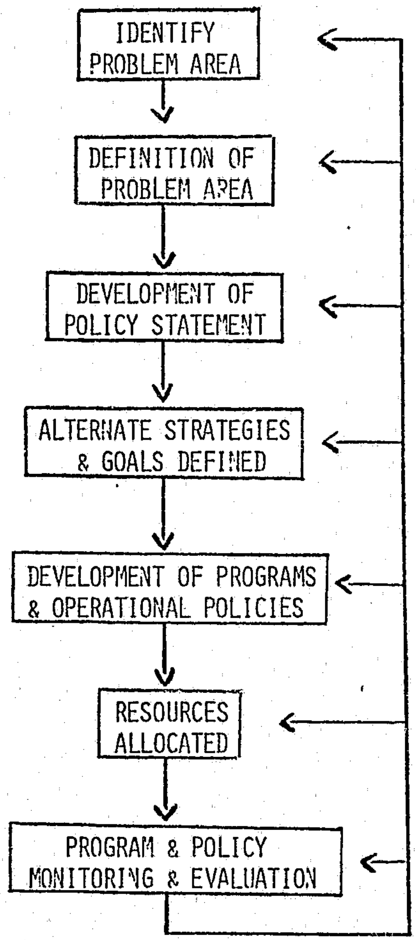


FIGURE II

SUGGESTED CRITERIA FOR RANKING PROBLEM AREA

OBJECTIVE		PROBABILITY ZERO	LOW	MED.	HIGH	WEIGHT*
CRIME PREVENTION	WILL IT REDUCE PROBABILITY OF INITIAL DEVELOPMENT OF DELINQUENT OR CRIMINAL BEHAVIOR?					
CRIME CONTROL	WILL IT REDUCE PROBABILITY OF CRIMINAL ACTIVITY AMONG HIGH " AT RISK" GROUPS?					
CRIME CONTROL	WILL IT REDUCE PROBABILITY OF RECIDIVISM OF ADJUDICATED DELINQUENTS AND CRIMINALS?					
EFFECTIVE MANAGEMENT	WILL IT IMPROVE PERFORMANCE OF CRIMINAL JUSTICE AGENCIES AND OPERATIONS?					
EFFICIENT MANAGEMENT	WILL IT REDUCE COSTS OF CRIMINAL JUSTICE ACTIVITIES WITHOUT DECREASING PERFORMANCE?					
PROMOTION OF FAIR SYSTEM	WILL IT INCREASE FAIRNESS OF CRIMINAL JUSTICE AGENCIES AND ACTIVITIES?					
PROTECTION FROM CRIMINAL CONDUCT	WILL IT REDUCE CITIZENS FEAR OF CRIME?					
PROMOTION OF MORE HUMANE SYSTEM	WILL IT COMPENSATE CITIZENS FOR CRIME LOSSES?					
COMMUNITY INVOLVEMENT	WILL IT INCREASE CITIZEN PARTICIPATION IN CRIME PREVENTION AND CRIMINAL JUSTICE ACTIVITIES?					
COORDINATION OF ACTIVITIES	WILL IT INCREASE CAPABILITY OF PROVINCIAL LOCAL GOVERNMENTS TO PLAN, MANAGE AND EVALUATE CRIME CONTROL ACTIVITIES AND PROGRAMS?					

*ASSIGN EACH CRITERION A WEIGHT TO SHOW ITS RELATIVE IMPORTANCE IN YOUR MIND. EACH ITEM SHOULD BE GIVEN A WEIGHT BETWEEN ONE AND TEN. USE LOW NUMBERS TO INDICATE HIGHEST PRIORITIES. FOR EXAMPLE, YOUR HIGHEST PRIORITY WOULD GET A ONE AND YOUR LOWEST PRIORITY A TEN. DO NOT USE THE SAME NUMBER MORE THAN ONCE.

is also in this situation that models may once again be used to estimate some of the possible impacts of different resource allocations on crime itself.

The final stage and one which impacts on all the previous stages is the monitoring and evaluation of the program or policy. It is here that perhaps the most extensive use of computers can be made in assessing, through the use of performance indicators, the achievement of specific program goals and in ensuring the compatibility of management information systems to develop such performance indicators. Figure III then gives a summary of the basic policy planning and evaluation process and the various components in each of the stages of the process.

In reviewing this process itself, it is important to emphasize that although a large proportion of the process is creative, in the sense of identifying policy issues and identifying alternative strategies for addressing these issues; a great deal is consultative in ensuring agreement on the priority of particular issues and their need for allocation of resources; a great deal is implementative and within operational reality; computer models themselves can be critical in ensuring that there is a good mesh between strategies which are to be contemplated and the basic problem area to be addressed. As we have suggested, the models may be used at a policy level throughout the development of alternative strategies and perhaps most substantially used in the final phases when basic information and evaluative indicators must be developed and regularly monitored in order to determine the degree of success and effectiveness of the program or policy undertaken. Thus, computers themselves, although participating mainly in a staff function, can contribute a fundamental part to any such planning and evaluative process. We will now address specifically some of the needs and constraints on the use of computers in such a process.

Computers in Planning and Evaluation

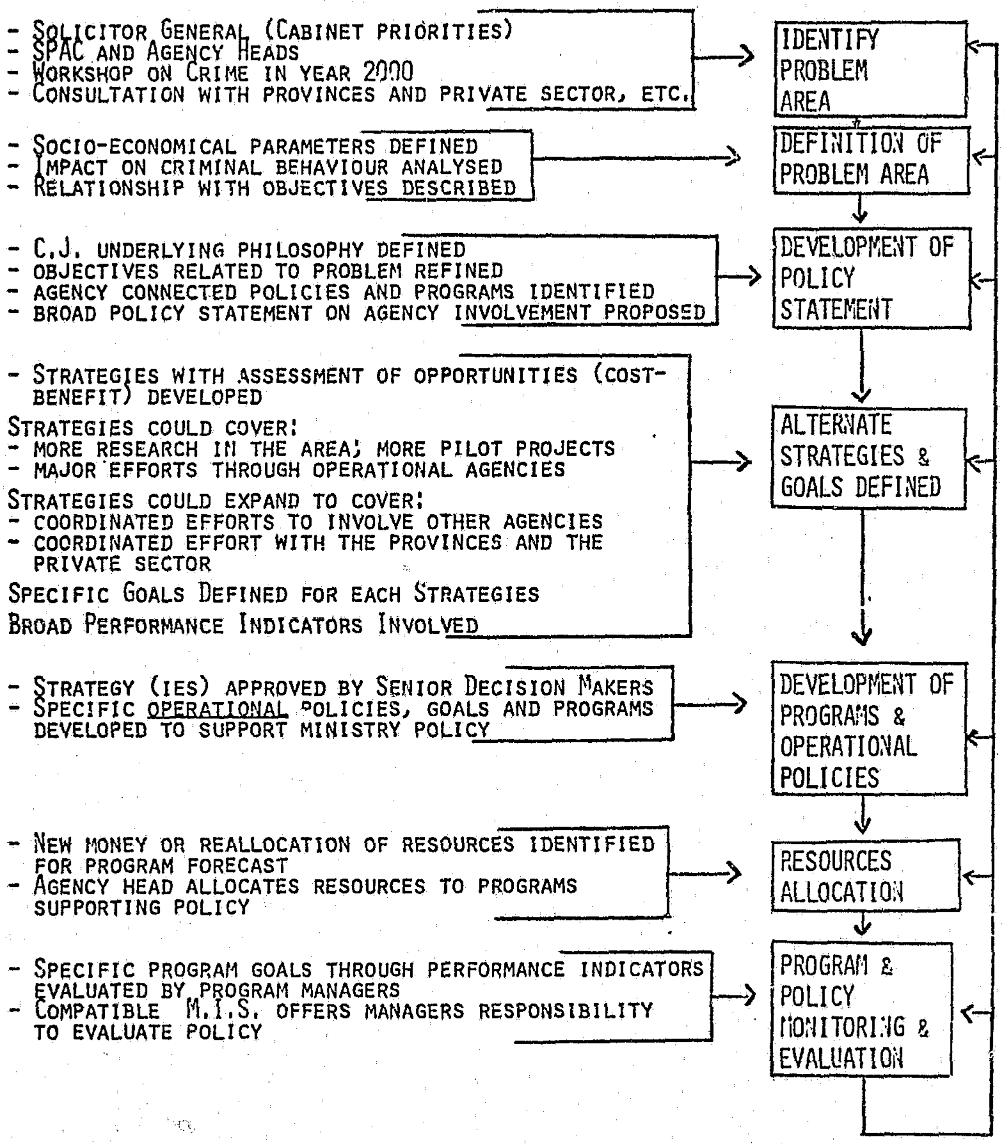
In reviewing the basic planning process described in the previous section, it can be seen that computers can, and probably should, be used both throughout the development of alternative policies and scenarios as well as in their final evaluation. However, basic to this use of computers is the notion that before there is any ability to say what should happen in the organizational environment, it is necessary to know what is going on presently within the system and to relate this to the types of problems which need to be addressed. Only then can one state how present initiatives should be changed to accommodate changing values or objectives of the system or society.

In terms of trying to assess whether a computer and/or simulation model might be applied to a given social system, G. Brewer, in his paper, "Policy Analysis by Computer Simulation: The Need for Appraisal", describes some of the possible reasons for using computer simulation:

1. It is either impossible or extremely costly to observe certain processes or the results of certain policies in the real world.

FIGURE III

PLANNING AND EVALUATION PROCESS MODEL



2. The observed system is too complex to be described by a "closed form" analytical model.
3. No straightforward analytical technique exists for solving the problems found in such a system.
4. The social process under investigation is subject to continuous change and is highly nonlinear in its behavioral patterns.

However, traded off against this is the difficulty of obtaining good data on the system and of knowing exactly the context of the kinds of policy analysis for which such a model might be used. For this reason, in developing a computer model, the tradeoffs must be assessed by the modellers and from this a "reasonable" model formulated within the described purposes.

The original JUSSIM model developed by Blumstein allows a high interactive capability while putting a relatively minimal dependence on data. Blumstein himself has very articulately described this tradeoff:

> "...There simply are no "precise rules" that adequately characterize the social systems. The rules will vary in a wide variety of ways - over time, as a function of workload on the system, by individual involved, etc. We are simply up against the reasons that there is far less knowledge in the social sciences than in the physical sciences. The relationships are phenomenally more complex and multivariate, and any models that were formulated that tried to specify those "precise rules" would also have to have an enormously complex and multivariate formulation for each such rule. But perhaps even more important, that rule would almost certainly be unstable in the sense that the phenomena that could be described today would probably not apply adequately next year because the structural relationships in the behavior will have changed. Thus, the modeler has the choice of chasing this pot of gold of "precise rules", or of acknowledging the complexity of that process and dealing with it somehow. One way to do this is to put the user into the calculation loop. Even though he may not know in a scientific sense what the "precise rules" are, he at least knows the nature of his ignorance of them. Then, if the ways in which those rules enter the model are sufficiently straightforward and simple, he can at least know something about the nature and magnitude of the errors he introduces. It is in the context of this process, with the associated uncertainties, ignorance and infeasibilities of ultimate models, that the CJS modeler must target his efforts."[3]

It is precisely for this reason that we felt Blumstein's JUSSIM model was most applicable for modelling the total Canadian criminal justice system. It is this model, CANJUS [4], which we will use as motivation for our discussion on the use of computers in planning.

---

[3] Private communication on the use of models in criminal justice, from A. Blumstein to the Rand Corporation, Santa Monica, California, 1976.

[4] The description of the CANJUS model itself is contained in Appendix I of this paper.

This particular computer model has some rather direct benefits simply as a description for policy and program planning and evaluation for many of the federal agencies in Canada. In this way, by providing much better quantitative data base as a background description of present activity within the Canadian criminal justice system, it assists at the identification and definition stages in developing better policy and programs and promotes better policy and program analysis for the total system.

The computer and its manipulation however, have a very specific use in the policy planning and evaluation process. The user of the CANJUS model can, by using its interactive component, incorporate a set of new assumptions about possible policy and program changes within the Canadian criminal justice system and then calculate the resource, cost, and flow (of offenders) implications of these changes on the administration of the system. This interactive component of the model allows the administrator or manager to quantify his intuition about how changes in one part of the system may affect other parts of the system. This then allows the analyst or the administrator to make program (or parameter) changes and assess the quantitative impact of these changes on the total system.

By "working with" the simulation model from a terminal (or other input device to a computer), the administrator becomes familiar not only with limitations of the modelling methodology, but also with its virtues, and how far it can be pushed in making quantitative predictions of particular changes within the system. He can also easily test the sensitivity of many of the programmatic changes which may be considered within the system. However, the important point which must be kept in mind is that the use of the model is only as good as the sophistication of the user. He must not only have a valid perspective of the model and its use but he must also have good numerical and policy (usually more general qualitative information) information about the present and accepted future operation of the system.

An example which might be used here is the prediction of penitentiary populations as a result of recent changes in sentencing in the Canadian criminal justice system. Here, it is useful to vary many factors such as crime rate, conviction rate, and parole rate, so that one can observe the impact of these parameters on the size of prison population. Thus, the user gets some "feel" or "sense" of the impact of these "parameters" on the size of the penitentiary population. A test of this use has been made and further validation in this area will be done in the future.

Thus, apart from its descriptive benefit, the model provides a possible tool for assisting policy planners in inputing a given set of assumptions about change to the system (derived from executive level personnel and decision makers) and then describing the possible impact of these different assumptions on the total CJS. Going even further it might be possible for the decision maker to assign his "prior responsibilities" on the different possible policy changes and thereby to impute the likely impact of the new costs, resources and flows on the Canadian criminal justice system for both short and long range horizons.

It is in undertaking this assessment of impact at the beginning and in later steps of the process that the real problems can begin in the use of computer models. A number of the following considerations have, at least in our experience, provided the "Achilles heel" in both computer model development and use:

a) the timing, often critical, cannot be compromised in terms of input back to the policy process, particularly given the influence of so many different interests and values;
b) the needs change frequently during the actual use itself, often meaning that certain parameter estimates must be included or not included, and possibly that the basic structure of the computer model itself must be modified (and/or the modeling approach);
c) the design of the analysis (pre-evaluation), because of the data or methodology, may have to be changed in the middle of the actual modeling exercise;
d) the programs themselves inevitably change and models are highly structured, as such providing substantial inflexibility [5];
e) the tradeoff between being too close and/or too far away and the co-opting of the computer model and its results is a serious danger, if it is to provide substantial input and an "objective evaluation";
f) understanding the model itself, particularly when there is a sophisticated, quantitative methodology being used, is critical since the decision maker is unlikely to accept something about which he has little or no understanding; and finally,
g) the "no result" occurs frequently for many reasons, in social program planning and evaluation, where the model simply says what doesn't work - not what works (see Wilson, 1975, for an eloquent discussion of this).

Throughout this process, and the modeling particularly, there needs to be an openness of communication and a real recognition of the fact that:

> "Organizational change (or decisions or policies) does not instantly flow from evidence, deductive logic, and mathematical optimization."[6]

Planning and computer modeling itself must take this into account. This has been increased significantly in the recent implementation of models but time only will tell if the process itself can take these different

---

[5] As we will see in our suggestions for the future, there are a number of different modeling approaches which encourage greater flexibility and allow substantial subjective input through such characteristics as an interactive component.

[6] Edward B. Roberts, "On Modeling", Technological Forecasting - Social Change, Vol. 9, 1976, pp. 231-238.

needs into account. However, our experience with the use of the computer models in the process has led to some concern for their use in the future, given in the next section.

Conclusions

In the second section, the policy priority and evaluation process was described in the context of the Federal Ministry of the Solicitor General in Canada. We made some preliminary analysis of the use and concerns which we have for computer models and their part in planning and evaluation in criminal justice. It is our feeling that they can play an important role, but that up to the present point, they have not come up to expectations. The question then is why? Some preliminary answers might be offered:

1. computer model development has far outstripped the original need in many cases;
2. models are not always oriented to the original use to which they were addressed; and
3. data and methodologies frequently present real difficulties.[7]

Perhaps the constraints and needs for successful models in policy evaluation can best be placed in context by looking at successful development of models in physical and technical processes in operations research and management science during the last 20 years. It will be remembered that in the 1950s, it was professional analysts within the particular physical, technical, (and often military) systems who structured the problem and so allowed the use of quantitative models. However, initially during the 1940s and 1950s, it was the design or structure of the problem itself which provided the constraint. It was only after this that the methodologists in operations research became important and gave added clout to the already structured and relevant problems.

This is nowhere near the situation which we have in criminal justice policy evaluation today. We are still trying in many cases to determine the objectives and relevant questions in planning and evaluation. In a few cases, the methodological developments have helped (such as in the multiple equation econometric techniques - which must be viewed as a mixed blessing), but we need a substantial input on the problem structuring and design. In addition, it is clear that social systems are frequently characterized by much more difficult measurements; thus, common measurements and indicators must be developed before substantial modeling efforts can expect any reasonable degree of success and/or wide acceptance. Moreover, the adaptability of social systems (addressed in section I) and of the individuals contained therein mitigates against the rather firm and deterministic experimental evaluation and model design which may work well for other systems (see Cassidy and Turner, 1976, for some preliminary quantitative evidence of this adaptability).

[7] Data in criminal justice is still unreliable and methodologies (even sophisticated econometric techniques), as has been suggested, cannot necessarily unravel the confounded relationships between parts of the criminal justice system, as well as between crime and the activities of crime control agencies generally.

It is only after the structuring has been agreed upon by the policy professional, decision maker, and analyst, that methodology and analysis become the major concerns. Indeed, there is substantial evidence that such well defined and deterministic structure may never exist for such social systems.

This is not to say that quantitative models have no part in policy evaluation. Rather that we must be extremely careful of the way they are used and the expectations we have from their application. Indeed, the process itself (see Cassidy, 1974, "Simulation of Social Systems: Product or Process") is useful in many different dimensions. For example, a recent effort within the Canadian Ministry of the Solicitor General had substantial spinoffs for information systems, intergovernmental liaison, and perhaps most importantly, some significant analysis and research efforts - ongoing at present.

With respect to the computer modeler, it is clear that if we wish to have the kind of interaction, communication, and respect for the viewpoint of the policy professional, he must be located within the agency (contract with full time consultants has problems which may be relieved by having permanent positions within an agency), and must at the same time have a strong methodological knowledge, recognizing the advantages and disadvantages of a modeling approach in a particularly evaluative context.

The problem itself must not be totally concerned with conceptual difficulties and/or conflict in values, must be amenable to some structuring, and should have some data which is both available and useful in the analysis. Otherwise, the exercise will be addressed, not by computer models, but by qualitative and conceptual arguments on the different aspects of the program to be evaluated.

The analysis itself, and here, we take perhaps an extreme position, should not result in a paper (the requirement that it not be published we find intriguing, since it would discourage the more complex but naive approach to modeling in policy evaluation and encourage a simpler and more sophisticated approach which is frequently necessary). We hope that this would put the emphasis on the problem and not the tool, a perennial difficulty where one obtains methodologically rigorous professionals who have simply sharpened their knives and are looking for an appropriate piece of material on which to work.

In summary, we feel there needs to be a balance with the computer modeler not too close, perhaps to encourage his objectivity, but close enough to ensure usability and relevance of the modeling within the policy evaluation to be undertaken.

ABSTRACT

In recent years, particularly, the operations research and management science literature has suggested alternative models and approaches for using computers and computerized methods for planning and evaluation in criminal justice. The present paper discusses the possible uses of computers in planning and evaluation and the type of planning process in which they might be situated. A specific type of model which might be used in such a planning and evaluation exercise is described. In this context, the relative advantages of computers generally, and the necessary conditions for their use, are presented based largely on the experience with several operational models.

ACKNOWLEDGEMENT

Much of the background work, including the original development of the systems model presented here and the collection of data could not have been accomplished without the advice and knowledge of Professor Alfred Blumstein, Carnegie Mellon University, and the assistance and support of the Federal Ministry of the Solicitor General of the government of Canada. In addition, the cooperation of Statistics Canada in providing information and assisting in its interpretation was invaluable. However, the content, including any errors, is the responsibility of the authors.

REFERENCES

Baker, W. 1969. Management by Objectives: A Philosophy and Style of Management for the Public Sector. Can. Public Admin. 12: 3, 427-443.

Baker, W. 1977. Administrative Reform in the Federal Public Service: The First Faltering Steps. Can. Public Admin. Workshop I: Productivity and Managerial Effectiveness in Public Agencies, University of Ottawa, Criminology, pp. 51-68.

Belkin, J. et al. 1971. Methodology for the Analysis of Total Criminal Justice Systems. U.S.I. Working Paper, School of Urban and Public Affairs, Carnegie-Mellon University.

Belkin, J. et al. 1971. An Interactive Computer Model for Analysis of the Criminal Justice System. U.S.I. Working Paper, School of Urban and Public Affairs, Carnegie-Mellon University.

Blumstein, A. 1971. Systems Analysis and Planning for the Criminal Justice System. Working Paper, Urban Systems Institute, Carnegie-Mellon University.

Blumstein, A. 1976. Private Communication to Dr. Jan Chaiken on the Rand Report on Criminal Justice Models.

Blumstein, A. et al. 1969. Systems Analysis of Criminal Justice. Operations Research. 17: 2, 199-232.

Blumstein, A. et al. 1975. The Dynamics of a Homeostatic Punishment Process. Working Paper, School of Urban and Public Affairs, Carnegie-Mellon University.

Blumstein, A. et al. 1969. Models of a Total Criminal Justice System. Operations Research. 17: 2.

Brewer, G.D. et al. 1973. Policy Analysis by Computer Simulation: The Need for Appraisal. Rand Corporation Report, P-4893.

Brewer, G.D. 1973. Professionalism: The Need for Standards. TIMS Interface. 4: 1, 20-27.

CANJUS Project Team. 1974. Flow of Offenders in the Criminal Justice System, 1971. Statistics Division Working Paper 9/74, CANJUS Project Report 15.

Cassidy, R.G. et al. 1973. Prediction of Penitentiary Population, Vol. I. Statistics Division Working Paper 8/73. CANJUS Project Report 5.

Cassidy, R.G. et al. 1974. Prediction of Penitentiary Population, Vol. II. Statistics Division Working Paper 1/74. CANJUS Project Report 9.

Cassidy, R.G. et al. Information and Statistics on the Canadi... Justice System. to appear in Criminology: A Canadi... ...ader, Butterworth Company, Canada.

Cassidy, R.G. et al. 1975. Criminal Justice System Behaviour. Working Paper No. 75-33. School of Business, Queen's University, Kingston, Ontario.

Cassidy, R.G. 1974. Simulation of Social Systems: Product or Process. Statistics Division Report 12/74. Ministry of the Solicitor General.

Cassidy, R.G. 1974. A Systems Approach to Planning and Evaluation in Criminal Justice Systems. Journal of Socio-Economic Planning Sciences. 39: 9, 1-12.

Cassidy, R.G. et al. 1976. Use of Systems Models in Planning and Evaluation. Proceedings of the SEARCH Symposium. Philadelphia.

Cassidy, R.G. et al. 1976. Planning for Public Agencies. presented at the 1976 ASC Meetings in Tucson, Arizona.

Cassidy, R.G. et al. 1977. Policy Evaluation. presented at the 1977 ORSA/TIMS Meetings in San Francisco.

Cassidy, R.G. et al. 1977. Models and Policy Evaluation: Oil and Water? presented at the 1977 Conference on Criminal Justice Evaluation in Washington.

Cassidy, R.G. et al. 1977. Pattern of Expenditures in the Canadian Criminal Justice System. Working Paper. School of Business. Queen's University, Kingston, Ontario.

Cassidy, R.G. et al. 1977. Interrelationship of System Behavior and Resources. Working Paper, School of Business, Queen's University, Kingston, Ontario.

Churchman, C.W. 1968. The Systems Approach. New York, Dell Publishing Company.

Ehrlich, I. 1972. The Deterrent Effect of Criminal Law Enforcement. Journal of Legal Studies. 1.

Ewing, B.G. 1976. Criminal Justice Planning: An Assessment. Criminal Justice Review. 1: 1, 121-139.

Hann, R. et al. 1974. A Preliminary Model of the Planning Process. an SDL Report to the Ministry of the Solicitor General on Feasibility Study for Penitentiary Prediction. Appendix II, Part I.

Hartle, D.G. A Proposed System of Program and Policy Evaluation. Can. Public Admin. 16: 1, 244.

Hopkinson, G. (Ed.) 1973. A Preliminary Description of the Canadian Criminal Justice System. CANJUS Project Report. Ministry of the Solicitor General and Treasury Board Secretariat.

Hoos, I.R. 1972. Systems Analysis in Public Policy. University of California Press.

Johnson, A.W. 1971. PPBS and Decision Making in the Government of Canada. Cost and Management.

Johnson, A.W. 1971. The Treasury Board of Canada and the Machinery of Government for the 1970s. Can. J. of Pol. Sci. IV: 3, 1971.

Lindbloom, C.E. 1959. The Science of Muddling Through. Public Admin. Review. XIX: 79-88.

Quade, E.S. 1975. Analysis for Public Decisions. American Elsevier Publishing Co., Inc., New York.

Roberts, E.B. 1976. On Modeling. Technological Forecasting - Social Change. 9: 231-238.

Rutman, L. et al. 1976. Federal Level Evaluation. Carleton University Graphics Services. Ottawa, Canada.

Shinnar S. et al. A Simplified Model for Estimating the Effects of the Criminal Justice System on the Control of Crime. New York.

Silver, M. 1974. Punishment, Deterrence and Police Effectiveness: A Survey and Critical Interpretation of the Recent Econometric Literature. A report prepared for the Crime Deterrence and Offender Career Project.

Tribe, L.H. 1970. Policy Science: Analysis or Ideology. Philosophy in Public Affairs. 11: 1, 66-110.

Wholey, J.S. 1972. What Can We Actually Get from Program Evaluation? Policy Sciences. 3.

Wildavsky, A. 1969. Rescuing Policy Analysis from PPBS. in The Analysis and Evaluation of Public Expenditures: The PPB System. 3: 835-864.

Wildavsky, A. 1964. The Politics of the Budgetary Process. Massachusetts, Little, Brown and Company.

Wilson, J.Q. 1975. Thinking About Crime. New York, Basic Books, Inc.

DISCUSSION

S. W. WITIUK: In the model that you showed us you admitted the lack of feedback factors but there seems also to be a second shortcoming. That is the incorporation of holistic variables. What is not easily represented in the model is a coefficient related to the deterrent factor associated with one system as opposed to another. Some variables don't seem to be incorporated easily into a microanalysis like this one.

R. G. CASSIDY: That is right. Some work in the United States is trying to deal with the particular variable you mentioned, the deterrent effect. One of the problems we have often had in working with policy processes has been a complete lack of understanding of the model by the users. They sometimes come to accept it as answering all the issues present in any policy being considered. After enough study they begin to understand that it answers only a small part and that there is a set of other variables that have to be incorporated.

S. W. WITIUK: Another aspect is the nature of simulations in general. There was a study in the Vancouver area in which it was proved that no matter what was done the pollution of Georgia Strait could not be prevented.

R. G. CASSIDY: The problem with any structured model, I guess, is that it will only give you insights into variables included in it. If enough factors are not included it will be impossible to consider alternatives which may be part of the basic structure. We found that all the policies ended up being so multidimensional that we could only handle a few of the dimensions. If you try to remove too many you end up with an inaccurate model that may not help to predict the impact of the policy.

J. G. ARNOLD: I am interested in the interactive aspects of your model. Who does the interacting and what type of facility do you use for the interaction? Do you use visual interaction, or do you use strictly numbers? A problem of model builders is that they sometimes inundate the user with numbers to which he cannot react.

R. J. CASSIDY: That is right. We have had different experiences. When we presented a lot of numbers, particularly to the senior policy advisory committee, they did not attempt to comprehend them. After a number of years we realized that graphs are not always the best things for getting ideas across. You can get attention for a long time only if you make ingenious use of visual displays. Our model may be used interactively on a Tektronix Silent 700 terminal, which is portable.

Let's go back to the first question, "Who uses it?". That is perhaps the most critical problem. When we originally developed the model I was in the Statistics Section of the Ministry of the Solicitor General. I was using it and I did not have any impact at all. Recently I have gone over to the Policy Planning Evaluation Section. Once again I and one of the people working for me are the main users. But we are closer to senior management. It is not that users or decision makers lack sophistication. They do not have time to get used to the model and they are a little upset by the terminal bleeping away and printing innumerable numbers and so on. The use of the model is really critical and I must say we have not solved that. We still basically have analytical computer people making use of it, but they are closer to the people who want the information.

W.J. BROWN: You mentioned setting objectives in your work. Have you attempted to operationalize the objectives and to measure whether you are meeting them?

R.J. CASSIDY: Yes, we have. The objectives we typically get for the criminal justice system, or indeed for the Ministry of the Solicitor General, end up with one of two things. Either you get everybody disagreeing about them, in which case you could measure them if you could get agreement, or you get everybody agreeing to them, in which case you know almost certainly that you will not be able to measure them in any reasonable fashion. As I said, the RCMP is an exception to this policy objectives and goals process.

W.J. BROWN: It is not then the case that you cannot operationalize the concept?

R.J. CASSIDY: It seems to be pretty difficult. We are still concerned with the objectives, for the department as a whole, but we have tried to get senior managers to set priorities for the next five or ten years. Then we insert these priorities at different parts of the model and attempt to keep track of them.

47431

POLICE AND COMPUTERS - THE USE, IMPLEMENTATION AND IMPACT OF INFORMATION TECHNOLOGY IN U.S. POLICE DEPARTMENTS*

KENT W. COLTON

Massachusetts Institute of Technology, Cambridge

I am going to talk about the use of computer technology in the United States. This relates a little to what David Mead talked about with respect to Canada, although I am not going to go into all the details of our results. Afterwards, I would be happy to refer you to specific publications.

Several factors have contributed to the growth of computer technology in the United States. First, I think that there has been a desire to improve the efficiency of police services. This has been coupled with, though, recommendations by the President's Commission on Law Enforcement and Administration of Justice which were made in 1967. The benefits of a number of technological innovations were discussed. That, in turn, was coupled - as we have already heard - with large-scale funding from the Law Enforcement Assistance Administration. This has helped to develop the use of technology in the law enforcement area. Finally, I think you have to give credit for innovation on the part of vendors who have gone from place to place to market their individual products. Sometimes they were interested in the results and sometimes not. Because of this wide application, a dialogue is now going on within the United States about the benefits and utility of technological innovation. Critics claim that many of the grants

---

*This paper is the edited transcript of a presented talk. Research for this project has been supported in part by Grant 76-N1-90-0043 from the National Institute of Law Enforcement and Criminal Justice of the Law Enforcement Assistance Administration, United States Department of Justice. Points of view or opinions stated are those of the author, and do not necessarily represent the official position or policies of the United States Department of Justice.

for technology have been wasted and that the innovations have done very little to improve the basic effectiveness of the law enforcement system. On the other hand, advocates are much more optimistic that the cost can be justified.

This report will focus on three questions or areas with respect to the present debate and dialogue.

THREE QUESTIONS ADDRESSED IN THIS PAPER

1. How are computers used by the police and how has this use evolved over time?

2. How successful has been the implementation of computer technology in the law enforcement area?

3. What is the impact of computer related technology? Do the benefits justify the costs?

The first area is how computers are used by the police in the United States and how this has evolved over time. This is related to what David Mead talked about in Canada. Secondly, I want to talk about how successful the implementation of computer technology has been and, thirdly, about the impact of computer use and whether the benefits justify the cost.

In asking these questions it is worth mentioning one caveat which I think is important. In addressing such issues researchers probe for understanding and explanations. Answers or relationships sometimes appear but often results uncover new questions and the process of enquiry continues. I think it is important and healthy for all of us on occasion to admit that we are groping to one degree or another. So it is with the issues that I have indicated; some have clear answers, for example those that pertain to the use of computers by police and how this has changed over time. Other questions, though, particularly those pertaining to the implementation and impact of technology, are less straightforward. In some cases, the data are simply inadequate to reach a conclusion. In others, even if better data is available, a final decision would depend, I think, on perspectives and value judgements.

Now, with these caveats, let us begin to answer questions. Basically, I have three sources of information to help me in these three areas. First, I designed some surveys that were administered by the International City Management Association in 1971 and 1974 about the use of technology by police departments in the United States. Second, I have had the opportunity to visit a number of police departments. More recently, I have been engaged in doing a series of seven or eight case studies, with emphasis on resource allocation and command control systems in the United States and then implementation and impact.

First let me take five minutes to give you the quick history (the five-minute version) of how computer uses have evolved in the United States. In order to do this I need to define several terms. When the surveys were conducted, we asked people to say whether they were using a computer in any of 24 different application areas listed on the right in Figure 1. I then grouped these into eight areas on the left. I think that you are familiar enough with them that I do not have to go into detail. But let me simply indicate that we talked about police patrol and enquiry applications, rapid retrieval of information, traffic, police administration, applying statistical files, miscellaneous operations and so on down the list in Figure 1.

In trying to analyze the information, I found it was very useful to make a distinction, which I think some people have referred to in the last couple of days (maybe not quite in the same way) which I find very useful for the analysis of the impact and the success of the implementation. That is to make a distinction between what I call the "routine" uses of computers and the "non-routine" uses of computers (Figure 2). In the routine area, we consider straightforward

Fig. 1

Computer Use by the Police

Application areas	Computer applications
Police patrol and inquiry	Warrant file Stolen property file Vehicle registration file
Traffic	Traffic accident file Traffic citation file Parking violation file
Police administration	Personnel records Budget analysis and forecasting Inventory control file Vehicle fleet maintenance Payroll preparation
Crime statistical files	Crime offense file Criminal arrest file Juvenile criminal activity file
Miscellaneous operations	Intelligence compilation file Jail arrests
Resource allocation	Police patrol allocation and distribution Police service analysis Traffic patrol allocation and distribution
Criminal investigation	Automated field interrogation reports Modus operandi file Automated fingerprint file
Computer-aided dispatch	Computer-aided dispatching Geographic location file

Fig. 2

Routine and Non-Routine Uses of Police Computer Technology

Routine	Non-Routine
Police patrol and inquiry -	- - ->
Traffic applications -	- - ->
Miscellaneous operations -	- - ->
<- - -	- Command and control (including computer-aided dispatch and automatic vehicle monitoring
<- - -	- Criminal investigation
Crime statistical files	
Police administration - - -	->
<- - -	- Resource allocation

repetitive manipulation and enquiry of prescribed data, often by means of a definite procedure. The same manipulation was usually done by hand before the advent of the computer. Technology simply makes the process quicker and easier. For example, in police patrol and enquiry you may be talking about a system which is sophisticated from a technical perspective but really you are doing a relatively straightforward manipulation of the data.

When you get to the non-routine area, applications are more elusive. Here the machine becomes a tool to aid in the decision-making and planning process. There are no absolute cut-and-dried methods for handling problems, either because the area is so complex or because it is so important that custom-tailored solutions are required. In the non-routine area examples include modeling, resource allocation, criminal investigation and command and control. On the routine side, you can see (Figure 2) I have listed police patrol and enquiry applications, traffic applications and police administration applications. Obviously when you talk about a spectrum like this, there are really no absolute cut-and-dried breakdowns. Rather you are talking about moving from one end of the spectrum towards the other. As applications move towards the non-routine end of the spectrum, systems design becomes more difficult and behavioral personality and organizational considerations become even more significant. Several application areas obviously fit in between. An illustration of this is crime statistical files (I think we have talked about this already in this conference). The basic collection of that data is a routine and straightforward process. However, when you begin to analyze the information and to use it for your purposes you move towards the non-routine side. Computer-aided dispatch is another application which has both routine and non-routine dimensions.

When talking about the evolution of the use of technology in the United States, I have found it useful to talk about evolution over four time periods - 1960 to 1966, 1966 to 1971, 1971 to 1974 and 1974 to 1977. Let me again give you the very quick version of this. You will have to believe me on a couple of things. In 1966 (Figure 3) major dominance fell in the area of routine applications. You can see routine applications drawn at the top and more non-routine applications drawn towards the bottom of each of the charts (Figures 3-6). Police administration, traffic, crime statistical files, police patrol and enquiry, miscellaneous operations, resource allocations, computer-aided dispatch and criminal investigation are shown. You can see that in 1966 real dominance and, in fact, half of the computer applications fell in the area of police administration and routine traffic kinds of

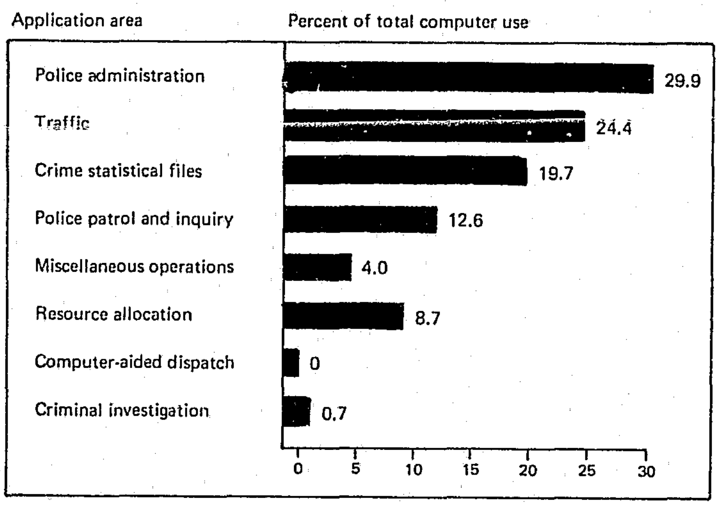


Figure 3 *Status of computer use in 1966*

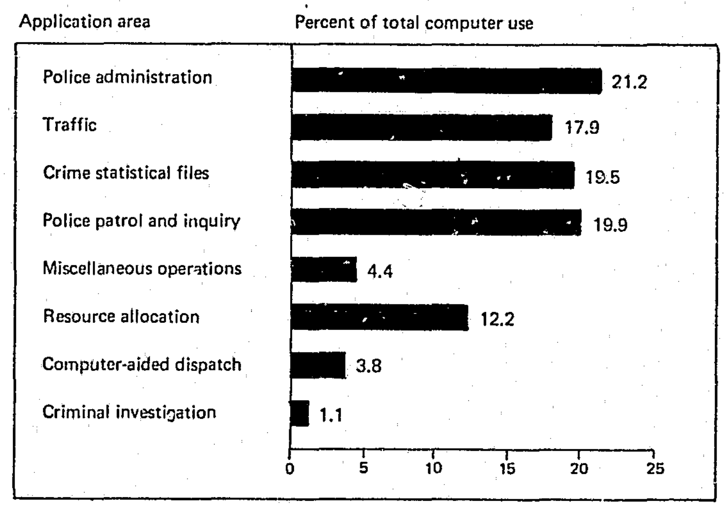


Figure 4 *Status of computer use in 1971*

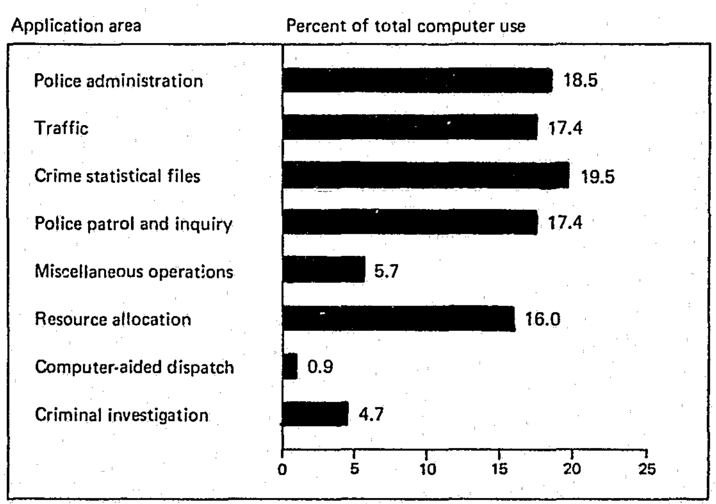


Figure 5 *Actual status of computer use in 1974*

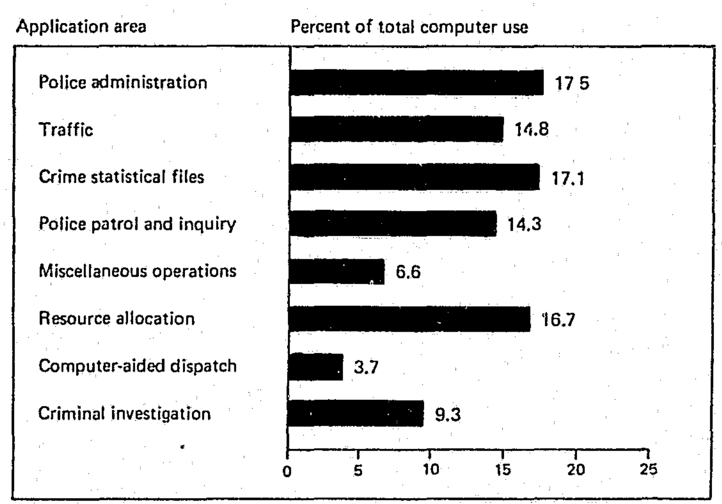


Figure 6 *Status of predicted computer use in 1977*

applications. Between 1966 and 1971 you see an interesting shift within the routine application area. These figures, by the way, represent percentages of total use of computers by the police. You see (Figure 4) continued importance for police administration, traffic, crime and statistical files. You also see a major increase in police patrol and enquiry applications. That is the period in the United States when the ALERT system in Kansas City and the ADAM system in Los Angeles began. Much effort was expended on police patrol and enquiry. Also CI got started in the United States during that time. Also in non-routine computer applications you see an interesting phenomenon begin, namely more and more effort and use by the police in resource allocation.

In 1974 a couple of other interesting things occurred (Figure 5). Much use continued in the structured areas. An interesting phenomenon is revealed by comparing data between 1971 and 1974 in terms of what police predicted and what they actually did. Something began to happen. Predictions in all of the structured areas of police administration, traffic, crime, statistical files, etc. far exceeded what they had actually ended up doing by 1974. Thus you had expectations of going ahead of what they talked about doing but still major emphasis in terms of that area. An interesting thing happened with respect to resource allocation. That was the only area where what actually was done by 1974 exceeded the predictions of 1971. So you see increasing emphasis by law enforcement agencies on resource allocation. In two other non-routine uses of computers, computer-aided dispatch and criminal investigation, the reverse occurred. People predicted extensive use. In 1971, 61 police departments talked about using a computer and having one installed for computer-aided dispatch by 1974. In 1974, the reality was that of those 61, 15 had actually begun to install some sort of a computer-aided dispatch system. So expectations were far in advance of what actually occurred in these non-routine areas.

One other interesting thing with respect to use of computers in resource allocation is that we asked police departments to rank the areas most important to them in the use of computer technology (Figure 7). In 1971 and in 1974 you see that departments say computer technology in resource allocation is the most important application. After a decade and a half, I think there is no doubt that in the United States computer technology will continue to be used in law enforcement. Clearly the use is here to stay and it will be here in the future.

The more critical questions I would like to discuss during the remainder of the time are: "What is the impact?" "Do the

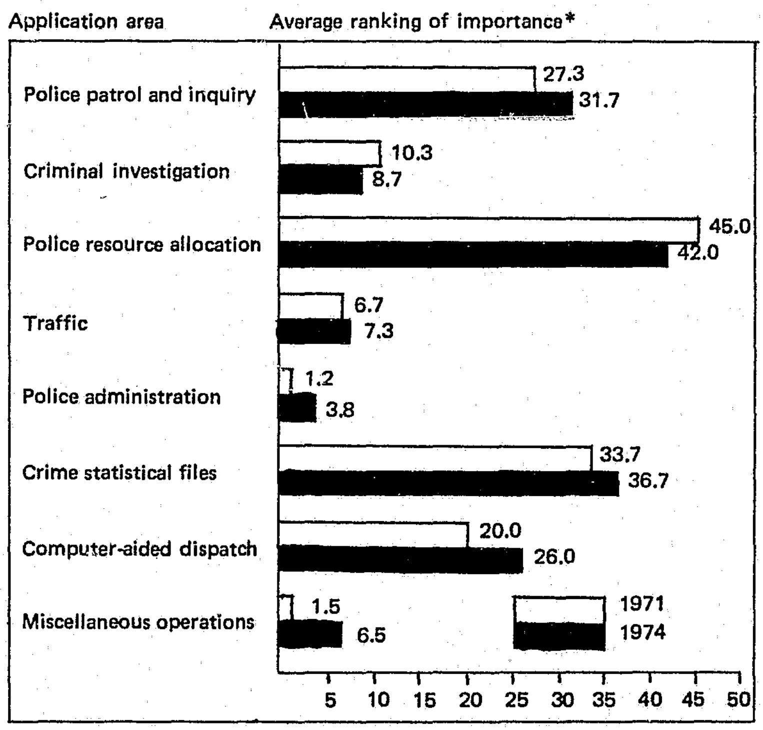


Figure 7 *Importance of computer applications in 1971 and 1974, as ranked by police departments*

* Ranking is based on the average number of times applications were selected by police departments as one of their three most important applications.

benefits justify the cost?" and "What has happened in terms of implementation?". To do that, I first must define a framework for evaluation. Let me give you a breakdown I have found useful.

FOUR PART FRAMEWORK FOR EVALUATION

1. Does the application "work" -- that is, does it stay in operation for a period of years and does it meet the objectives that were originally specified?

2. What are the technical impacts? e.g. Lower costs of processing data, availability of new or better information, greater speed in processing, wide distribution, etc.

3. What are the service impacts? e.g. changes in police task or the service delivered by the police.

4. What are the power impacts? e.g. changes in the structure of decision making, losses of one person's power as compared to another person, greater to centralization, etc.

This is to talk about evaluation in four different areas. I will go through this quickly and you can ask questions at lunch if you wish. First of all the most basic: Does the application work? Let us go back to the original objectives that people stated when they started to implement the system. Were those objectives fulfilled? Then you begin to get into succeeding levels of more difficult dialogue about impact. First: What are the technical impacts? By this, I mean things to do with the processing and the input and output of information and, for example, lower costs of processing data, availability of new and better data and greater speed at processing the information. Those are the types of things I mean by technical impacts. Then we begin to move to a more difficult level. What is the service impact? What does it mean in terms of the police task and what does it mean in terms of service delivered to the public? I will give some illustrations of that later. Finally, an even more difficult area but a very important one, has to do with the power shifts. What are the changes in the structure of the decision-making process - centralization versus decentralization. And beyond that, who gains and who loses, in terms of the power? For example, there are questions having to do with privacy which fit under privacy impacts. Does the individual citizen lose in terms of access and control over information, say as compared to bureaucracy?

Let us talk about the use and impact in the various areas I have talked about. First may I very rapidly go through applications in the routine areas. This is why the distinction turned out to be helpful for me. I found that, with respect to criterion number one throughout the United States, although the success varied greatly from department to department it was very easy to point to a number of computer areas where the application had been in use over a number of years. In fact when you talked about the original objectives - information to the man in the street in seven seconds - that objective had indeed been met. With regard to technical impacts, again you found that technical impacts existed in the routine uses of computers. You really did have extensive additional availability of new information, rapidly processed and widely distributed. Of course the important question there is what do you do with this data sitting around on tables and shelves and so forth. What difference does it make? What influence does it have on service impacts? There the situation is more difficult to describe even in routine applications. If I talk about service impacts in a very narrow way, then I can identify a number of cases where the routine uses of computers are cost effective systems.

Let me give you a couple of very quick illustrations from the book that I am doing. Obviously in the book I go into this in much greater detail. But, for example, in Tulsa, Oklahoma, they set up a traffic citation collection system and in the first year they brought in $180,000 of profit above the system cost in revenues collected. They had a more efficient routine system to follow up on traffic violations. In Long Beach, California, membership in an automated want/warrant system brought an increase in the number of warrant arrests of 31 per cent in the first year that it was installed over the warrant arrests of the year before. These are the kinds of results you can describe as long as you restrict yourself to narrow definitions of success.

However, when you consider some of the broader service impacts, it gets more complicated. You have, for example, the Chief of Police in Kansas City saying that "We have a great system - the

ALERT system - which gives information to the man in the street about stolen cars, wanted persons, and so on. It works just great. The problem I am having is that the men are using it too much and, in fact, now I have them spending all of their time running car checks on the cute girl in front of them driving down the street, or on stolen cars when in fact I would like them to spend time on other aspects of police service". So you have unintended service shifts taking place through the use of routine applications.

Secondly, and I think this is probably much more important in the United States than here, we have had resources from the Law Enforcement Assistance Administration. This money can be a "seductive stimulant" and I can point to a number of cases where technology has been implemented where probably it should not have been. Because it was there, they wanted to use it. And in fact the use has not been well received. Again, I have found it is extremely difficult to measure with confidence the service impacts of technological innovations on crime. Crime statistics are a function of a whole range of things, from the time of day to the season of the year, the weather, neighbourhood reporting patterns, reporting requirements within individual police departments, etc. I would argue that to try to relate the use of technological innovations to changes in crime patterns requires a leap of faith which is far too great. In fact we are probably hunting the wrong set of measures when we say we deployed this new resource allocation system and the crime rate changed by x, y or z. Because I can show you that you change ten other things at the same time and those ten other things might have contributed to the shifts that you saw in crime rates. So again you get into real difficulties in measuring the service impacts, both in routine and non-routine applications. Finally you get questions about the power impacts, privacy issues come up and need to be dealt with (as we have heard and talked about this morning) and you have questions of shifts of control. Do people who understand quantitative data, like all of you folks, gain in power in a police department because of the use of this technology? Probably so, but the data still isn't completely clear. In summary, though, I would say routine applications have been successful. Some questions still exist with respect to three and four, but again relatively straightforward things are beginning to happen.

When you get into the non-routine area, questions are much greater. We have already heard about that and Gordon Cassidy talked about the whole area of resource allocation. Let me just make a few comments with respect to some of my findings on resource allocation applications in police departments in the United States. I found that a fascinating dichotomy existed there. On the one hand, as I indicated earlier, police departments say that this is the most important area for computer use. On the other hand, you begin to realize that they are really talking about a set of crime statistics available to make ballpark guesstimates as to how allocation ought to go, and that out of all the people talking about resource allocation applications, only about 18 per cent are beginning to use any sort of mathematical modeling. So you really have to understand what you are looking at.

Then, when you begin to look at the actual implementation, you discover that the state of the literature often exceeds the state of the art. You read that you have this fantastic system and then you discover that it was in operation for about six months but nobody has used it for long. We did three case studies of resource allocation applications in St. Louis, Missouri, in Los Angeles, and in Boston. In all of those, problems had existed with respect to implementation and in only one, Los Angeles, did the system meet the first criterion of actually being operational over a period of time. We discovered that the modeling efforts and the queuing theory that they were using at the outset had been abandoned and that they had converted to a management information system. It had the same name but it was really a management information system with a different set of objectives from the ones they had when they started out. So you have to realize that expectations may not always be met in these applications. On the other hand I would argue that the three case studies obviously do not represent the cutting edge of the state of the art.

Some of you might be familiar with several other models which are now receiving fairly extensive use in the United States. These include the Patrol Car Allocation Model (PCAM) which was developed by Jan Chaiken at the Rand Corporation. Also, a colleague of mine at MIT, Dick Larson, has done a lot of modeling work on the hypercube model which is receiving publicity. I guess there are perhaps 30 police departments around the United States that are trying to implement one of the two models but the success and level of implementation are still not known. I would argue that the general application of models is found in other areas. For example, the Rand Corporation did a study on the use of models in the criminal justice area and concluded that, in general, models have failed to achieve the level of use for policy decisions that was intended. Well, does that mean that, frustrated, we ought to abandon any efforts? I would argue not. I can't go into detail on all of the conclusions that you can read about in my report to the LEAA, which will be published in book form, but let me give you a few highlights.

CONCLUSIONS CONCERNING THE USE OF COMPUTER TECHNOLOGY TO AID IN THE RESOURCE ALLOCATION OF POLICE SERVICES.

1) Experimentation will continue to grow, but success will continue to be limited and some of the earlier expectations in this area will not be met.

2) Modeling efforts help us to learn more about the criminal justice system, but the education process must be two way.

3) There is a strong need for careful evaluation and special attention to the process of implementation.

4) There is no one best way to allocate law enforcement resources.

Experimentation on resource allocation will continue to grow but success will continue to be limited and some of the earlier expectations will not be met. You know back in the 1960's they were talking about fluid patrols. A police officer comes on duty and he doesn't have a standard beat but will get his allocation on a daily basis based on predictions of what is going to happen to the crime patterns that day. Hey folks, that is not going to happen for at least ten, 15, 20 - probably 50 years! There are some basic things about the way that the police operate and you are always going to have to interact your modeling effort with the basic nature of the police departments. The fact is that the men do not want to change beats every day and there is a whole different psychological effort. I can tell some interesting war stories on that. Modeling efforts, though, do help, as we heard in the last session. I can understand about the criminal justice system and the way it works. However, I would argue very strongly that the education process has to work both ways. It can't just be the model builders getting educated; it also has to be the users of the models helping to educate the model builders. That two-way process is extremely difficult to bring about. There is a strong need for continued and careful evaluation and special attention to the process of implementation.

Finally, you really have to realize that there is no one best way to allocate police resources. One of the fascinating things we found, in the Los Angeles case, was that the police department began to implement a modeling system which basically aimed to allocate resources to respond to calls for services 95 per cent of the time without a delay. Basic criterion of that model-response to calls for service. At the same time they began to implement a team policing strategy starting with the basic car plan and then a team policing program where the emphasis was on putting a set of officers in a particular area of the city and keeping them there. Those two strategies conflict, folks. You have to understand that there are alternative ways that one can allocate resources and one of the reasons that the modeling effort got pushed aside is priorities. I think that this is fine, and that police departments ought to be able to do this. It was much more concerned with the team policing approach than with rapid response to calls for service.

But you have to realize, when you are talking about models, ~~that these implementation considerations are important and there are~~ implications that follow. So you can't just take a package from Joe Vendor that is going to solve the problems of the world. There will be some implicit assumptions in that model and the users have to understand those assumptions. That is why the process of model building has to be a two-way street.

Well, I think that my time has almost run out. We did work on CAD and command and control systems. Let me mention a couple of things and then the paper can go into some of this in greater detail. We found that there certainly are operational CAD systems in the United States that are working pretty well with regard to technical and some service impacts. On the other hand, there are some questions about how the information is to be used. The real success probably has to wait until we discover the ability of police managers to take advantage of all this information. It is my feeling that police chiefs have not always viewed themselves as managers of a set of police resources. Rather their job is one of public relations, to make sure that things are moving smoothly, and to get greater resources. They want to get more dollars for the department. But managing those resources is a style you do not find very often, at least among the police chiefs I have come in contact with. So the behavioural side is very important. We have done a detailed study (we being a couple of colleagues of mine) on the use of automatic vehicle monitoring (AVM) systems in St. Louis, Missouri, which is available in the literature. If any of you are interested I would be glad to take your name and send you a copy. That calls into question whether AVM is going to have any impact on response time and that is often one of the main reasons we want to set up this new automatic vehicle monitoring (or automatic vehicle locator system).

This just raises a lot of questions about whether or not that's really going to be the case.

Perhaps I can just show you a chart showing in outline some of the things which seem to be essential for successful implementation.

> FOUR BROAD AREAS WHICH ARE NECESSARY TO SECURE THE SUCCESSFUL IMPLEMENTATION OF COMPUTERS
>
> Improve the quality of the computer technology.
>
> Establish better quality controls between vendors and users. e.g. establish standards in "truth in technology".
>
> Greater interaction between builders of technology and the users.
>
> Greater integrity of personal behavior among individuals involved in the process of implementing innovations.

These are dealt with in detail in my book.

DISCUSSION

J. G. ARNOLD: I have two questions. With regard to the interaction in the model and the modeler himself, who should be inputting into the model? The man in the street, the police administrator, how low should we go?

K. W. COLTON: Well, if you were to talk about the ideal world, you might want to go all the way and involve everybody. I think you have to be realistic. First, I think you have to start with the first level, those people who are going to be making the decisions with respect to the allocation of resources. It turns out that in police departments that sort of decision very seldom involves the man in the street. It's a decision made by the head of the bureau - field operations or whatever they call it. But I think you do have to involve the chief of police if he's interested, and there has to be an interaction there if he is going to be the user of that system. Certainly you have to go beyond that and you have to talk to the head of field operations or district commanders - the people who are actually going to use the system. For example, in St. Louis they were one of the first areas to use police modeling, and they tried to use exponential smoothing techniques to do some prediction of the crime rate. They would come up with a kind of ideal allocation of resources. The police commanders, however, were never involved in the process. It turned out they were the people who had to use the model; they had to understand it, and they had the final decisions on the actual allocation of resources. They decided whether they would ignore the recommendations from the model or implement them. They ended up being very uninterested and, when I went there at the end of 1969, when the system was still around, you would talk to people at central headquarters who would say "Yes, we have this great modeling technique". Then you would go out and talk to district captains and they would say "Oh yes, resource allocation. We gave that up last year, didn't we". You found a real disparity, so I think you probably have to go down to the level where the decisions are made, and that turns out to be at least at the district command level. Beyond that, I think you're being very unrealistic.

J. G. ARNOLD: Have you run into problems with police unions?

K. W. COLTON: Well sure, and that's where you get into the other side of the interaction and again, that's an interesting story from St. Louis. They don't have a police union but they have an important patrol officers' association (and there is a distinction, by the way). They decided that, in terms of the deployment patterns, it made a great deal of sense to shift the duties. They have their shifts going from 7 to 4, 4 to 11 and 11 to 7 - their basic three shifts around the clock. They decided that it made good sense to wait for an hour at 11 o'clock at night - one of the peaks - and to change the shifts to 8 to 5, 5 to 12 and 12 to 8. They implemented that and found major opposition from the police department and from the officers. The reason was that it put the police officers commuting right with all the other commuter traffic. Before, they had gotten off just before five o'clock and could get home and avoid the rush hour. The resistance was so great that within a period of six months they had to go back to their original shifts. So you have to understand that we can utilize scientific rationality so far but we do have to interact with the officers. Now they might have avoided some of those problems if, when they got to the implementation stage, they had used a much more extensive kind of education and communication.

Often you discover that implementors of innovations make some interesting assumptions about their technology. If the technology exists, there must be a need and implementation should proceed. That may not be the case.

COMMON IMPLEMENTATION ASSUMPTIONS

If the technology exists, there must be a need and implementation should proceed.

If only the technical problems can be resolved implementation can move forward.

Time constraints mean that implementation must rely on a small group of supporters.

Law enforcement supervisors really don't need to understand how innovations work, they simply need to know how to use them.

The sooner, the better.

If the new technology is installed, positive results will occur.

If only the technical problems can be resolved, implementation must rely on a small group of supporters. We don't have the time to involve all the people. It's too complicated to do that.

Law enforcement supervisors really don't need to understand how innovations work - they simply need to know how to use them. I don't go along with that. I think that they need to get into it in much greater detail.

The sooner the better - oftentimes not the case.

Or, if the new technology is installed, positive results will occur. Well, not always the case. So you have to talk about that in much greater detail. It turns out that you can turn these assumptions around and develop a checklist of things that are interesting to talk about.

S. W. WITIUK: Did you find many situations where you did these things, or tried to do them, and the first reaction was "I don't want to get involved in it. I don't understand it. Let one of my people do it". And yet, usually the group on which you want to minimize the impact of shifts of power was hesitant to get involved in a serious way?

K. W. COLTON: You have this dilemma and that's why at the outset I said it's important for us to realize that we don't know the answers to everything and we are indeed probing. In fact you think you know that this is the way you ought to proceed, but the resistance is there. You might even have to come to grips with it, if you are the innovator of technology. But there must be other more productive ground on which to cast the seed. So there really may be places where you decide that the innovation that makes sense in a particular police department is not very sophisticated technologically, but it's a question of doing some quick and dirty analysis based on available statistics. Let's not worry about a model with lots of bells and whistles on it. Let's just try to go the next step. And that's why you have to fit the effort and the content of the particular environment you're in and that makes a great deal of difference.

S. W. WITIUK: That applies right down to the individual level, as far as I'm concerned. What will work for three managements will never work for the fourth.

K. W. COLTON: That's right. And there isn't a consistent kind of answer. So you really can't answer the question "Do the benefits justify the cost?" because that's going to vary from department to department, depending on how the implementation occurs.

J. G. ARNOLD: Where do your innovations and models come from - universities, Rand Corporation, the commercial sector, or elsewhere?

K. W. COLTON: They have come from a range of places. I alluded to them at the outset but I can go into them in more detail. The President's Commission on Law Enforcement and the Administration of Justice recommended a number of technological innovations. Those bacically came from the academic community interacting with law enforcement personnel at a national level - a kind of brainstorming effort. I think that carried the thrust for four or five years. Clearly, the vendors are very important in the United States for innovation. They are the technology change agents. We could talk about that at some length if we wanted to. They go from department to department selling, for example, their CAD system. Often they have a vested interest, obviously, in selling their product, so they tend to present information in a certain light. One of the things I think would be fascinating in the United States, and I'm sure also in Canada, is this. You begin to now have a series of kind of experts in police departments who understand both the technology and the police. I think that's a resource you can draw upon more, to help be a technology change agent. Then there really is an effort within the department to do a better job, so I think one can be too cynical about the reasons. I think people really do want to improve police services and part of it really does spring from within the department. The attitude towards innovation varies significantly in the United States from department to department. In certain departments they're very innovative and they are the ones that have had the ideas.

ATTENDANCE LIST

Mr. J. G. Arnold
Computer Graphics Section
Electrical Engineering Division
Bldg. M-50
National Research Council
Ottawa, Ontario. K1A OR8.
Phone: (613)993-2003/2629.

Mr. W. Harvey Brodhecker
Manager, Programme Development
Ontario Police Commission
25 Grosvenor St.
Toronto, Ontario. M7A 2H3.
Phone: (416)965-3281/6071.

Mr. W. J. Brown
Operational Analysis Group
Edmonton City Police
4 Sir Winston Churchill Square
Edmonton, Alta. T5J 2C2.
Phone: (403)428-3920

Mr. Bruce Butler
Operational Analysis Group
Edmonton City Police
4 Sir Winston Churchill Square
Edmonton, Alta. T5J 2C2.
Phone: (402)428-3920.

Mr. Raymond Cantin
Statistics Canada
Coats Building, Station H
Tunney's Pasture
Ottawa, Ontario. K1A OT6.
Phone: (613)995-0855.

Dr. R. Gordon Cassidy
Research & Systems Development Branch
Solicitor General of Canada
340 Laurier Ave. West
Ottawa, Ontario. K1A OP8.
Phone: (613)992-2898.

Mr. Samson K. Chang
International Association of Chiefs of Police
11 Firstfield Road
Gaithersburg, Maryland. 20760.U.S.A.
Phone: (301)948-0922.

Staff Inspector K. R. Cocke
Vancouver Police Department
312 Main St.,
Vancouver, B.C. V6A 2T2
Phone: (604)665-3472

Prof. Kent W. Colton
Massachusetts Institute of Technology
Room 9-521
Cambridge, Mass. 02139. U.S.A.
Phone: (617)253-7736.

Mr. Lyle A. Cox, Jr.
Lawrence Livermore Laboratory
Livermore, California. 94550.U.S.A.
Phone: (415)447-1100 ext.3654.

Mr. Victor M. Davis, Jr.
Systems & Programming Division
City of Atlanta
City Hall
Atlanta, Georgia. 30303.U.S.A
Phone: (404)658-6490.

Prof. D. H. Douglas
Dept. of Geography
University of Ottawa
Ottawa, Ontario. K1N 6N5
Phone: (613)231-4045.

Dr. C.R. Eves
Protective & Forensic Sciences Section
National Aeronautical Establishment
Building M-55
National Research Council
Ottawa, Ontario. K1A OR6.
Phone: (613)993-3737/3778

Mr. R. J. Friesen
Research Consultant
Personnel Security and Privacy Procedures
Security Systems Branch
'P' Directorate
Royal Canadian Mounted Police Headquarters
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2.
Phone: (613)995-9766.

Mr. Roger G. Fujaros
Communications Research Centre
P. O. Box 11490
Station H
Shirley Bay
Ottawa, Ontario. K2H 8S2.
Phone: (613)596-9617.

Assistant Commissioner J. Gongos
Director CPIC
Royal Canadian Mounted Police
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2
Phone: (613)993-9740.

Det. Sgt. Blaise Gregoire
Montreal Urban Community Police
511 Place d'Armes, 5th floor
Montreal, Quebec. H2Y 2W8
Phone: (514)872-2577.

Mr. S. R. Gwilt
Protective & Forensic Sciences Section,
National Aeronautical Establishment
Building M-55
National Research Council
Ottawa, Ontario. K1A OR6.
Phone: (613)993-3737/3778.

Mr. A. H. Hall (Ret'd)
Protective & Forensic Sciences Section
National Aeronautical Establishment
Building M-55
National Research Council
Ottawa, Ontario. K1A OR6.
Phone: (613)993-3737/3778.

Prof. Perry O. Hanson III
Department of Geography
SUNY - Buffalo,
4224 Ridge Lea Road
Buffalo, New York. 14226.
Phone: (716)831-1611.

Mr. E. L. Hayes
Director of Records
City of London Police Department
P. O. Box 3415
London, Ontario. N6A 4K9.
Phone: (519)679-5644.

Mr. Lyndon Holmes,
ADL Systems, Inc
10 New England Executive Park
Burlington, Mass. 01803. U.S.A.
Phone: (617)272-3400 ext. 20

Mr. J. R. Hopkins,
Officer i/c Systems Analysis and Programming Branch, CPIC
Royal Canadian Mounted Police Headquarters
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2
Phone: (613)993-9740.

Mr. Z. Jaksic
Photogrammetry Section
Physics Division, Room 8
Building M-36
National Research Council
Ottawa, Ontario. K1A OR6.
Phone: (613)993-2052/2505.

Mr. Marcel Lalonde
Montreal Urban Community Security Council
511 Place d'Armes, 5th floor
Montreal, Quebec. H2Y 2W8.
Phone: (514)872-2577

Lt. Jacques Lecompte
Montreal Urban Community Police
511 Place d'Armes, 5th floor
Montreal, Quebec. H2Y 2W8
Phone: (514)872-2577.

Dr. F. R. Lipsett
Computer Graphics Section
Electrical Engineering Division
Building M-50
National Research Council
Ottawa, Ontario. K1A OR8.
Phone: (613)993-2629/32003.

Inspector D. G. Lyon
Ottawa Police Force
60 Waller St.
Ottawa, Ontario. K1N 7G5.
Phone: (613)236-0311.

Mr. David H. Mead,
Department of Attorney - General
Justice Information Systems
1190 Melville St., 7th Floor
Vancouver, B.C. V6E 3W1.
Phone: (604)687-8721.

Mr. R. A. K. Meyer
Assistant Director -
Technical Services
CPIC
Royal Canadian Mounted Police Headquarters
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2.
Phone: (613)993-9740.

Mr. Bernard Poirier
Executive Director
Canadian Association of Chiefs of Police
116 Albert St., Suite 1002,
Ottawa, Ontario. K1P 5G3.
Phone: (613)233-1106.

Mr. T. Allan Porter
Statistics Canada
Station 19A
Coats Building
Institutions & Public Finance Branch
Tunney's Pasture
Ottawa, Ontario. K1A OT6.
Phone: (613)995-0868.

Deputy Commissioner A. C. Potter
National Police Services
Royal Canadian Mounted Police Headquarters
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2.
Phone: (613)993-1249.

Mr. Richard Prytula
Chief, Computer Systems Group
Instronics Limited
Stittsville, Ontario. KOA 3GO.
Phone: (613)836-4411.

Mr. David Swan,
Macdonald Dettwiler & Associates Ltd.
Airport Executive Park
10280 Shellbridge Way
Richmond, B.C. V6X 2Z9.
Phone: (604)278-3411.

Mr. D. C. Symons
Chief, Planning Information System
National Capital Commission
48 Rideau St.
Ottawa, Ontario. K1N 8K5.
Phone: (613)992-1022.

Prof. D. R. Fraser Taylor
Department of Geography
School of International Affairs
Carleton University
Ottawa, Ontario. K1S 5B6
Phone: (613)231-4396.

Mr. K. R. Thomas
Officer i/c Facilities Planning and Research Branch, CPIC
Royal Canadian Mounted Police Headquarters
1200 Alta Vista Drive
Ottawa, Ontario. K1A OR2.
Phone: (613)993-9740.

Dr. Gordon Turnbull
Police Scientific Development Branch
Horseferry House
Dean Ryle St.
London SW1P 2AW. England.
Phone: 01-211-3003.

Dr. John E. Watkin
Protective & Forensic Science Section
National Aeronautical Establishment
Building M-55
National Research Council
Ottawa, Ontario. K1A OR6.
Phone: (613)993-3737/3778.

Mr. Sid W. Witiuk
Statistics Canada
Spatial Systems Section
Census Processing Division
Carling Avenue
Ottawa, Ontario. K1A OT7
Phone: (613)994-5386.

Mr. M. Wood
Woods, Gordon & Co.
160 Elgin St.
Ottawa, Ontario. K2P 2C4.
Phone: (613)236-7467.

END