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Computers in Planning: A Knoxville Example

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To the Graduate Council:

I am submitting herewith a thesis written by Lynn E. Miller entitled "Computers in Planning: A Knoxville Example." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Architecture.

Joseph M. Prochaska, Major Professor

We have read this thesis and recommend its acceptance:

George E. Bauer, Robert L. Miles

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Lynn E. Miller entitled "Computers in Planning: A Knoxville Example." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

Joseph M. Prochaska, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

E

COMPUTERS IN PLANNING:

A KNOXVILLE EXAMPLE

A Thesis

Presented for the

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Lynn E. Miller

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ABSTRACT

The availability of computers at the local level of government has been steadily increasing. With this increase, planners are in a unique position to utilize computer capabilities to assist in the full range of planning activities. The problem to date seems to be one of a lack of understanding as to what computer applications are being used and how these applications can be useful to planners. This research is, therefore, oriented towards presenting an overview of computer applications used in planning agencies. Attempts are made to show how these applications are used and how they relate to planning needs.

An extensive literature search and review provided much of the pertinent information relating to computer applications. For specific information on Knoxville's computer applications, interviews were conducted with Metropolitan Planning Commission staff members and with representatives of the Department of Information Systems. The computer applications reported in the literature and the extent of computer utilization in Knoxville reported in the interviews were then compared.

While computer utilization has been increasing since the late 1950's, the applications currently utilized represent the automation of routine, repetitive, mechanical tasks such as utility billing, budgeting, accounting, or payroll. Knoxville fits into this characterization of computer utilization, although Knoxville began using the computer relatively late for a community of its population. Computer applications have been expected to increase in areas of particular interest and

importance to planning, however, the increases have not been as rapid or comprehensive as anticipated by some. Information systems and data base development holds interest for planners and other governmental officials, as do modeling techniques, computer mapping and graphics, and simulation. A paradox is evident here in that such systems are highly desirable, but the actual resources needed to begin planning and implementation have not been forthcoming. While computers do have a place in planning activities, there is no danger of complete computerization of planning operations. Planners are not the ultimate decision makers so until local officials are convinced that the high investment and long range commitment necessary to develop a system of planning related computer applications are worthwhile, applications are likely to continue on a piecemeal basis especially in Knoxville.

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CHAPTER I

INTRODUCTION

Planners, in their attempts to provide assistance to the decision makers and to institute effective planning in their communities, constantly test and use new tools in their work. The computer is such a tool. It has become more accessible to planners since its availability at the local level of government has been steadily increasing. While the acceptance and utilization of computers has not been as complete or rapid as anticipated by some, computers do represent an opportunity to add a new dimension to many elements of planning. It is to the planner's advantage, therefore, to understand this tool. Planners should take an active role in developing applications specifically related to planning activities rather than not benefiting from the opportunities computers present as they come into general use in many communities throughout the country.

The increase in the extent of computer usage and availability at local levels of government is documented in a series of Urban Data Service Reports. The reports, from several studies by the International City Management Association, present information showing the extent of computer usage with particular emphasis on data processing. According to these reports, use of computers in local governments for such things as data processing has occurred from the time computers were first

introduced. The greatest impacts, however, began to be felt in the late 1950's. In a 1975 report, it was found that

> {a}lmost 100% of cities 100,000 and over and 92% of cities 50,000 to 99,999 are using computers, with most of these adoptions having taken place during the late 1950's and early 1960's. Small municipalities (under 50,000) have experienced the greatest number of adoptions since 1970 and may be expected to continue adoptions at a high rate.[1]

One item of note is that despite this increase in the number of communities gaining access to computer capabilities, the number of applications and the range of usages has been limited. Most applications began with the automation of highly repetitive, mechanical tasks such as billing or payroll functions. As these administrative and housekeeping functions[2] become operational, communities will be in a position to further utilize the capability of their computer system by moving into the realm of more complex applications such as development of information systems or data bases for use by many governmental agencies in their day to day activities.

In a 1970 state of the art study by O. E. Dial et al., four major categories of municipal functions with computer applications were identified. These categories were public finance and administration with 44.6 percent of the total number of computer applications, physical and economic development with 21.5 percent, public safety with 18.3 percent, and human resource development with 15.6 percent. City

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[1]"Municipal Computers: Growth, Usage, and Management," Urban Data Service Report 11/75 7 (November 1975):12.

[2]Housekeeping functions include automation of routine, highly repetitive operating activities such as payroll, utilities billing, or other accounting activities.

planning, zoning, and urban renewal applications accounted for approximately 16 percent of the physical and economic development subsystem and about 3 percent of total computer applications.[3]

Planning and zoning applications, however, were examples of more complex applications that were expected to increase. These applications are receiving support and financial aid from the United States Bureau of the Census and the Department of Housing and Urban Development.

> The types of planning and zoning applications expected to experience the greatest growth are in the areas of census applications, geoprocessing applications, and community or neighborhood analysis, which are derived by combining census data and municipal operations data and relating them to geographic areas.[4]

These potential applications are based on two particular computer capabilities. First, computers have the capability to store great quantities of data in flexible, accessible form. Secondly, computers can perform numerous functional transformations and mathematical operations at extremely high speeds. As a result of these two capabilities, computers have a composite capability of

> . . . following through very long chains of reasoning which involve bringing together at appropriate points large amounts of information and manipulating this information through extended sequences of arithmetic calculations and logical comparisons.[5]

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[3]O. E. Dial et al., Municipal Information Systems: The State of the Art in 1970, (Springfield, Va.: National Technical Information Service, 1970), pp. 5, 10.

[4]Urban Data Service Report 11/75, pp. 5-6.

[5]Britton Harris, "Computers and Urban Planning," Ekistics 28 (July 1969):4.

Due to these capabilities, computer applications valuable to the planner in various planning activities are possible. Information and data necessary as inputs for various computer applications in local government, are also essential to the planner. Planning, regardless of how it is defined and how it is done, is based on accurate and appropriate data and information. Information, in relation to planning activities, performs several functions. Information can be used to describe the current state of events and the pattern of those events. Information is also essential in probing relationships among events and allowing for the forecasting of future change. Additionally, information used in these ways can help in the formulation of plans and policies seeking to influence future events and the future shape of the community.[6]

To plan creatively, planners should have access to the most reliable, up to date information as quickly as possible in a form most usable for the development of policies, plans and alternatives. Use of computers can be the means of providing such information to planners. Data and information can be computerized in several ways useful to planners. First, data can be organized into information systems. Such systems are based on the ability of the computer to store, process, and retrieve data. The information can be organized into data bases useful not only to planners, but for many other agencies in local governments with the need for similar data.

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[6]Doris Holleb, Social and Economic Information for Urban Planning, 2 vols. (Chicago: Center for Urban Studies, University of Chicago, 1969), 1:47.

Data are also essential in developing and running computer models of urban processes and in systematic analysis of planning operations and decision making. Through the use of simulation or small scale models, specialized analysis and data manipulation can be performed to predict changes through trend analysis or through the assessments of the impacts of particular actions. In addition, the output from these activities can be in any number of useful forms including computer graphics such as charts, graphs or maps; hardcopy output; or cathode ray tube (CRT) display. Computer graphic techniques allow production of a wide variety of style and type maps, at a relatively low cost, for use by planners in base studies, during the assessment of impacts in a particular area, or for presentations to community groups.

Computer applications such as these can enhance the planners' efforts to analyze and understand greater quantities of data related to a particular problem at hand. This information can also be made available to both public and private parties to facilitate coordinated community growth and development. With other public and private concerns using information provided by the planning agency, the possibility exists for greater acceptance and implementation of community plans and policies. Rationality of public and private decision making can thereby be increased through the use of the computer to quickly retrieve and analyze appropriate data and to output it in usable form.

While computers add to the effectiveness of planners, current computer technologies and applications have generally outstripped the

planners' ability to cope with and use to best advantage the new techniques. Planners should arrive at a better understanding of computer capabilities and of potential computer applications to facilitate the best integration of this useful tool into planning. The underlying premise of this research is that "the need to adapt to the use of computer methods in local planning offices is inevitable."[7] The purpose of this research is, therefore, to provide some measure of the necessary understanding and to point out by example the ways computers can and are being used as tools in planning.

Computers are not, however, the ultimate answer. They should not assume a dominant role in planning. Computers cannot deal with all the information used to arrive at decisions in local governments. Sole dependence upon computer output, therefore, could reduce planning to a rigid and inflexible activity too far removed from day to day operational reality. Combinations of tools and professional judgements are a much needed part of planning activities. Qualitiative insights such as judgements of the current political climate in a jurisdiction, understandings based on experience, and written and verbal communications, for example cannot be input into the computer. As a result, output based solely on input data and information may not represent the best and most appropriate decision under the given circumstances. The following list further illustrates additional limitations of most

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[7]Britton Harris, "How to Succeed With Computers Without Really Trying," Journal of the American Institute of Planners XXXIII (January 1967):11.

computers without highly qualified personnel to instruct and program them. Computers cannot:

1. Set the boundary conditions for any problem
2. Define a problem
3. Say how worthwhile it is to explore a particular problem in the first instance; hence it cannot indicate the rational use of resources of money or persons in work on an original problem
4. Imagine the variables or other information which may be relevant to a consideration of a problem
5. Decide what to include or exclude in the initial operations on a problem
6. Select the functions to be explored
7. Make decisions regarding the range to be covered in any variable
8. Construct a model
9. Select the criteria to be explored . . .
10. Decide how to collect the basic data
11. Decide upon a strategy of operations, such as deciding what proportion of resources should be devoted to different stages of a problem or the means for its solution
12. Design or evaluate a sensitivity analysis.[8]

Computers, then, can be used as tools to aid in more rational decision making. They cannot, however, take the place of sensitivity, creativity, and imaginative design on the part of those using them. While planners are not the ultimate decision makers, they have a responsibility for bringing creative recommendations to policy design and problem solving that can result from the successful melding of computer usage and traditional planning methods.

Problem Statement

In light of the evidence that suggests an upsurge in computer usage not only in governmental and planning activities, but in everyday

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[8]Leslie T. Wilkins, "Computer Impact on Public Decision Making," Public Administration Review, November/December 1968, pp. 503-504.

activities as well, it is important to recognize the current state of computer applications. Planners should make attempts to discern and understand current computer applications as they relate specifically to planning activities and as they relate to other governmental activities important to planning. Computer applications in other fields can, in some instances, be adapted for use in planning agencies and, therefore, should not be ignored.

To date, the experience of the planning profession with computers has been relatively limited. There seems to be some resistance towards the utilization of computers which may be due, in part, to a lack of knowledge and understanding. Other contributing factors may include the political climate within the local governmental unit and the availability of financial resources. The computer has the potential to be a powerful tool, therefore, further study is necessary to identify appropriate applications and locations for those applications within the context of planning activities.

With this in mind, the problem under study here is to help answer and analyze the following questions in terms of a general review of the literature and with specific references to the Metropolitan Planning Commission (MPC) in Knoxville:

What computer applications are used by planning agencies?

How are these applications used and how do they relate to planning needs?

Limits of the Study

Several limitations must be considered regarding this thesis. In examining the topic chosen two broad options for further refinement present themselves. One is to select a particular subject area or planning activity and examine all possible computer applications associated with it in an in depth manner. On the other hand, an overview approach could be taken with a number of planning activities included to show as wide a range and variety of computer applications as possible. This latter approach was the one selected since utilizing an overview approach would serve as an introduction to a topic not currently given a great amount of attention in planning literature. In depth analysis of any particular planning area and its associated computer applications is avoided, leaving such study to other interested researchers. In taking the overview approach, it is impossible to cover the full range of computer applications related to planning since no commonly accepted definition has been presented as to what that 'full range' entails. Arbitrary judgments were made during this study to determine those applications related to planning that would be included and those to be left out.

Another point to consider is the degree of technical discussion presented. A decision was made to avoid technical analysis of the most technical aspects of computers such as hardware and languages. The technical aspects and mathematical aspects of models and information systems were also avoided. These elements, however, cannot be entirely ignored and will be mentioned at appropriate points in the study.

Several other important subjects to be considered in a discussion of adoption of computer applications by local governments and planning agencies were also eliminated. Issues dealing with invasion of privacy, confidentiality of computer files, and security are not dealt with. Additionally, the entire realm of problems and opportunities associated with planning for the development of a computer installation and its programming functions are not handled in this thesis. It is recognized that these issues and subjects are important in a full discussion of all ramifications associated with computer hardware and software development, however, such discussion is beyond the scope of this thesis.

This thesis is not a handbook for establishing computer applications in planning. It is merely an attempt to point out the kinds of applications that are available. In addition, it is an attempt to make the point that computer activities do have a place in planning by virtue of computer capabilities.

Methodology

This research followed a two tiered approach utilizing several methods. First, an extensive literature review was conducted utilizing the following resources: 1. The University of Tennessee Library; 2. the Graduate School of Planning Library; 3. the Metropolitan Planning Commission Library; 4. the Tennessee Valley Authority Library; and 5. the personal libraries of several professors at the Graduate School of Planning. The literature review provided the necessary historical and background information relating to computer applications. From this information, a compilation of computer applications was made

based on computer capabilities and their usefulness in planning. These applications then became the basis for analysis of computer applications by the Metropolitan Planning Commission (MPC) in Knoxville.

The second tier of the research presented here was a case study in which the specific computer applications used by MPC were examined. Essentially, the case study of Knoxville was a comparison of computer applications in Knoxville by MPC with the possible applications drawn from the literature. Data for the case study was gathered through personal interviews with MPC personnel and personnel associated with the city computer center. Additional information came from the review of city and MPC internal documents such as memos, studies, or papers relating to computer applications.

Organization of the Thesis

Chapter I is an introduction to the thesis. It contains background information relating to the problem under study and the limitations of the study. In addition the methodology is described and the organization of the thesis is presented.

Chapter II begins with a history of the development of computer hardware traced from ancient origins through several generations. The history continues with a description of computer applications in local governments and planning from the early years through the 1950's and 1960's. Basic approaches to computer applications are presented in the context of local governments and planning.

Chapter III is an examination of the current state of the art in terms of computer applications related specifically to planning.

Applications in use and those touted as potential are presented. The importance of computers in planning is shown and approaches and applications to be used in the comparison with Knoxville are presented.

Chapter IV is the case study of the Metropolitan Planning Commission (MPC) and Knoxville. A history of computer hardware and software development in Knoxville is presented. Specific current computer applications relating to MPC planning activities are examined as are potential applications.

Chapter V examines, compares, and contrasts the computer applications found in the literature with those applications currently used by MPC. MPC plans for further computer applications are also compared to the potential applications identified from the literature. Conclusions are drawn relating specifically to an analysis of computer applications utilized by MPC and those reported in the literature. Additional conclusions are drawn in a more general manner concerning the use of computers and what the future may hold for the planning profession.

CHAPTER II

HISTORY OF COMPUTERS AND APPLICATIONS

In some respects, historical antecedents of the computer can be traced back to the calculating devices of the ancient Greeks. The abacus, a calculating device that first appeared thousands of years ago in the Near East, was an ancient forerunner of the computer. In the 19th century, Blaise Pascal developed the first mechanical digital calculator. The potential for the development of the modern computer, however, is generally considered to have begun with the work of Joseph Marie Jacquard and Gottfried Wilhelm Leibnitz. Jacquard developed a card that allowed instructions to be introduced to a machine. Leibnitz developed an automatic device that, through repeated addition and subtraction, accomplished multiplication and division.[1]

Charles P. Babbage, in the 1800's, built on the previous work. He developed a "difference engine" and an "analytic engine." The difference engine relied on a difference method of computation, but was beyond the technological capabilities of its time. The analytic engine was developed by 1833 and was capable of executing ". . . a changeable sequence of operations and [had] internal storage for data."[2] While

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[1]Public Administration Service, Automated Data Processing in Municipal Government: Status, Problems, and Prospects (Chicago: Public Administration Service, 1963), p. 2.

[2]Gordon B. Davis, Computer Data Processing (2nd Ed.; New York: McGraw Hill Book Company, 1973), p. 7.

this engine was never completed, its basic design features were later used in the development of the stored program concept of the modern computer.

By 1886, a machine was developed by Dr. Herman Hollerith to facilitate processing of the United States Census. It was a semi-automatic ". . . data processing system consisting of 3x5-inch corner-cut cards divided into half-inch squares, a punch, a pin-press capable of completing circuits to actuate electromagnetic counters and a sort box."[3] Early users of this equipment included the cities of New York and Baltimore and the state of New Jersey. Compilation of vital statistics, cost accounting, and utility billing were examples of uses of the Hollerith equipment. These uses foreshadowed later applications of the computer in both the public and private sectors.

Beginning in the early 1900's, a number of improvements were made to earlier calculating equipment that helped pave the way for eventual development of the more modern computer system. "This equipment continued in use with the adoption of the modern day computer as useful peripherals to the new machinery."[4] These improvements included:

1917-The mechanical verifier and electric keypunch.
1919-The alphabetic printing tabulator.
1928-A typewriter connected to the keypunch for simultaneous punching and typing, and the general-purpose accounting machine.
1931-The multiple punch and the summary punch.

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[3]Public Administration Service, p. 2.

[4]O. E. Dial, et al. Municipal Information Systems: The State of the Art in 1970. (Springfield, Va.: National Technical Information Service, 1970), p. 5.3.

1933-The alphabetic printing punch.
1934-An automatic carriage for printing tabulators.
1936-The collator.
1938-A reproducing gang summary punch.
1939-Mark-sensing for cards.
1941-The tape-controlled card punch.[5]

These developments were adopted in their turn because of the improvement they offered over competitive accounting machinery.

Concurrent with the development of some of the previously mentioned machinery important as peripherals to the modern computer, came the development of devices more recognizeable as direct forerunners of modern computers. An automatic sequence controlled calculator was developed in 1937 by Dr. Howard H. Aiken. This machine, known as Mark I, was developed along the principles of Charles Babbage's analytic engine and was still in use in the late 1950's.

> It was electromechanical in operation and capable of performing an addition or subtraction in three-tenths of a second. It stored numbers containing up to 23 decimal digits, and accepted input from punched cards, handset dials, or long loops of punched paper tape.[6]

The Mark I was not, however, a computer as the term is currently used. It was a mechanical rather than electronic machine.

> The Mark I, completed in 1944, is historically important because it was the immediate predecessor of the electronic computer and contained many features, such as the pre-established program of operations, now associated with computers.[7]

Later modifications were made to the basic Mark I resulting in the

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[5]Public Administration Service, p. 3.

[6]Ibid.

[7]Davis, p. 7.

Mark II, Mark III, and Mark IV which performed calculations by electronic relay and utilized magnetic tape for input and output.

By the mid-1940's, machines using electronic tubes for calculating were being developed. The first of this type of machine was the ENIAC (Electronic Numerical Integrator and Calculator) built at the University of Pennsylvania. This machine was capable of executing a greater number of operations more quickly and of storing more numbers than the Mark I. Since electronic circuits had been utilized, ENIAC has been considered the first electronic computer. Like the Mark I, however, it was a special purpose, hand built machine. Several other one of a kind computers were constructed in the late 1940's and the early 1950's. Design elements were refined in these computers and a number of other innovations, such as use of a binary number system and internal storage of instructions, were introduced.

The first mass-produced commercial electronic computer was the UNIVAC I, produced by Sperry-Rand in 1951. It was installed in the United States Bureau of the Census in that same year representing the first public sector use of the computer in the United States. The UNIVAC I was followed in subsequent years by National Cash Register's NCR-102 and the International Business Machines' Model 701. These computers appealed to the private sector as well as the public sector with the first business uses of computers occurring in 1954.

These early computers, built from the introduction of the UNIVAC I in the early 1950's to the late 1950's, were considered first generation machines. They used vacuum tubes, had limited memories, and were

restricted to receiving a few basic instructions. They did, however, operate at faster speeds than any of the machines that preceded them. A major drawback was that they ". . . required several large rooms to house their cabinets, power supplies, and the substantial air conditioning equipment needed to keep the circuits from melting from their own heat."[8]

Improvements were made on these earliest computers resulting in second, third, and fourth generation machines. These improvements were largely in the area of size reduction through miniaturization of parts leading to increased operational speed. Further physical changes and improvements included increases in direct access storage and a reduction in cost of the physical computing hardware. "No small part in this development has been played by the U. S. Government, which is always in the market for the latest and biggest systems available."[9]

Applications most closely associated with the first generation of computing machinery included housekeeping and administrative functions. Early computers were viewed as clerks for municipal recordkeeping. "Once a computer has been installed, the emphasis has been on using it for high-speed calculating of finite quantities—such as tax or water bills—or for the printing of numberless reams of continuous forms, registers, receipts, checks, ledgers, and similar material."[10] This

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[8]Public Administration Service, p. 4.

[9]John McCarthy, "Information," in Computers and Computation, Readings from Scientific American (San Francisco: W. H. Freeman and Company, 1971), p. 10.

[10]Public Administration Service, p. 2.

emphasis treated computers simply as another office machine, albeit a faster and more expensive one.

"The introduction of a computer into both business and government followed approximately the same organizational route—through the function of the controller."[11] Early uses of the computer were, therefore, associated with fiscal housekeeping activities such as payroll, accounting, and general financial record keeping. The cost of physical computer machinery was high, resulting in a priority on computer use for high speed production purposes and an accompanying emphasis on operating efficiency. Procedures previously conducted manually were simply transferred to computer routines.

The housekeeping approach to computer utilization was characterized by an emphasis on data processing and the mechanization of highly routinized tasks. Data processing activities included sorting, counting, and simple arithmatic operations. The goal of data processing in the housekeeping approach was ". . . to automate simple, repetitive elements of data processing operations to enable faster more accurate manipulation of record information."[12]

Since the 1950's, data processing has become closely associated with and to a certain degree synonymous with computers in local government. The growth of electronic or automated data processing

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[11]Herbert H. Isaacs, "Computer Systems Technology: Progress, Projections, Problems," Public Administration Review, November/December 1968, p. 490.

[12]Kenneth L. Kraemer and John Leslie King, Computers and Local Government Volume 1: A Manager's Guide (New York: Praeger Publishers, 1977), p. 11.

installations can be considered growth of computer installations since numerous data processing tasks would not be possible without the data handling capabilities of computers. The real impact of data processing in local governments began to be felt in the 1950's due to the availability of smaller, more compact electronic computers such as the IBM 305 or IBM 1401.

> Automated data processing (ADP) technology was adopted largely to handle the increased demand for services placed upon local and municipal governments by an ever increasing urban population as well as to handle the increased need for information about overall trends, community goals, and alternative methods to meet these goals.[13]

Since the beginning of the "electronic rush" by the Federal government in the 1950's, ". . . progress in the electronic technology of computer circuits, the art of programming and programming languages and the development of computer operating systems has been rapid."[14] In the late 1950's to early 1960's, the second generation of computers was introduced. Electronic advances of the time allowed the use of transistors rather than vacuum tubes in these computers. Drum and delay-line memories were replaced by magnetic cores, thereby increasing memory and storage capacities. Other second generation developments included a reduction in physical size, a reduction in power and space requirements, and the need for little if any air conditioning. These developments helped make the second generation computers more reliable and more accessible to local governments than first generation machines.

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[13]"A Survey of Municipal Automated Data Processing," Urban Data Service Report 10/70 7 (October 1970):2.

[14]McCarthy, p. 10.

These second generation computers were viewed as highly practical. Their uses were oriented towards well understood tasks involving routine processing of large quantities of data and information largely representing a continuation of the housekeeping applications of the first generation.

The advent of the third generation of computers followed closely on the heels of second generation development. "The change to third-generation characteristics began in 1963-1964, but the major transition was in 1965, when IBM began deliveries of its third-generation System/360."[15] The major change in the third generation hardware was the development of computational ability simultaneous with input and output operations, thus increasing equipment operational speeds. Third generation characteristics also included increased processor speeds, increased miniaturization, larger memories, and ". . . the development of computer 'families' or compatible machines ranging from the very small to the very large, which operate in response to the same set of instructions."[16] The cost of computer hardware dropped significantly and more advanced peripheral devices were introduced.

The decade of the 1960's was an important one in regard to the development of approaches to computer utilization in local governments and the specific applications resulting from the various approaches. The greatest number of applications were developed during this time period. These applications utilized not only the newest third

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[15]Davis, p. 9.

[16]Public Administration Service, p. 4.

generation computers, but second and first generation hardware as well. Many of these applications have remained in use through the present time and have formed the basis for future application development in local governments and local planning agencies.

As was the case with first generation computers, the applications associated with second and third generation computers in local government continued to be closely tied to data processing uses. The 1960's were viewed as the peak years for the installation of computers as data processing equipment. In 1960 approximately 120 computers were reported to be in use by states, counties, or cities.[17] About half of these units were in state highway departments with relatively few at the local governmental level. "Except for engineering employment in the highway departments, the principal applications at all levels of government lay in the functional field of finance, payroll, billing, accounting, or tax work."[18] A 1965 Urban Data Service Report indicated 1964 was the peak year for the establishment of data processing installations in local governments, however, a 1970 follow up report indicated 1967 was the peak year in cities with population greater than 25,000. The years 1965 through 1969, in general, showed a steady growth trend in the utilization of computers by local governments. By 1970 nearly 60 percent of cities with population of 50,000 or greater were using computers, with the rate

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[17]Harry H. Fite, The Computer Challenge to Urban Planners and State Administrators (Washington: Spartan Books, 1965), p. 4.

[18]Ibid.

of usage greater than 90 percent for cities with population of 100,000 or greater.[19]

An example of applications at this time was Rhode Island's Municipal Cooperative Data Processing System (MCDPS) which became operational in 1969. Data processing services were provided by this system to all Rhode Island communities. The service was especially beneficial for those communities unable to afford their own data processing installations. The computer applications utilized were mainly housekeeping functions such as payroll, tax rolls, tax billing, and accounts receivable.[20]

Data processing was a central element of several other approaches to computer utilization. The ability of the computer to deal with masses of data led to the development of a databank approach to computer applications beginning in the mid-1960's. The databank approach focused on data collection and organization in local governments. The collected and organized data were then processed to meet the informational needs of various governmental departments and agencies. "The early proponents of the databank asserted that much of the data collected in day-to-day routine operations could be shared on a government-wide basis, thereby reducing duplicate collection and storage of data, and could be used for planning-management as well as operations thereby increasing the

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[19]International City Management Association, "Municipal Use of Automated Data Processing," in The Municipal Yearbook 1971. (Washington, D. C.: International City Management Association, 1971), p. 38.

[20]Urban Data Service Report 10/70, p. 15.

multiple use of data."[21] Data needs were to be identified on a government wide basis with data collected relating to the environment around the agency and to the internal operations of the agencies themselves.

A major example of the databank approach with a land planning orientation was the Tulsa Metropolitan Data Center Project. This project, financed by a two-thirds grant from the federal government through the Housing and Home Finance Administration, stressed the use of computers in serving its five basic functions. The Metropolitan Data Center Project was

> . . . an experimental attempt to develop a comprehensive integrated data-processing system as a practical means for providing the current, reliable data required for making sound decisions about urban planning, renewal and related activities.[22]

The five major functions the Metropolitan Data Center was designed to serve included:

1. Provision for centralized data handling
2. Reference services and publication
3. Extension and consulting services
4. Research and development
5. Maintaining liaison with other urban research and data centers.[23]

Government wide, comprehensive databanks have been relatively unsuccessful. Numerous problems in development and execution contributed to the lack of success. Initially, a failure to adequately define necessary elements of the data base resulted in extraneous data

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[21] Kraemer, Computers and Local Government Volume 1, p. 14.

[22] Fite, p. 23.

[23] Ibid.

incorporated into the databank. Available data, in some cases, was not the data necessary or suited for the specific applications of user departments. Data was difficult and expensive to collect for inclusion in the databank data base. Consequently, data in the databanks became rapidly outdated and represented a static rather than dynamic view of governmental operations and the real world situation.

Also in the 1960's, use of computers for planning activities increased substantially with the development and building of models, especially in relation to major metropolitan transportation studies. "The model-building approach uses the powerful computational capability of the computer to perform simulation and modeling of real-world situations for planning, management, and research purposes."[24] While models were developed independent of computers, computers were needed to activate the more sophisticated models by handling the large amounts of data generated and used during the model building process. Data used and manipulated were both real data; data generated and collected during the course of actual governmental and planning operational activities, and artificial data; data developed to test hypothetical conditions and outcomes. These models utilized computers in attempts to simulate the urban environment for analysis purposes by performing complex data manipulation and mathematical analysis that could not or would not be performed manually.

> The great advantage of computer use in modeling is that of speed; once the model has been programmed and calibrated, very many runs can be made with different parameters in a very

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[24]Kraemer, Computers and Local Government Volume 1, p. 16.

> short time, and when the output has been digested by the planner, alternative sets of parameters can be substituted and their influence seen, again very quickly.[25]

Many variables such as housing supply and demand, population and other demographic data, employment and economic statistics, and environmental data, were incorporated into models. "By constructing models based on these data, then changing input parameters, it was hoped that the simulations would offer insight into the dynamic nature of urban and environmental problems."[26] The benefit of models and modeling to planners lies in the potential for greater understanding of urban systems and the knowledge models provide regarding potential actions and the impacts that could be anticipated from those actions.

Models and modeling played a particularly important role in the urban transportation process in the 1960's through the use of urban growth and activity allocation models. These models, largely for major metropolitan transportation studies, exhibited several basic similarities. Large volumes of data were produced and collected during the planning process that could be used in the models. The data were analyzed by several sets of mathematical models including prediction models, cost models, and network analysis models. Throughout all of this data collection, manipulation and analysis, computers were essential to the handling of the large amounts of data, for calibrating the models to real world conditions, and in actually running the models. Such

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[25]George Chadwick, A Systems View of Planning (New York: Pergamon Press, 1971), p. 201.

[26]Kraemer, Computers and Local Government Volume 1, p. 16.

models were simply not possible without the use of the digital computer.

While most of these models in transportation studies were initiated in the 1960's, establishment of the study efforts began as early as the late 1950's. The Penn-Jersey Transportation Study, while not the first such study established, did produce an important first in the late 1950's. It represented the first attempt to simulate spatial interaction on a large scale through the use of urban development models. The urban development model was the method of elaborating the various transportation alternatives. The basic assumption underlying the Penn-Jersey study and the other transportation studies of the time was that significantly different land use and land development patterns could be created and identified based solely on alternative transportation systems.

The importance of computers to these efforts can be seen in the elaboration of those transportation alternatives. Two components of the Penn-Jersey effort were particularly related to computer uses and applications. A central component of the planning process for the Penn-Jersey study was the use and development of a regional growth model to simulate locational behavior in economic terms. When problems of data availability and time pressures became paramount, the model was modified into the Activities Allocation Model (AAM). AAM was a more aggregate model with less data and time requirements. In both cases, computer methods were important in testing and developing the models. The second component of the Penn-Jersey study relating to computer use was the testing of the transportation policy variants by the actual running of the models under the various input parameters.

The experience of the Penn-Jersey study was reflective of the experiences of many of the transportation studies. There were problems of data assembly and processing to contend with in the development of the models and in their calibration. Ultimately, the models, when run, failed to produce the variations in land uses that were originally anticipated from the alternative transportation inputs. This failure was not, however, a result of computer methods used, but rather a reflection of the transportation policy alternatives considered.

Several other major metropolitan transportation studies used computer techniques and computer models of urban growth and development for the elaboration of various transportation and land use alternatives. These studies included efforts in Baltimore, Boston, the Twin Cities, Detroit, Pittsburgh, and Washington, D. C. Three types of models used in these and other transportation studies represented three levels of sensitivity to the urban growth process. The three types of models included:

1. models for forecasting regional totals of population, employment, and economic activity;
2. models for spatially allocating regional growth or private investment, referred to here as urban development models;
3. models for simulating systems performance, such as flows or a transportation network.[27]

The three levels of sensitivity of these model types to the urban growth process were identified based on distinctions between the use of

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[27]David E. Boyce, Norman D. Day, and Chris McDonald, Metropolitan Plan Making (Philadelphia: Regional Science Research Institute, 1970), pp. 42-43.

manual or computer methods.[28] The first, least sensitive level, relied on manual methods for elaboration of alternatives. The Bay Area Simulation Study was an example of this sensitivity level. The second level of sensitivity was one in which the option for use of computer methods was available. Boston and Philadelphia (the Penn-Jersey study) represented examples of this level of sensitivity with the use of computer methods, while the Chicago Area Transportation Study (CATS) was an example of the use of a moderately sensitive model without computer methods. The highest level of sensitivity was not actually evident in the transportation studies examined by Boyce, Day, and McDonald. "Implied at this level are much more stringent demands on computer model capability than have been met to date."[29] The Twin Cities, Pittsburgh, and Washington, D. C., however, showed some promise of achieving this highest level of sensitivity.

Other large scale models were developed during this same time that were not tied specifically to transportation planning, but utilized computer techniques. Examples of these types of models included the San Francisco Housing Market Model, the University of North Carolina Land-Use Succession Model, and the Lowry Urban Development Model. The San Francisco model, developed by Arthur D. Little, Inc., simulated ". . . the interactions and effects on residential housing of (1) public policies, programs, and actions; (2) investment behavior of the private market; and (3) the location decisions of households."[30] The University

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[28]Ibid.

[29]Ibid.

[30]Harry B. Wolfe, "Model of San Francisco Housing Market," Socio-Economic Planning Sciences, 1 (September 1967):72.

of North Carolina Model, developed by F. Stuart Chapin and associates, predicted ". . . the conversion of vacant (rural or urban) land to residential use as an urban area grows."[31] The Lowry model, developed by Ira Lowry, represented an attempt at total system simulation in Pittsburgh.

All these large scale models suffered from similar problems, making successful running of the models difficult. They were hampered by "the lack of comprehensive urban theory, limitations of existing computer technology and the problems of data availability . . ."[32] The use of urban development models and computer methods for the elaboration of alternatives in the transportation studies required, in addition to a great deal of elaborate data, measures for the future holding capacity and levels of service of the transportation alternatives described. These requirements made it difficult to operationalize the models. Although the alternatives ultimately generated through the use of these models and computer techniques were considered more objective and consistent than those produced by manual methods, the alternatives were generally reviewed in a subjective manner for reasonableness. Changes resulting from this review made the models, in some respects, less accurate simulations. The ultimate difficulty, especially in terms of the transportation models was that no significant differences in land

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[31]John P. Crecine, "Computer Simulation in Urban Research," Public Administration Review, January/February 1968, p. 71.

[32]Peter Kamnitzer, "Urban Problems," in Computers and the Problems of Society, ed. by Harold Sackman and H. Borko (Montvale, N. J.: AFIPS Press, 1972), p. 286.

use and transportation alternatives were produced regardless of the method used. The price of these models, in many cases, became very high in terms of data requirements, staff time and expertise, and the need to produce visible results.

Gaming simulation and real time process control were two other approaches to computer applications that were developed in the 1960's for use in local governments. Real time process control techniques manifested themselves in local government by such things as traffic control systems or public utility control systems. The emphasis in this approach was on data collection and the actual use of that information to improve the efficiency of mechanical systems. "The process control approach utilizes computer technology to control continuous or repetitive operations like traffic signals, water and electrical utility lines, heating and air conditioning systems and emergency vehicle dispatching."[33] In most cases information in this approach went directly to computerized process controls rather than to human users.

Gaming simulation techniques represented attempts to introduce nonquantifiable social variables into simulation models. These techniques were differentiated from the model building approaches by the inclusion of role-playing situations that were not necessarily reflective of any real world situation. The interaction in gaming techniques was in a compressed timeframe with decisions made within the given game constraints. The computer, while not absolutely necessary in

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[33]Kraemer, Computers and Local Government Volume 1, p. 16.

gaming, was important in the more complex games. Examples of such games included Peter House's City I and City II and Richard Duke's METRO and APEX.

The final approach to computer applications taken by local governments and examined here is the information system approach. This approach was similar to the other approaches discussed previously in that its development and evolution began during the 1960's. In some respects, this approach could be considered a synthesis of several of the other approaches and elements presented. The information system approach was an attempt to gather data throughout local government for use by various governmental agencies as the need arose. Regardless of whether the information system was integrated or single purpose, it was composed of elements such as a data base and various data processing techniques that could be construed to be housekeeping functions. The data processing techniques, utilizing data from the data base of the information system, produced information and indications of current conditions, in addition to projection of future conditions based on the same data. Simulation and gaming techniques were also possible in conjunction with the information system approach. Outputs from this approach could be in the form of computer graphics such as maps, charts, or graphs; hardcopy from a line printer; or CRT and interactive displays in the more advance systems.

Early urban information systems were often not really systems, but rather simple automation of existing procedures. While sophisticated computer techniques were not utilized, attempts were made to handle local governmental housekeeping functions in a more organized fashion.

The increased data handling capabilities of computers, however, lead to the development of more sophisticated management information systems.

The federal government, largely through the Department of Housing and Urban Development (HUD), was instrumental in the development of these more sophisticated and integrated information systems following research efforts in the mid-1960's. Research conducted at the University of Southern California, University of Connecticut and the IBM-New Haven project, for example, was oriented towards building broader information system capabilities for cities. The approach followed was an

> . . . attempt to view broadly and within a unified framework the processes of government and the use of information for decision making within those processes. It also views the utility of information technology in its potential contribution to improving the operational information and decision processes in urban government.[34]

An April 1968 report of the Intergovernmental Task Force on Information Systems recommended federal involvement in the development of local government wide information systems and in the support of urban information systems. An Urban Information Systems Inter-Agency Committee (USAC) was formed following publication of the report with the purpose of supporting research and development of Integrated Municipal Information Systems (IMIS). IMIS was to represent a holistic view towards system development based on a comprehensive, regularly updated data set at the local governmental level.

> The central idea is that the information needed for better planning and management in local government can be readily

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[34]Kenneth L. Kraemer, et al. Integrated Municipal Information Systems: The Use of Computers in Local Government (New York: Praeger, 1974), p. 5.

> found in the data that is already processed in local government in the myriad of transactions that occur in the various branches of local government. Given this assumption the task of the IMIS is to systematically capture this routine transaction-based data and provide means for integrating the various bits to meet the information needs of managers, planners, and budgeters.[35]

Based on this approach, contracts were offered by USAC and HUD to local governments for the development of complete or partial information systems. Seventy-nine communities responded submitting ninety-nine grant proposals.[36] Contracts were signed in 1970 with six communities. Two communities were to develop total IMIS systems and four were to develop partial systems.

Concurrent with this IMIS activity, "the Department of Housing and Urban Development contracted with Systems Development Corporation (SDC) to study the problem of how the availability and accessibility of information can be improved through the application of automatic data processing."[37] This approach to information systems was different in several ways from the IMIS approach previously discussed. Financial aid was not part of HUD's activity in regard to the resulting report. The study was to culminate in a report setting forth guidelines for planning agencies interested and involved in developing and implementing computer

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[35]George C. Hemmens, "Implementing the Integrated Municipal Information System Concept: The Charlotte, North Carolina Case" paper submitted for presentation at the 57th Annual Conference of the American Institute of Planners, San Antonio, Texas, 1975.

[36]Kraemer, et al. Integrated Municipal Information Systems, p. 13.

[37]U. S. Department of Housing and Urban Development, Urban and Regional Information Systems: Support for Planning in Metropolitan Areas (Washington, D. C.: Government Printing Office, 1968), p. 9.

based urban or regional information systems. The report and the guidelines contained therein were directed towards planners and planning activities rather than local governments as a whole. The envisioned geographic scope of Urban and Regional Information Systems (URIS) was to include more than a single jurisdiction.

"An Urban and Regional Information System is defined as a collection of people, procedures, a data base, and a data processing system organized to develop the information required to support the mission of a planning agency."[38] There was apparent recognition that the requirements of an information system oriented towards planning was different from a system oriented towards day to day government operations. "The fundamental difference between the two types of systems stem from the nature and process of planning activities and the data needed to support them."[39] The information system required for planning was seen as more open-ended and flexible than an information system for day to day governmental activities, although it was still felt that the data needed for planning purposes was available from other governmental agencies who collected such data in their own routine operations. The available data needed to be assembled in a form useful to planners that would also allow for extensive data sharing.

In addition to these two HUD sponsored activities related to information systems, the federal government played a further role in the development of information systems and computer use in local government and planning agencies through work done in preparation for the new

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[38] Ibid.

[39] Ibid.

computer organization of the 1970 census. Information needed for effective planning and computer applications included both census data and locally generated data. An integrated information system could allow the combining of census data with data from other sources. The innovations introduced by the Bureau of the Census came under the general rubric of the Geographic Base File/Dual Independent Map Encoding System (GBF/DIME). The Geographic Base File was simply a street map covering the urbanized portion of every Standard Metropolitan Statistical Area (SMSA) that could be used by a computer. "DIME is a method of representing map features numerically for processing by computer."[40] The GBF/DIME System; including GBF,DIME, ACG,ADMATCH, and CUE; provided a method by which local governments and planning agencies could handle census and other local data in a manner allowing for spatial and small area analysis.

Specific computer applications related to planning activities have been mentioned throughout discussion of more general approaches to computer applications taken by local governments as a whole. These specific applications do not, however, represent the entire range of computer applications in use by planning agencies in the 1950's and 1960's. Specific applications have been developed to enable computers to perform a variety of functions in a planning program, freeing planners for other tasks. While the list is not exhaustive, Table 1 contains many specific computer applications present in planning

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[40]"GBF/Dime, Dollars, and Sense," Nation's Cities, November 1975, p. 24.

TABLE 1

SELECTED COMPUTER APPLICATIONS RELATED TO PLANNING
DERIVED FROM THE LITERATURE

Land Use Applications

basic research
finance surveys
selecting locations for public facilities
project control system
cost accounting
land use data and analysis
location and geographic indexing
assessment and sales ratio analysis
area and percent vacant land analysis
land use by area and number of units
land use by geographic location
public properties by geographic location
land use and zoning compliance analysis
capital expenditures projections
public service projections

Transportation Applications

traffic needs study
transportation facility inventory and projection
traffic flow computation
travel forecast
trip generation
modal split
trip distribution
trip assignment
data plotting
origin destination study
parking survey and analysis

Housing Applications

standard and substandard housing analysis
neighborhood and environmental analysis
building floor area study
structure condition and age analysis
dwelling unit density analysis
occupancy density analysis

TABLE 1 (continued)

home value and rental analysis
assessment and sales ratio analysis

Population Applications

population projections
income and employment by geographic unit
place of work and means of transit projection
school area and facility projection
population movement and turnover

Economic and Employment Applications

industrial production by geographic area
employment levels by type of work
employment levels by geographic area
personal income by geographic area
labor force analysis and projections
income levels by household by area
gross sales by area
government expenditures and contract analysis

Source: Fite, Harry H. The Computer Challenge to Urban Planners and State Administrators. Washington: Sparta Books, 1965.

Public Administration Service. Automated Data Processing in Municipal Government: Status, Problems, and Prospects. Chicago: Public Administration Service, 1966.

Varnin, Daniel W. "Computer Applications in State Planning." Socio-Economic Planning Sciences. 1 (July 1968): 335-344.

agencies throughout the decade of the 1960's. Many of these applications deal with data and the manipulation of data to produce information useful to planners, following the emphasis on data processing discussed earlier.

In terms of generations of computer hardware, after the third generation the situation was open to discussion. No dramatic and distinctive change in the physical composition of computers occurred that would make the differentiation of generations as easy as it was for the first three generations. There was little agreement as to whether the modifications were substantial enough to warrant new generation designation.

The IBM System/370 series, introduced in 1970, represented the greatest change from the older IBM/360, however, it was not considered a herald of a new generation. Improvements in the 370 were considered to be enhancements in price, performance, and hardware design over previous equipment. Several other significant trends were begun in the early 1970's related to computer hardware. Minicomputers were introduced which, as their name implies, were smaller scale than previous hardware. They did, however, retain important computational capabilities. These minicomputers were introduced at lower costs and allowed for decentralization of computing functions. Computers were developed with increased capacity for interactive use through man-machine systems, graphics and graphic displays. A trend of timesharing has also evolved allowing multiple users simultaneous access to computers, but requiring increased memory and core capacity in computer hardware.

The physical computers have been rapidly evolving and changing. This rapid advance in technology has resulted in the introduction of a wide variety of new, more advanced computer applications to complement and upgrade earlier applications. Local governments and planning agencies have greater access to computers due to decreases in cost, however, the acquisition of computer hardware is still a substantial expense. Those applications with the highest rate of return for the amount of resources expended are the ones that will continue to be most often utilized.

CHAPTER III

THE CURRENT STATE OF THE ART

Moving into the decade of the 1970's, it becomes apparent that few startling or revolutionary changes have occurred in terms of either computer hardware or software. Changes and modifications that have occurred represent improvements and greater sophistication in hardware and applications available and in use earlier. While several generations of computer hardware have been described and are generally available, this does not imply a corresponding availability of the same number of generations of computer applications. Classification of applications does not fit neatly into a specific time frame. Changes brought about by the introduction of new computer machinery has not meant a wholesale adoption of that new equipment. Types of computer mainframes and hardware in use in communities throughout the country span the full range of generations of hardware available. Likewise, the range of applications currently in use spans the full gamut of applications available. Current users of computer hardware and software, therefore, are distributed across all generations of computers.

A number of reasons may be cited for this type of evolution of computer hardware and applications in local governments and planning agencies.

> Precise computer programs must be developed in a world of imprecise, subjective human values and procedures.
>
> The development of effective, user-oriented systems depends on several very fragile processes of communication and cooperation.

Objectives shift constantly.
The cost of it all is startling.[1]

Due to these and other factors, comprehensive and immediate implementation of the newest in computer hardware and applications has not occurred. The adoption and implementation process has generally been one of adaption, learning and conversion.

As a result of this process of adaption, learning, and conversion, the computer applications currently in use in local governments represent a continuation of the trends identified in the 1950's and 1960's. These trends include increasing numbers of computer installations becoming operational, especially in smaller municipalities. Municipalities with populations of 50,000 to 99,999 have experienced the greatest number of adoptions of data processing and computer installations from 1966 to 1970 while municipalities with population under 50,000 have experienced the greatest growth of computer installations since 1970.[2] Some of the more sophisticated applications of computers developed during the 1960's are being pursued by local governments. More money is being spent by local governmental units to perform more computer tasks than ever before. "Nevertheless, the most common uses of computers continue to be the same routine high volume tasks such as recordkeeping and calculating/printing that first attracted municipalities to computers in the 1950's."[3]

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[1]Frederic G. Withington, "Five Generations of Computers," Harvard Business Review 52 (July/August 1974): 106-107.

[2]"Municipal Computers: Growth, Usage, and Management," Urban Data Service Report 11/75 7 (November 1975):2.

[3]Ibid., p. 1.

Applications utilized currently by local governments, therefore, serve a wide variety of municipal functions through largely housekeeping tasks. Four categories of municipal functions served by computer applications can be identified. These categories include public finance and administration, physical and economic development, public safety, and human resources development.[4] A study by the International City Management Association published in an Urban Data Service Report reflects the state of the art of the municipal information systems approach to computer applications in 1970. Of the four categories of municipal functions, ". . . Public Finance is the dominant area served by computers, accounting for 45% of all municipal applications."[5] The functional applications included in this category reflect the trend of continuation of housekeeping tasks. The applications include: accounting and disbursing, budget preparation and control, revenue collection, treasury management, auditing, purchasing and property management, data processing, personnel accounting, assessing, legal, city clerk, and licensing.[6]

The physical and economic development category accounts for 21 percent of the computer applications with specific areas of application including: general physical and economic development, city planning, zoning, subdivision regulation, urban renewal, community and industrial development, land recording, building inspection, engineering, street

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[4]"Municipal Information Systems: The State of the Art in 1970," Urban Data Service Report 1/72 4 (January 1972): 10.

[5]Ibid.

[6]Ibid.

maintenance, parks, water utility, sewer utility, electric utility, gas utility, refuse collection and disposal utility, airport utility, public transportation, off street parking, and other utility services.[7] Although a great number of applications are contained in this category, utility applications, if grouped together, represent the greatest percentage. All utility applications together represent 63 percent of the total number of applications in this functional category, while city planning applications constitute only 13 percent of the applications.[8]

The public safety and human resources development categories account for a respective 18 and 16 percent of the total number of computer applications.[9] In the public safety category, the overwhelming number of applications relate to law enforcement. Other applications include general public safety, traffic engineering, fire supression and prevention, safety code enforcement, and civil defense and emergency planning. The human resources development category is the most underdeveloped in terms of computer applications. No single application is dominant in this category, although education applications head the list. Other applications in this category include general human resources development, health services, hospitals and clinics, ambulance, restaurant and food handling inspection, vital statistics, welfare, library and recreation, voter registration, employment services, public housing, housing code enforcement, and community action program.[10]

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[7] Ibid.

[8] Ibid., p. 11.

[9] Ibid., p. 10.

[10] Ibid., p. 11.

These applications, although categorized by municipal function, can also be examined in the context of the approaches to computer applications previously discussed. Many of the application categories fall into the housekeeping approach with an emphasis on data processing. In the public finance and administration category, for example, computer applications are a part of the housekeeping and administrative process of issuing various types of licenses such as occupation licenses, beverage licenses, or motor vehicle licenses. City clerks are using the computer for a variety of applications that can be classified as housekeeping including indexing of court clerk records, vote tabulation, election returns, and index and retrieval of legal instruments and council actions.[11] In the other functional categories, the experience is much the same with clerical, accounting, and data storage type applications emphasized.

Two studies reported in 1975 show the further continuation of these trends in computer applications. One study, by the International City Management Association, developed a measure of the sophistication of computer usage in local governments based on information processing tasks (IPTs). These IPTs include more than the simple information and data processing operations previously discussed and, as can be seen in Table 2, involve applications from many of the previously discussed approaches to computer applications. Record-keeping and calculating/printing, for example, can be viewed as housekeeping/administrative and data processing applications as discussed in Chapter II. Record

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[11] Ibid., p. 11.

TABLE 2

A TYPOLOGY OF INFORMATION PROCESSING TASKS
CHARACTERIZATION

	Type		Examples
1.	Record-keeping	Activities which primarily involve the entry, updating, and storage of data, with a secondary need for access; the computer facilitates manageable storage and easy up-dating for nearly unlimited amounts of information.	Inventories, such as voter registration files and land use files; statistics-keepers, such as Uniform Crime Reports data; throughput systems, such as accounting ledgers.
2.	Calculating/ printing	Activities which primarily involve sorting, calculating, and printing of stored data to produce specific operational outputs; utilizes the computer's capabilities as a high-speed data processor.	Payroll processing, utility billing, preparation of mailing lists, simple budget preparation.
3.	Record-searching	Activities where access to and search of data files is of primary importance; by defining parameters, relevant cases can be retrieved from a file with speed and comprehensiveness; on-line capability of computer is particularly useful.	Regional, state, and national wanted warrant files among police agencies; parking ticket "scofflaw" systems; jury selection.
4.	Record restructuring	Activities which involve reorganization, reaggregation, and/or analysis of data; the computer is used to link data from diverse sources or to summarize large volumes of data as management and planning information.	Social services information and referral systems; program budgeting systems; geoprocessing systems, such as ACG/DIME.

TABLE 2 (continued)

	Type		Examples
5.	Sophisticated analytics	Activities which utilize sophisticated visual, mathematical, simulation, or other analytical methods to examine data; the special capabilities of computers make possible the manipulation of data about complex, interdependent phenomena.	Computer mapping and graphics systems such as SYMAP, regression models to estimate the appraised value of real property, planning simulation models, revenue and expenditure forecasting.
6.	Process control	Activities which approximate a cybernetic system; data about the state of a system is continually monitored and fed back to a human or automatic controller which steers the system towards a performance standard; the computer's capability for real-time monitoring and direction of activities is utilized.	Police, fire, and ambulance dispatch; budget monitoring and control; traffic signal control; water and power distribution control.

Source: Danziger, James N. "Computers, Local Government, and the Litany to EDP." Public Administration Review. 37 (January/February 1977), p. 30.

restructuring and record-searching IPTs are equivalent to data bank and information system approaches to computer applications. The sophisticated analytics IPT incorporates the models and modeling approach and the gaming/simulation approach. Finally, the process control IPT is equivalent to the real time process control approach discussed earlier.

This study provides further evidence that housekeeping/administrative applications continue to be the applications most commonly utilized. In reporting cities, recordkeeping and calculating/printing applications dominated computer usage with 42 percent and 35 percent respectively.[12] The remaining computer applications were distributed among the remaining four IPTs. In terms of current operational applications, record-searching accounted for 8 percent of the total, record restructuring accounted for 6 percent, sophisticated analytics accounted for 5 percent, and process control accounted for 3 percent.[13]

The second study, conducted by the Public Policy Research Organization of the University of California Irvine, presented functions of computers having the greatest value to local governmental chief executives. As might be expected, clerical functions such as record keeping, accounting, and other routine tasks were the use most frequently valued by 90 percent of the respondents.[14] Information retrieval was the second most valued application by 72 percent of the

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[12]Urban Data Service Report 11/75, p. 7.

[13]Ibid., pp. 7-9.

[14]James N. Danziger, "Evaluating Computers: More Sophisticated EDP Uses," Nation's Cities, October 1975, p. 31.

respondents.[15] Analysis and interdependent data pooling, involving relatively straight forward treatment of large data files were the third and fourth most frequently cited choices.[16] The most complex functions, forecasting and computer decision making, were the most valued current applications by only 9 percent and 5 percent of the chief executives respectively.[17]

> There is a clear ranking from the most simple and routine functions to the most complex functions. . . . Thus, it is the view of chief executives that the sophisticated computers currently utilized by many local governments are valued for the simpler, high volume tasks, which were also provided by the less sophisticated computers that preceeded them.[18]

While it is clear that housekeeping/administrative and simple clerical functions are the most numerous computer applications in local governments today, the more sophisticated applications such as modeling simulation, graphics, and more advanced information systems have not been eliminated. Development of these applications is progressing based on the experiences of the 1960's. Model development for planning has been scaled down. The demands of models developed in conjunction with transportation studies in the 1960's for data and information far exceeded the capabilities of planners to provide it. As a result, the models were not as realistic as might have been desired. Development of models for use with computers today is characterized by smaller models with fewer data demands. These models are reflective of a smaller portion of the urban system and, while not as comprehensive, may prove

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[15] Ibid.

[16] Ibid.

[17] Ibid.

[18] Ibid.

to be more valuable due to their ability to more accurately reflect the portion of the urban system modeled.

Information systems are being developed for planning use in conjunction with other governmental agencies. Despite the financial assistance planning agencies have received from the federal government through the Department of Housing and Urban Development and the U. S. Bureau of the Census, it has become too expensive for planning agencies to develop information systems solely for their own use. To obtain necessary resources in terms of both dollars and data, planners have had to work closely with other governmental agencies. The cost of updating and keeping data current is most easily borne if shared by a number of interested agencies.

Comprehensive systems such as the Integrated Municipal Information System (IMIS), discussed previously, provide interesting insights into the current possibilities for such systems. The IMIS concept has not endured in viable form after the experiences of the early 1970's. Of the seven cities originally slated to receive financial assistance for system development, only one, Charlotte, North Carolina, is still being mentioned in the literature that was reviewed. The IMIS project was initiated under the pilot project concept, that is, the federal government funded only a very few projects with the hope that other communities would pick up on the experiences of the few and transfer the computer applications to their own governmental operations. The IMIS project is over in terms of federal funding and the question of transferability has yet to be answered.

The Charlotte experience is an interesting one and points out problems associated with the attempted development of a comprehensive system. Outside personnel were brought in to conduct the systems analysis and to determine the informational needs of the operating local governmental agencies, including the planning agency.

> After nearly two years and perhaps a million dollars, two very high stacks of reports—systems analysis and systems conceptualization—were completed. In the next three years these documents received so little use, and proved of so little usefulness when staff tried to use them, that they were essentially worthless. The system analysis in great detail turned out to be obsolete and incomplete when the analysts tried to use it for system design. Further, when discussing the design of details of the computer based system with city personnel it almost invariably turned out to be simpler and surer to do a new analysis for the particular activities under consideration.[19]

While the concept of a comprehensive information system created whole is appealing, the Charlotte experience suggests that it cannot be done under the guidelines and procedures established for the IMIS project.

Other problems have been pointed out in conjunction with the funding of local computing projects by the federal government.

> Many executives have observed the effects of federal funding for local computing projects. In a significant number of cases, large sums were spent on the development of new information systems with little proportionate success. Reasons for such limited success include lack of technical expertise among local EDP personnel, the high cost of getting the system up and running, and high on-going costs that were borne by the government.[20]

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[19]George C. Hemmens, "Implementing the Integrated Municipal Information System Concept: The Charlotte, North Carolina Case," paper submitted for presentation at the 57th Annual Conference of the American Institute of Planners, San Antonio, Texas, 1975.

[20]William H. Dutton, "Major Policy Concerns Facing Local Executives," Nation's Cities, October 1975, p. 34.

As a result of these experiences, local governmental officials are wary of federal aid for information systems development, although aid from the Bureau of the Census in the form of GBF/DIME system applications are being used.

The Charlotte IMIS did, however, begin to develop some modules, computer programs and data required to complete a major task, functionally related to planning. A plan monitoring module was developed which monitored the condition of various city neighborhoods by computing a neighborhood status index. The neighborhood status index was comprised of two measures, neighborhood physical quality and neighborhood socioeconomic quality, developed from data available from operational activities of various local governmental agencies and from the data gathering activities of the planning agency. The computer served as the depository for data which the planners called upon when they wished to compute the neighborhood status index. The computer also performed the data manipulations necessary to actually calculate the measures and indices.

The module served several important purposes for planning. It provided reports on the performance of city administrators as they affected the social, physical, and fiscal well being of the city. It was a dynamic tool for evaluating the potential effects of various policies, and provided regular reports on the general status of the city.[21] It is not known whether this module has been transferred to

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[21]Michael J. Kevany, "Computer Support for Municipal Management/Planning and Analysis," paper presented at the Fourth European Symposium on Urban Data Management, Madrid, Spain, April 1974.

other local governments for use in their planning departments, however, it illustrates the important role computers can play as the sophistication of planning activities and computer hardware and software increases.

The lack of sophistication on the part of local governments and planning agencies may, in part, help explain why more sophisticated computer applications seem to be receiving less attention than the routine applications. More smaller municipalities are just beginning to adopt computers and computer applications. They have been attracted to computers for the same reasons cities were attracted to the computer in the 1950's and 1960's. These smaller municipalities are currently at rudimentary stages of development in terms of both computer hardware and computer applications. After having just made a substantial investment in computer mainframes, these municipalities are seeking to get the most for their money by utilizing applications stressing the routine, high volume housekeeping/administrative tasks discussed previously. The sophistication and number of computer applications is, therefore, directly related to the size of the community involved, its available resources, and the length of time it has had computer hardware.[22] Communities that have had computers and computer applications longer are more likely to be exploring the realm of more advanced applications since the basic housekeeping functions have already been operationalized and are in adequate working order.

Computer applications related specifically to planning are, therefore, a distinct possibility, especially in municipalities with

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[22]Urban Data Service Report 11/75, p. 12.

well established computer functions. The growth and development of computer applications in planning is a direct result of the general growth and development of computer applications in local governments as a whole. General applications can be and have been adapted for use in planning.

> The pattern of computer utilization in an urban context has paralleled that in many other fields. There was a logical progression from bookkeeping to record keeping, and to more sophisticated forms of data banking. Extensive data analysis routines with numerical output followed, with graphic output added later. Each development broadened the base from which other new developments could then be realized.[23]

The most effective computer applications related to planning make use of the capability of the computer to store, communicate, and manipulate large amounts of data and information. Regardless of the method involved, data and information are important in planning. Reliable information about physical, environmental, social, and economic conditions is necessary for formulating realistic policies and programs for guiding urban growth and development and for attacking the many problems of an urban area. Types of information and data potentially useful in developing planning recommendations that reflect the goals and objectives of the local community are numerous and varied. Useful information and data might include physical data such as sewer and water facilities, zoning changes, building permits, types of land use, and housing types and conditions; economic, demographic, and social data such as population, vital statistics, school enrollment, income levels,

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[23]Peter Kamnitzer, "Urban Problems," in Computers and the Problems of Society, ed. Harold Sackman and H. Borko (Montvale, New Jersey: AFIPS Press, 1972), p. 277.

street address, and census tract; financial information such as government property inventory, government agency expenditures, tax rates, and assessed land values; and environmental data such as soil type, drainage features, slope, water quality, and types of vegetation and animal life.

Planners need these types of information and data and more concerning the full range of governmental activities and community needs for a variety of planning activities. The information and data is used to assist in formulating goals and objectives, to design alternative programs and policies to meet those goals and objectives, to evaluate the various alternatives, and to monitor the selected programs and policies through implementation.

> Most communities have a pressing need for data, for facts and figures and analysis, and for use in studies, surveys, and research programs. The rapid growth of American cities has required the handling of expanded volumes of data; more important, it has dictated the need for additional data to plan for and control this growth.[24]

While many similarities exist between computer applications in local government as a whole and computer applications related to planning, several significant differences can be pointed out. These differences may, in part, help explain the slow development of planning applications. As mentioned previously, applications in local government can be adapted for planning uses. The computer applications that are most common, however, relate to repetitive tasks that are easily understood and transformed to computer routine. The use of a computer

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[24]W. K. Williams, "Computers in Urban Planning," Socio-Economic Planning Sciences 1 (July 1968): 298.

for planning purposes is likely to occur on a less frequent basis. That is, the necessary information must be available, but it is not likely to be used by planners in a routine manner. It is more likely that the computer will be utilized during the course of a planning study with an emphasis on manipulation and generation of information for decision making rather than emphasizing efficient programming techniques. Computer applications related to planning are less likely to be simple adaptions of manual techniques to automated procedures. The planning techniques are more likely to be developed through heuristic programming and interaction between planners and between planner and machine.[25]

These differences stem from the nature of planning activities and their informational needs. During the course of day to day local governmental operations, much administrative data is generated. In some respects, this data is important to planning, however, it is not always in the appropriate, usable form for planners. "The data problems of planning agencies seem to be questions more of indigestion than of starvation."[26] Planners and administrators need different forms of the same data due to their differing views of the community in which they work. Administrators are interested in keeping track of the number of building permits issued, for example, to assure the proper completion of the appropriate paperwork. The planner may be interested in the same

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[25]William K. Benton. The Use of the Computer in Planning, (Reading, Ma.: Addison-Wesley Publishing Company, 1971), p. 17.

[26]Doris B. Holleb. Social and Economic Information for Urban Planning, 2 vols. (Chicago: Center for Urban Studies, University of Chicago, 1969), 1:64.

information, but not on a day to day basis, although the planner wants the data to be current when he has reason to call upon it. The planner's interest may stem from an attempt to study the spatial distribution of the building permits to determine where increased demands on sewer and water systems or the school system may be anticipated. "In short, the urban planner is concerned with the dynamic, changing pattern of living as it applies to his particular geographic area."[27] This concern manifests itself in the use of and interest in a variety of types of data including population, land use, structures, establishments, circulation, investment activity, housing, urban design, civic facilities, employment, and economic activity.

In many cases administrative data is fragmented and ill-defined. Each local governmental agency collects data pertaining to its own separate functions as the need arises. Little consideration is given to the fact that several governmental agencies may be duplicating efforts and adding to administrative costs. Data banks and information systems may help alleviate some of this problem, however, the problem still remains of what data are necessary and important and what data are irrelevant. To identify and interpret the data necessary for planning, planners need to have a well defined, well structured view of the problems they face. This is not always possible in planning due to the complexity of the problems involved.

These complexities increase the difficulty of discussing planning in programming terms. Difficult procedural problems must be faced due

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[27]Williams, p. 298.

to the many facets of urban problems. It is not a matter of simple automation of existing routine tasks as is the case with many of the housekeeping/administrative computer applications currently utilized by local governments. In writing a computer program dealing with an assessment of the impacts of various policies, for example, decisions must be made regarding the level; primary, secondary, or tertiery; of impacts considered. The elements and variables involved in the problem must be identified and decisions must be made as to which elements are to be included in the analysis and which are to be eliminated. Elements to be considered in an impact assessment program might include environmental impacts, economic impacts, cultural impacts, fiscal impacts, social impacts, or aesthetic impacts. Computers can be used to evaluate impacts and alternatives, but only after the objectives are clearly stated and the problem is clearly defined.

Another problem associated with computerization of planning activities is that the application of alternative policies may change the nature of the planning problem. Planning problems are not static. They do not wait for the planner to define them and collect the necessary information to assist the decision maker. Problems change constantly by virtue of the decisions made and decisions not made.

> The fundamental design problem in confecting optimal or even satisfactory sets of policies for urban metropolitan areas arises from the fact that design decisions do not act independently to produce their results, but are in fact both pairwise and collectively strongly interactive, sometimes reinforcing and sometimes nullifying each other.[28]

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[28]Britton Harris, "Computation is Not Enough," Socio-Economic Planning Sciences 4 (March 1970): 7.

The use of computers in planning, then, represents an amalgamation of the approaches and applications previously discussed. Planners are interested in urban management and the functioning of an urban area on an operational basis. Planners are also engaged in activities that could be described as research and development especially in the development of long range alternatives and plans. The distinction between these two levels, however, is not clear. This fact implies important ramifications in terms of computer roles and applications. While intellectual enrichment may be the greatest payoff of computer applications to planners through modeling, simulation, or man-machine interaction, decision makers and the general public are impatient for more immediate results and for evidence of operational usefulness of computer installations. The use of computers for more theoretical work is often put aside in favor of applications that produce visible evidence of their usefulness.

A conflict of priorities is evident here. Computer systems have been developed for urban management involving day to day activities and data storage problems of local governmental agencies. These systems, in large measure, are part of the data bank or information system approach which allows ". . . for more effective handling of the vast amount of data applicable to urban affairs."[29] To address effectively the full range of urban problems planners confront, however, planners need to draw on this available data to develop more sophisticated applications. More sophisticated systems could be built from the base of the data

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[29]Kamnitzer, p. 279.

already available and expand through the use of computer graphic capabilities, modeling capabilities, and interactive gaming and simulation capabilities in an attempt to further define and understand planning problems. Such systems would ". . . generally cross departmental lines and make the most of the information benefits by using computers as tools for aggregating, manipulating, and analyzing data to produce useful information."[30]

Planning system components of computer systems include a number of elements. Initial provisions must be made for file generation, file maintanence, and data reporting. File generation is composed of the initial data collection and its organization into useful data sets termed files. File maintanence involves updating the original data in the files on a regular basis. The key here is data standardization. Information gathered by many local governmental agencies can be used in the data files if the data are in standardized form, if the same units of measurement are used, and if the data are collected for identical geographic areas.

The data reporting element is particularly important since to be useful, data must be easily and effectively accessible. Several data processing routines are essential to the data retrieval and reporting function. A file search and extraction routine must be developed as must a sequencing or sorting routine. Processes for formating and reporting the extracted data are also important. Several types of

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[30]Kenneth L. Kraemer, "Who Really is in Charge of Decisions About EDP?" Nation's Cities, October 1975, p. 38.

output routines and output formats are available. Data can be listed in either detail or summary form or can be placed in tables in detailed or summary form. Summaries of data values can be obtained through the use of predetermined ranges such as frequency distributions or other statistical routines. Finally a capability exists for the output of data in a graphic form.[31]

The whole area of computer graphics is especially important to planners due to the fundamental role of maps in urban administration and planning.

> The large amount of data being collected and stored, and the difficulty of comprehending them in a spatial context, have stimulated the development of computer graphics. Maps can be generated via computer graphic systems displaying geographic and demographic data as well as the result of statistical analysis.[32]

Computer graphic techniques have the advantage of speed and ease of production of a number of maps, each of which may contain a number of variable combinations. These techniques are well suited to dealing with urban problems due to the spatial characteristics of those problems. Mapping or plotting programs are the predominant form of computer application since the use of graphics for things other than fairly simple mapping is constrained by high hardware costs.

The federal government, through the United States Bureau of the Census, has played an important role in the development of computer graphic systems and geographically oriented urban data bases through its

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[31]Williams, pp. 300-302.

[32]Kamnitzer, p. 281.

work with the geographic base concept. A geographically oriented urban data base

> . . . involves the relation of diverse urban data to maps by means of coordinate indexing using digitizing devices. The advantages include: a common denominator correlating urban data; geo-retrieval; potential for graphic displays; and socio-economic indicators.[33]

The continued development of the Geographic Base File/Dual Independent Map Encoding (GBF/DIME) system is expected to increase the use of computers for planning applications through increased census applications, geoprocessing applications, and community or neighborhood analysis. The GBF/DIME system has been employed as a foundation for information systems by planning agencies and as a complement to land use files. With GBF/DIME the geographic description of an area can be input into the computer to provide the referencing points for a land use file. The GBF contains numeric descriptions of street segments and other non-street features and has the capability to automatically code data collected by street address to geographic areas. The DIME file addition to the system allows the connecting of street segments or block faces and shows how adjacent blocks or block faces are interconnected. Other uses for the GBF/DIME system include construction of population estimates, housing surveys, capital improvements and employment studies, and for zoning. "Use of GBF/DIME enables planning departments to gather

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[33]Robert Keston, "Information Systems in Urban Government," Computers and Automation, September 1971, p. 22

small-area data necessary for conducting planning on an individual neighborhood basis."[34]

In the area of neighborhood and community analysis, census data and municipal operations data can be combined through the GBF/DIME system and related to geographic locations.[35] This geographically based information can then be described and displayed through the use of a computer graphics system. Such techniques and applications help fill the need for

> . . . the orderly development of a responsive system which is oriented to simplified communications between the computer system and the urban user. The data base should be geographically oriented so that it may be used in conjunction with a variety of base maps which form the foundation of urban planning and administration.[36]

Computer roles and applications in planning ". . . provide the means to describe the essential features of a city in many dimensions simultaneously and to keep constant and close tab on what is happening on a number of fronts."[37] The computer systems that prove to be of greatest utility in fulfilling the role of computers in planning are information systems, computer graphic systems, urban model systems, and man-gaming or simulation systems.[38] Each of these systems involves

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[34]Constance Klepper, J. D. Eveland, and Everett M. Rogers, Applications of the GBF/DIME System by Public Agencies (Ann Arbor, Mi.: University of Michigan, Department of Journalism, 1977), p. 33.

[35]Urban Data Service Report 11/75, pp. 5-6.

[36]Sidney H. Brounstein, "Some Concepts and Techniques for Constructing and Using a Geographically-Oriented Urban Data Base," Socio-Economic Planning Sciences 1 (July 1968): 315.

[37]Holleb, p. 65.

[38]Kamnitzer, p. 279.

obtaining, processing, storing, and retrieving information; analysis of that information to make predictions; and assisting in the general problem solving activities planners engage in.[39] These computerized systems can be used for four broad tasks in planning activities. The basic tasks of utility to planners are selective data retrieval and display, the generation of standardized detailed and summary reports, statistical and modeling analysis, and computer graphics and mapping.[40]

The systems and tasks described above have a number of important features in common. Of most importance here, however, is their reliance on data and information. Each of the tasks described as current computer applications and those described during the course of the discussion of the historical development of computer applications have at their base strong requirements for information. Most of these systems must begin with some form of data bank or data storage function to provide the basis from which other applications can be built.

Information systems represent attempts to utilize the storage concept of a data bank while overcoming the data bank problem of static, outdated information. Housekeeping/administrative tasks described earlier can be subsumed under an information system. Data processing is involved in an information system as well as the other systems mentioned since each approach requires processing of data and information to

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[39]Britton Harris, "Computers and Urban Planning," Ekistics 28 (July 1969): 4.

[40]Darwin G. Stuart, Information Systems in Urban Planning: A Review, PAS 260 (Chicago: American Society of Planning Officials, 1970), p. 15.

accomplish the necessary tasks for planning. Modeling and simulation also make use of a data base and data processing techniques provided by information systems. The foundation for any of these systems and subsequent tasks or computer applications is the data relevant to each function and the manner in which it is organized and stored. Such data are typically organized in the form of various data files.

The data file becomes the basis from which all applications originate. Files included in an urban planning data base might be land parcel files, real property inventory files, land use inventory files, demographic data files, or activity files. Each of these files then becomes a part of whichever computer system is available to the planner and, with proper updating and editing, provides the appropriate data for any other more sophisticated uses of the computer the planner may wish to make.

The parcel files, real property inventory files, and the land use files all consist of physical data related to land parcels. Dimensions of land and land use included may be activity, ownership, intensity of use, aesthetics and quality of use, legal restrictions on use, public services affecting use, financial value, location, or type of structure.[41] Uses of these files might include drawing survey samples; calibrating of mathematical activity allocation models; measuring housing, open space, community facilities and other inventories; and comparing development

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[41]Metropolitan Washington Council of Governments, Metropolitan Planning Data from Local Governments: A Demonstration of Land Use Data Compatibility (Washington, D. C.: Metropolitan Washington Council of Governments, 1970), p. 21.

trends against plans for directing the sequence of development and provision of public facilities.[42] Demographic data includes any and all appropriate population statistics at a small area level. Activities files include information and data related to employment, retail sales, governmental operations, and financial actions.[43] Additional files and computer applications are listed in Table 3.

While Table 3 does not provide an exhaustive list of planning related computer applications, it can be seen that the list is highly varied. Discussion of applications is relevant only in a general way since such a wide variety of applications relating to planning activities exist. In addition, few communities are likely to have all the applications listed. They are more likely to be in the process of adopting computer applications on the basis of the systems previously discussed. Specific computer applications utilized by a particular planning agency are a function not only of computer hardware and software sophistication and capability, but also of the range of activities engaged in by planners. Specific applications evolve from the basic systems as the need for such applications arises and as the resources of the agency enable such development.

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[42] Ibid., p. 42.

[43] Williams, p. 302.

TABLE 3

COMPUTER APPLICATIONS RELATED TO PLANNING IN USE
BY LOCAL GOVERNMENTS IN 1975

land use inventory file
zoning ordinance
zoning inspection file
subdivision inspection file
capital improvements file
U. S. Census data
population
housing
government
other demographic data
labor force and employment data
industrial production data
commercial business activity and sales
neighborhood oriented data file
population
land use
transportation and traffic
economic
land information system
housing survey data
geoprocessing
Street Address Conversion System (SACS)
Address Coding Guide (ACG)
Dual Independent Map Encoding (DIME)
Address Matching (ADMATCH)
graphics and mapping
Synagraphic Mapping System (SYMAP)
Grid Related Information Display System (GRIDS)

Source: Kraemer, Kenneth L. et al., The Municipal Information Systems Directory 1975. Irvine, Ca.: Public Policy Research Organization University of California, 1976.

CHAPTER IV

A KNOXVILLE EXAMPLE

Knoxville is a community of 182,000 situated in Knox County in eastern Tennessee. It has a mayor council form of government with an independent planning commission. While the city and county governments are not consolidated, the Metropolitan Planning Commission (MPC) serves both the city of Knoxville and Knox County. Consolidation options are currently being considered which would impact city and county governments and computer utilization in the community.

The Metropolitan Planning Commission was organized in 1956. Prior to that time, there was a separate city planning agency and a county planning agency. MPC is composed of fifteen appointed members who are the decision making and policy making body. Appointments are divided between the city and the county with the authority to make appointments resting with the city mayor, the county commission, and the county court. The mayor of Knoxville makes seven appointments to MPC, the Knox County Commission makes six appointments, and two elected officials from the county court complete the MPC membership.

A total staff of forty-eight is currently employed by MPC to conduct technical planning and to report their findings and recommendations to the commission. The staff is internally divided into three sections. These sections are planning, support services, and code administration. Of those forty-eight staff members, fifteen are

professional planners. Included among this professional staff are several persons whose responsibilities include working with data processing, data base and file development and computer programming.

Computers were first put to use in the city of Knoxville in 1971. The first venture into computers and computer applications involved International Business Machines (IBM) equipment and was a result of the impetus of two federal grants. One grant was for law enforcement and the other was through the highway department. Applications were first available only through the police department and involved the development of an accident recording system. This first endeavor, however, was short lived.

In 1973, after removing the IBM equipment, the need for computers was once again realized. The emphasis for computer applications this time was on budgeting and budget preparation. Initial development of budgeting applications for the city was done on computer facilities at Fort Sanders Hospital on the late night shift. In the meantime, the city of Knoxville contracted with Honeywell Corporation to acquire hardware and to establish their own computer installation. The city's use of the Honeywell Corporation equipment began in 1974.

The federal government had an impact on the development of early computer applications in Knoxville in a round about way through the Urban Information Systems Inter-Agency Committee (USAC). As mentioned previously, USAC was formed following the publication of a 1968 report by the Intergovernmental Task Force on Information Systems. Funding was offered through USAC and the Department of Housing and Urban Development

for developing total Integrated Municipal Information Systems (IMIS) or for developing a particular subsystem of IMIS. Tulsa, Oklahoma, applied for, but did not receive one of these grants to develop a financial subsystem of IMIS. Nevertheless, Tulsa went ahead with the development of such a subsystem as described in their original grant application.

Knoxville learned of the activities in Tulsa and a decision was made to transfer the financial software and packages from Tulsa to Knoxville for use by the Finance Department. There was an initial problem with a lack of documentation concerning how the packages were organized and how they would work. Additionally, Tulsa did not conduct business in the same fashion as Knoxville, so the software and packages had to be adapted and modified. Nearly a full year was spent getting the Tulsa software and packages to run in Knoxville to the satisfaction of the Finance Department.

The major software package transferred from Tulsa to Knoxville was the Municipal Accounting Control System (MACS). MACS biggest functions included the capability to conduct accounting, budgeting, purchasing, and treasury management activities for all city agencies and to interface with the city payroll system. Once MACS was up and working, it represented an essentially new software system compared to the original software transferred from Tulsa. To assure proper functioning, MACS was run parallel to manual operations for approximately a year and a half.

In February 1978, official authorization was given by the Knoxville city council to obtain new computer hardware from Burroughs Corporation. Decisions to push for the adoption of Burroughs rather than Honeywell

equipment, however, were made somewhat earlier. Interim Burroughs computer hardware is currently installed at the Department of Information Systems. This interim 3700 system is scheduled to be replaced by a new, more sophisticated 2815 processor at some future date. Since the new machinery was authorized, the staff at the Department of Information Systems has been working to redo its programs to convert from the Honeywell to the Burroughs equipment. The conversion was done on the computer facilities of a local bank.

It is fairly obvious that the history of the development of a computer system has not been smooth in Knoxville.

> The history of data processing over the past seven years in Knoxville City Government includes two very expensive false starts. Taking one step backwards for each two steps forward, the data processing department struggled into FY77. With a demotivated staff, a user group which had no confidence in the department, antiquated computer equipment, and contract problems with the current vendor; it is an understatement that major obstacles to achievement presented themselves.[1]

The question of whether these problems are righting themselves still persist and a problem with staff turnover has done little to rest the issues. Three directors and two interim directors have headed the program since 1972 with no director on occasion. An interim director is currently in charge of the Department of Information Systems as the most recent director resigned in mid-1978.

Currently the Department of Information Systems is recovering from its efforts to convert some 354 programs from Honeywell to Burroughs hardware. Future directions are unclear. The anticipated move to the

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[1]Department of Information Systems, "Fiscal Year 1979 Plan," Knoxville, Tennessee, undated.

new City-County Building will create problems and opportunities. The option exists for consolidation with the county computer system to have one rather than two systems in the new building. Such a centralized operation would prevent duplication of machinery and functions, however, agreement has not been reached on this issue. Research and development are being conducted to devise new computer applications, while existing applications are kept running. Current operating application systems in Knoxville are listed in Table 4. Future, potential systems are listed in Table 5.

Within this context of uncertainty and upheaval, MPC has made some effort to utilize computers to satisfy data processing needs while attempting to maintain stable relations with both the Department of Information Systems in the city government and the county computing operation. As early as 1965, MPC conducted a study concerning the feasibility of electronic data processing for MPC and Knoxville. The study itself was an intensive effort involving a review of the literature available at that time on data banks, attendance at conferences on the subject and visits to local governments having data bank installations, MPC staff meetings, and meetings with other city and county agencies. As a result of the study, recommendations were made that MPC develop a Metropolitan Management Information System. This concept represented a slight expansion of the concept of a land inventory data bank since it was felt that a land inventory data bank approach was too costly for MPC to implement alone. By expanding the concept to include additional data, the data bank would have greater value to planning and to other

TABLE 4

CURRENT SYSTEMS IN KNOXVILLE OPERATED AND MAINTAINED BY THE DEPARTMENT OF INFORMATION SYSTEMS

FY79 Resources	Technology	Operations	Financial (350*)	Personnel (50*)	Operational Support (15*)	Management (60*)	Support Systems (15*)
Staff Capacity Cost	2 150 Changes per year $54,715	10 200,000 transactions/day $279,736	Weekly Payroll Bi-Weekly Payroll Pension Payroll General Ledger Trial Balance Statement of Financial Condition Bank Accounting Investment & Cash Reports Revenue Collection Analysis Cancelled Check Reconciliation Budget Preparation Personnel Financial Forecast City Sticker Billing Parking Ticket Bill & Collection Garbage Billing & Collection	Position Control Departmental Summary Vacancy Index EEO Analysis Personnel Register	Waste Water Plant Control Parking Ticket Hot Sheet Crime Analysis	Citizens' Complaint Receipt & Scheduling Statement of Appropriation Accounts Vendor Listing Purchase Order Listing Comparative Statement of Revenues Fleet Accounting & Control Budget Analysis	Terminal Network Control State Registration File. On-Line Program Development

*denotes number of programs

Source: Department of Information Systems. "Fiscal Year 1979 Plan." Knoxville, Tennessee, undated.

TABLE 5

POTENTIAL SYSTEMS FOR KNOXVILLE DEVELOPED AND INSTALLED BY THE DEPARTMENT OF INFORMATION SYSTEMS

FY79 Resources	Management Services	Applications Development	High Priority Systems	Est. No. Programs
Staff	1	7	Employee History & Benefits	40
Capacity	5 Major Systems	500 Programs	Payroll Systems (Rewritten)	50
Cost	$31,307	$116,502	Payroll/MACS Interface	10
			Fixed Assets Accounting	60
			Stores Inventory	60 **
			Contracts—Control & Accounting	40
			Project—Control & Accounting	100 **
			Real Property Information	70
			Tax Collection Control	35
			Maintenance Scheduling	25
			Building Inspections	30
			Permits Control & Administration	40
			Street Inventory	25
			Traffic Control Inventory	15
			Personnel Productivity Analysis	60
			Revenue Collection & Depository Control	80
			Automated Accounts Receivable	15
			Automated Accounts Payable	15
			Automated Salary Deposits	40
			Investment Portfolio Analysis	25 **
			Traffic Records	20
			Engineering Calculations	80 **
			Statistical & Linear Programming	50 **

**denotes intention to purchase or transfer rather than develop in-house

Source: Department of Information Systems. "Fiscal Year 1979 Plan." Knoxville, Tennessee, undated.

governmental agencies. The inclusion of more comprehensive data would also make updating the data bank easier since agencies using the data would also contribute data.[2]

The system was not to be developed to function in a housekeeping/ administrative capacity. It was envisioned as providing information useful in making management level decisions. The Metropolitan Management Information System was to consist of four files; a parcel file and a street file each for the city and the county. Some fifty-seven data elements were to be included in the parcel file and seventy-one included in the street segment file. The elements included were similar to those mentioned previously and include such things as assessed value, legal description, address, type of construction, number of floors, land use code, and current zoning for the parcel file and street number, census tract, signals, parking, police calls, fire alarms, traffic capacity, and bus stops for the street segment file.[3]

Various agencies were expected to contribute data they had collected and recorded to supplement and reinforce data collected by other agencies. Table 6 shows the various contributing agencies and the data they were expected to contribute. MPC was to be responsible for supervision of data gathering and coordination of file definition, however, a consultant was to write the needed computer programs, user manuals, and the systems analysis for data gathering. Uses of the

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[2]Metropolitan Planning Commission, "EDP Feasibility Study," Knoxville-Knox County, Tennessee, 22 October 1965.

[3]Ibid.

TABLE 6

AGENCIES AND DATA TO CONTRIBUTE TO THE PROPOSED METROPOLITAN MANAGEMENT INFORMATION SYSTEM DEVELOPED IN 1965

Agency	Data
Metropolitan Planning Commission	locational data land use data
City and County Tax Assessors	structural data legal data
Police	crime events accidents
Traffic Engineer	traffic data
County Health Department	health statistics
City, County, and State Welfare Departments	social data
Public Works	physical data streets

Source: Metropolitan Planning Commission. "EDP Feasibility Study." Knoxville, Tennessee, October 1965.

established system were to be quite extensive including land needs studies, tax billing, public safety, capital improvements budget studies, planning-zoning information, recreation needs studies, urban renewal studies, programming of extension of services, and special studies.[4]

In 1969, the Service Bureau Corporation conducted an analysis of the information handling problems of Knoxville through a contract with MPC. Specific emphasis was to be given to the application of data processing techniques to planning. The study was conducted in several phases beginning with an analysis phase. The analysis phase was composed of several elements including:

1. The definition of the data to be "banked."
2. The organization of this data for efficient processing.
3. The maintanence problems of the data bank.
4. The retrieval and reporting of data from the files.[5]

It was recommended that the initial effort in Knoxville regarding data processing should be the establishment of two files; a parcel file and a street/intersection file. Data elements to be included closely resembled the data that was called for in the 1965 study. The list was, however, expanded to include over 200 data items. Component tasks of the Knoxville Management Information System were described as definition and organization of data for efficient processing, creation and maintanence of data files, retrieval of information and presentation of output reports, and growth and evolution of the system. A great deal of attention was given to the mechanics of file creation, updating,

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[4]Ibid.

[5]Service Bureau Corporation, "A Management Information System for the city of Knoxville, Tennessee," Wheaton, Maryland, 1969.

maintanence, and access. Consideration was also given to problems of cost and computer hardware requirements, however, it was the opinion of the Service Bureau Corporation that Knoxville, at some unidentified future point in time, would no longer have any option other than to utilize electronic data processing along the lines outlined in their study.[6]

A report was prepared in 1974 by MPC concerning computer utilization for Knoxville and Knox County. A Task Force on Computer Utilization was established by executive order of the mayor with the report providing task force members information regarding the relationship of planning, management, and data processing and the problems involved in such relationships. Recommendations were made relating to future goals and priorities for a management information system with both immediate implementation and future planning considered. Specific recommendations included an emphasis on procedures and methodologies rather than on computer hardware and software, processing and consolidation of the parcel file maintained by the Knox County Tax Assessor's office with the U. S. Bureau of the Census DIME file, revision of Capital Improvements Program (CIP) for input on the existing electronic system, and the development of a mathematical projection and allocation model for population projections. Long ranged proposals were also included that called for the development of a hydrologic model to assist in assessing the impact of existing and proposed development on drainage, the development of auxiliary CIP programs to perform more detailed financial

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[6]Ibid.

studies, the development and acquisition of mapping and plotting techniques and equipment, and the preparation of all techniques and procedures with consideration of the potential for a change in the form of local government, i.e. the possibility of consolidation. Benefits that would acrue through the use of a management information system were presented, however, the specific details of a management information system were not described.[7]

The most recent report by MPC relating to computer applications was the Preliminary Data Base report which called for the creation, implementation, and maintanence of an Urban Planning Information System (UPIS). UPIS would be utilized by MPC as well as other local governmental agencies and would include a number of components. These components would include a data base made up of a parcel file; computer mapping capability; a geographic base file; data files; functional subsystems such as administration, code administration, library, planning support, land use, and utility/audit; modules comprising the subsystems for editing, updating, reporting, and loading; computer hardware; and the administrative and operational roles to properly run the system.[8]

Each of these studies and reports describes the need for data processing and computer applications in Knoxville. Comprehensive

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[7]Metropolitan Planning Commission, "Computer Utilization: Future Goals and Priorities for Knoxville-Knox County," Knoxville, Tennessee, 25 November 1974.

[8]Metropolitan Planning Commission, "Preliminary Data Base Report: The Basic Concept," Knoxville, Tennessee, undated.

systems are touted as the answer to those needs, however, the studies all stop at a similar point. Some new ideas and concepts were introduced in the later reports, but the call for a comprehensive management information system of some kind has remained constant. Generally the studies covered proposals that would allow development of more sophisticated data handling techniques while enhancing the availability of that data not only for MPC, but for many other local governmental agencies as well. The specific details of what such proposals would entail in terms of financial resources, hardware, and human resources were discussed in only one of the studies and reports. At the present time, the jump from manual techniques to a comprehensive computerized system has not been made, however, some utilization of computer capabilities by MPC is taking place and plans are being discussed for increased use.

MPC, by virtue of being a combined city-county agency, has access to both city and county computer hardware, however, greater use has been made of the city computer. Access to the city computer has been facilitated through the use of an Entrex terminal located in the MPC offices. The Entrex terminal provides a telephone hook-up to the computer center for data entry. No capability currently exists for MPC to access any input data, as a terminal for output is not at MPC offices. MPC is, however, moving towards the use of an in-house terminal that will provide direct access input and output. In addition to the city computer and the county computer, MPC has utilized the computer facilities of the University of Tennessee (UT), the Tennessee Valley Authority (TVA), and the United American Service Center. MPC maintains

an account with UT and has conducted some DIME file activities there. The UT facility has served as an intermediary between MPC products and a product the city computer center can use. TVA has been utilized to some extent, largely through the 208 Water Quality Management Study. Water quality simulation models were developed involving storm water runoff, lake aging, and river pollution. This software is currently in TVA hands. The United American Service Center computer facilities were used in conjunction with an annexation study conducted by MPC in 1977.

The use and importance of computers and computer applications at MPC revolves around the computer capability for storing, manipulating, and outputing reliable, current information for decision making at an affordable price. The data is needed on an aggregate and disaggregate basis and at a planning scale. A planning scale is not necessarily parcel level data, however, it is also not at an engineering or design scale. The appropriate scale varies depending on the use to be made of the data. In Knoxville, the geographic area is divided into planning units, census tracts, sectors, traffic zones, and small areas which aid MPC in analysis and in developing planning recommendations. If all necessary information was available at the parcel level and was in a form that made it relatively easy to aggregate and disaggregate, it follows that all information for any of the above mentioned geographic areas would be available. Assembling large amounts of information and data at the parcel level of detail, however, is a fairly expensive proposition.

Beginnings have been made in the development of parcel file level information by MPC building on the work of the county tax assessor's

office. The tax assessor's parcel file is copied and taken to the city computer for use in projects conducted by MPC. The file contains relatively few data elements, but is at the parcel level. Elements included are property assessment, property size, property classification, and land use. While this information is useful to MPC, the parcel file does not contain all data and information relating to MPC activities that could be helpful. This parcel file was heavily utilized in the fall of 1977 when MPC undertook an annexation study for the Knoxville mayor. Information contained in the parcel file was used to build a case on a cost/revenue basis for areas of Knox County to be annexed to Knoxville.

The use of the DIME file has also been approached by MPC. Negotiations began approximately three years ago with the Bureau of the Census to cover all of Knoxville and Knox County in the file rather than only the urbanized area. Code administration, zoning decisions, and small area plans were expected to be assisted through the use of the DIME file. A crash program conducted in February and March 1978 relating to the election commission was possible because of the existing DIME file base. A court order was received to check all Knoxville and Knox County voting records to determine if voters were voting in the correct precincts. This project was handed to MPC, who used the DIME file, extended it into the previously uncovered portions of the county, and designed and wrote specific computer programs to conduct the appropriate analysis.

MPC is additionally becoming involved in the computerization of records. Currently zoning records and employment data are being entered

into the system through the Entrex terminal. The zoning records composed of zoning cases, street names, use on review, variances, and subdivisions; are nearly completely entered into the computer. They are expected to be used to fill the constant requests for information from the MPC staff, individuals, and elected officials concerning zoning actions. In-house recommendations and decisions will be made in response to such requests through reference to the zoning file rather than refering to the one set of nonreproducable zoning maps currently utilized. The employment data have just begun to be entered and is expected to serve a number of functions. Such data would help identify patterns of activity and shifts in employment type, for example. In both cases, however, once the data are entered through the Entrex terminal it cannot be retrieved since MPC has done little in the way of software development to edit, update, and report file data and does not have the hardware necessary to receive output. No use, therefore, is being made of the data currently being entered, although $30,000 was allocated in the current budget for the computerization of records.

The land use capability portion of the 208 Water Quality Management Study conducted by MPC involved a more environmentally oriented data base. The base used is available on tapes, however, the study has been used largely as a reference tool. Land use information was hand coded into the programs written to select specific sites for particular purposes based on the characteristics desired. The information and analysis was used to a certain extent in a recent study on land fill locations by MPC. These data would be difficult to use in conjunction

with the parcel file or the DIME file as the basic referencing systems are different.

Other computer applications utilized by MPC involve relatively simple programs largely in the area of statistical analysis. Original programs have been written for specific uses of the parcel file and the DIME file. The Statistical Package for the Social Sciences (SPSS) available at the UT computer center has also been utilized for statistical analysis in specific projects.

Computer mapping applications are also important items relating to MPC utilization of computers. An ad hoc, informal computer base map task force was formed in the fall of 1977 by several governmental agencies interested in developing a computer mapping system for Knoxville. Agencies included were MPC, the city traffic engineer, Knoxville Utilities Board (KUB), Waste Water Control, and the City and County Tax Assessors. Each of these agencies had an interest in maintaining current, regularly updated maps, but were unable to afford a computer system alone. Reconciling the differing needs of each of the agencies, however, proved to be troublesome. A computer mapping system for the city would enable updating of the base map on a regular basis and would increase the capacity of each agency to relate information. In the case of MPC, two or three variables could be displayed on a single map without the difficulty of hand, overlay techniques. The capacity for presenting maps at different scales would also be increased. The biggest problem with the implementation of such a system proved to be the local elected officials. Fifty thousand dollars were requested

for the new fiscal year to hire a consultant to develop a mapping plan. A ten year development period was envisioned with $100,000 per year requested for implementation. This item was, however, the first thing to be cut from the budget during the recent budget hearings.

MPC is currently at a crossroads in terms of computer hardware development and the development of computer applications related to planning. Little has been accomplished to date. What has been done has been on a project by project basis as the need arose. Plans are being formulated to extend MPC's computer usage, however, several important questions and issues must be settled before effective plans can be made.

The first question revolves around the city-county consolidation issue and involves not only MPC, but all other city and county operating agencies as well. With the situation as yet unsettled, plans are difficult to formulate. The problem for MPC is not quite as great, however, since MPC is already a combined operation. In terms of computer facilities, the consolidation issue presents a number of problems. Currently the city and the county computers are not compatible in terms of software transfer. In addition, KUB and the school system have their own computer facilities. If consolidation or metropolitan government came about, the options for combining computer facilities would present themselves. Continuation of separate systems, however, would also be a possibility with major departments developing their own systems unrelated to one another. A greater amount of financial resources would be expended should this option be followed. As a result, duplication of capabilities and efforts would persist. Until

these questions are cleared up, all local governmental agencies are in limbo in terms of capacity for future computer utilization.

The second question concerns the computer and their data handling capacity. Computers can serve MPC's needs for data and information by making it available on a regular, up to date basis in a desirable form. The question, however, as to what data and information are specifically needed has yet to be answered. Planning activities cover such a wide range of subject areas; from transportation to social considerations, to the environment, that nearly all data that could be collected might be of value at some point. Collecting data and information because it might be useful is both expensive and can be a waste of resources. A wide ranging data collection effort and its subsequent computerization could be useful to other public and private agencies as well as MPC. The extent of MPC involvement as the agency functioning as an information depository is another unanswered question. Such a role would be possible for MPC, however, such an option would involve meeting the informational needs of other agencies as well as MPC. A good deal of coordination and cooperation would be required as would a significant increase in the level of resource allocation for such activities.

Regardless of the various activities MPC has engaged in that have utilized computer capabilities, MPC is still at the beginning stages of computer application development. They are now beginning to decide where they want to go in terms of computer usage and which approaches they wish to follow. The kinds of information needed are being examined. Costs are also being examined to determine if the money spent

for computer applications is justified rather than investing the same money in improved manual techniques. Recommendations for the next three years are being developed as are specific recommendations for steps to be taken in the next twelve months.

Future plans are progressing along the lines of the development of a comprehensive data processing system for MPC involving the concept of distributed processing. The distributed processing concept does not require that MPC obtain their own computer hardware. The necessary hardware is located elsewhere, however, terminals for both input and output would be maintained at MPC offices with a telephone hook-up to the central processing hardware. The system would be developed in three areas that interrelate both with one another and with the internal sections of MPC. The three areas are computerized text processing involving the generation of reports, memos, and notifications; computerized mapping and graphics; and computerized, interactive records and record management. Each of the three internal sections of MPC; planning, code administration, and support services; would utilize each of the three areas of the system, although for slightly different purposes. Code administration might, for example, utilize the interactive records to answer a question regarding the existing zoning of a particular piece of property. The planning section, in contrast, might use the same records to aggregate data to ascertain the number of parcels zoned R-1 in a particular traffic zone. Unusual requests might be handled through a simplified user language which would allow planners to input their own data and analysis requests. Underlying this system

would be a geo-base comprised of a parcel file and a file such as the DIME file. The parcel file would contain a description of a parcel of land and other pertinent information while the DIME file would describe the road network and would tie the parcel file description to a particular spatial location.

Such a system is, however, some distance in the future. MPC has been making and is continuing to make progress in the development of files such as the parcel file and the DIME file that will have applicability to the development of a more comprehensive system. Use of computer capability for statistical analysis and the computerization of records are also important steps. At this point, however, those making the decisions regarding resource allocation have not been convinced that the high development costs and long term commitment to the development of such a system are outweighed by the anticipated benefits.[9]

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[9]The information contained in this chapter represents a synthesis of the results of interviews conducted with Metropolitan Planning Commission staff members and representatives of the Department of Information Systems.

CHAPTER V

SUMMARY AND CONCLUSIONS

The literature pertaining to the development of computer hardware and computer applications with a special emphasis on planning shows several interesting characteristics. There seems to be a gap in the literature between the applications reported as currently in use in local governments and the applications reported as most desirable. The applications in use are housekeeping/administrative applications dealing with repetitive operations such as utility billing, budgeting, and payroll. The applications reported as desirable and those most expected to increase include various activities related to planning such as modeling, data file development, geographic base file development, computer mapping and graphics, and simulation.

The most interesting aspect of these applications is that studies conducted in the late 1960's reported this same breakdown between current and potential applications as did studies conducted in the early 1970's and through 1974. The point is that the literature indicates that while the development of such applications would be desirable, few if any steps in the direction of the development of more sophisticated techniques and applications that would be especially important to planning seem to have been taken. It must be kept in mind, however, that this gap in the literature may not be reflective of a gap in actual practice. It is possible that applications have been moving towards

and, in fact, encompassing the uses viewed as highly desirable and potentially important in the late 1960's and early 1970's, but have simply not been reported in the literature reviewed.

Regardless of whether this gap is real or is a result of the lack of documentation in the literature, the overwhelming evidence suggests that a continuation of the trends of the 1950's and 1960's in terms of computer applications is the rule rather than the exception. A variety of reasons can be cited for the continuing emphasis on this sort of computer applications. The most common recordkeeping and calculating/printing applications still offer the greatest return on the initial investment in computer hardware and application development at the local governmental level. Tasks such as accounting, budget preparation and control, treasury management, purchasing and property management, assessing, and auditing can be performed on a repetitive basis at a lower cost per use since the initial development of the application is complete. It is in these areas that the cost savings touted as an advantage of computer utilization came into play.

In terms of computer applications in planning, the issue becomes one of information more than of computer utilization. Planners utilize a wide variety of information to develop planning recommendations to assist local governmental officials in decision making. Those decision makers often have little concern as to where the information comes from, how it is assembled, stored, manipulated, or analyzed. Their interest is in having the appropriate information at their finger tips when a decision must be made. If the information serves its purpose, it is immaterial whether it is generated by manual or computer techniques.

Another facet to this same issue is the apparent assumption in the literature that computer utilization will provide better information for planners and decision makers and that more information will lead to better plans and decisions. This becomes a two sided problem based on the opposing points of view of those who refuse to accept the computer and those who unquestioningly do. Neither attitude is particularly useful. There is a potential for generating deceptive reports based on the underlying assumptions and parameters of the computer programs utilized. In one sense there is no such thing as accurate, objective information, therefore, ". . . computer-based data and decision making should not be viewed with either more or less trust or hope than other forms of data and decisions."[1] It is difficult to measure if, in fact, the availability of more, better data leads to better, more effective decisions.

The issue of information looms central in any discussion of computer applications as they relate to planning. The ability to edit, update, store, retrieve, analyze, and report data is essential to a planning agency, however, the availability of computer access can stimulate an overaccumulation of information. While a number of definitions of the basic informational needs for good, effective planning have been advanced, little agreement has been reached regarding the definitive information elements needed. The kind, quantity, and quality of information needed is generally based on the functional

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[1]James N. Danziger, "Computers, Local Governments, and the Litany to EDP," Public Administration Review, January/February 1977.

subarea of planning examined, although many data items are important in a number of subareas. Planning agencies operate in a varying range of subareas with differing geographic perspectives and utilize a number of different models and analysis techniques. For these reasons, it is unlikely that one point of view will emerge in terms of standards for information necessary in planning.[2]

This is not to say that computers cannot perform in a planning capacity and be utilized to the full extent of their capabilities. The literature points out time and time again that computers have the potential to become significant tools in planning. The difficulty is not with the use of computers, per se, it is with the resource commitment required to develop the potential capabilities fully. Ideally, every administrator and decision maker would want a full range of necessary information available at his finger tips with the capability to perform interactive analysis and to output reports and maps in whatever form desired. Budget constraints, however, place severe limitations on this sort of development. Currently, in terms of computer usage and development of computer applications, it is difficult to justify the relationship between the resources expended and the benefits derived. Local officials are as likely as not to respond to requests for the development of such systems with the arguments that the

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[2]Joseph W. Duncan, "Creating Federal/State Statistical Systems for Meeting Planning Needs," paper presented at the 57th annual conference of the American Institute of Planners, San Antonio, Texas, 27 October 1975.

system the community has works, so why spend the extra money especially in these days of increased tightening in local governmental expenditures.

When costs are realistically considered, such arguments carry a great deal of weight. The literature indicates that the cost of computer mainframes has rapidly decreased with each new generation and is expected to continue to do so. Relatively speaking, this is true, however, the cost is still high in local governmental terms. The institution of computerized techniques for whatever uses in local government may not lead to the substantial personnel reductions and financial savings as has been mentioned in the literature. Workers in manual operations have simply been replaced by workers in computerized operations without the total number of employees being reduced substantially. Different tasks brought about by increased computer utilization require different kinds of training on the part of workers rather than a fewer number of workers. The substantial cost of the initial investment in computer hardware development has already been mentioned, however, there is a corresponding cost for application development. A great deal of money may be expended to get the software for a particular task up and running. It is only after the task has been operational for some time, that financial savings begin to acrue and amortization of the original investment can begin. An additional cost that must generally be borne by local governments beginning computer applications is associated with running the preexisting manual system parallel with the new computer system to serve as a check and source of verification of the results of the computer system.

When fitted into this context, Knoxville's experiences with computer hardware and software development seem to be fairly typical. The computer applications currently utilized in Knoxville are many of the housekeeping/administrative tasks that represent the continuation of the trend in computer applications begun in the late 1950's and 1960's. Knoxville entered into the field of computer utilization relatively late for a community of its population. Studies have shown that, while undoubtedly cities in the 100,000 to 200,000 population range are still just beginning computer utilization, a number of them began such operations in the 1960's. Examination of the Municipal Information Systems Directory, developed by the Public Policy Research Organization (PPRO) of the University of California at Irvine in their evaluation of information technology in local government, shows that of the eighty-nine cities in the above mentioned population range, fifty-one or fifty-seven percent established electronic data processing and computer uses prior to 1970.[3] Forty-one cities or forty-six percent, had their hardware facilities located in a finance department.[4] Knoxville is atypical in this regard as their computer hardware is in an independent department.

Referring again to the PPRO study, all eighty-nine cities indicated computer applications of some sort including such applications as police protection, assessing, central garage/motor pool, planning and

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[3]Kenneth L. Kraemer, et al., The Municipal Information Systems Directory 1975 (Irvine, California: Public Policy Research Organization, University of California, 1976).

[4]Ibid.

zoning, geoprocessing, sanitation, and utilities (Table 7). Forty-three cities indicated planning and zoning applications or geoprocessing applications with the most common application is these categories being land use inventory files and U. S. census data with a wide variety of geoprocessing activities. It is probably safe to assume that since the study was conducted in 1974, more communities have become involved in planning and zoning applications as Knoxville has. Knoxville, then is currently developing housekeeping and administrative computer applications (Table 4, p. 72) much like numerous other communities of similar population size. The Department of Information Systems and MPC show evidence of the desire to develop applications in areas of greater sophistication (Table 5, p. 73), however, MPC has shown the greatest evidence of taking positive steps in that regard.

The greatest constraint to the development of computer applications relating to planning seems to be finances. As mentioned previously, a reluctance to spend the resources required for complete systems development is in evidence. Arguments that instituting data processing and other computer applications will save money are not entirely true. Rather the institution of computer applications allows additional functions to be served and tasks to be performed faster resulting in a streamlining of manual operations. Incremental steps are being taken, however, as time and money permit. If these incremental steps are pursued in a fashion oriented towards the goal of a system based on a comprehensive concept, then these steps will continue to be beneficial. Any kind of system development such as the development of data files

TABLE 7

FUNCTIONAL AREA COMPUTER APPLICATIONS IN USE BY LOCAL GOVERNMENTS IN 1975

Public Safety	
	police protection
	fire protection
	courts
	emergency preparedness
Finance/Administration	
	accounting
	treasury/collection
	assessment
	budget and management
	purchasing/inventory
	personnel
General Government	
	data processing
	geoprocessing
	public information
	clerk/recorder
	central garage/motor pool
	other general government
Community Development and Public Works	
	planning and zoning
	housing and urban renewal
	licensing and code enforcement
	engineering
	transportation
	streets and highways
	sanitation
	water supply
	utilities
Human Resources	
	public health/hospitals
	public welfare
	parks and recreation
	vital statistics
	libraries
	voter registration

Source: Kraemer, Kenneth et al. The Municipal Information Systems Directory 1975. Irvine, Ca.: Public Policy Research Organization, University of California Irvine, 1976.

must be done within these budget constraints, but also within the ability of MPC to update and access.

In Knoxville, another problem MPC has had to contend with is one of administration and personnel. In some respects this problem is greater than the one of cost. Stability has not been a hallmark of the Department of Information Systems and the city computer program. A change in directors has often signalled a change in computing emphasis and priorities. Knoxville's problems have also been compounded by changes in computer hardware vendors and a resulting change in software. MPC needs a greater degree of continuity and cooperation to continue to effectively utilize the computer capabilities currently available in Knoxville.

Regardless of the approach to computer applications utilized by communities such as Knoxville, an underlying conceptual scheme is important to allow the organization of current hardware and applications and for the planning of development of new applications for use as tools in planning. A number of options are available for communities considering planning applications of the computer. One option might be the organization of functions and files on a functional basis. Such an option might include a housing file, a traffic file, and a health file, for example. From these files, pertinent information could be extracted for use in the specific analysis of a particular planning problem.

Another option might include tying computer applications to a geographic base. All data files, in this case, would be based on a computerized description of parcels and roadways. Data from these files

could be used to answer questions pertaining to a specific parcel of land or could be aggregated to produce pertinent data at traffic zone, census tract, or city wide level.

A third option might be the development of simulation techniques to model city functions. The development of models and subsequent simulation of an increasing number of city functions could supply planners with necessary insight relating proposed actions to anticipated outcomes.

The literature surveyed did not provide enough information to allow an indication of preference among the options and approaches described. Governmental officials should, therefore, examine the needs of their city and its resources to define the options best suited for each local government. In some communities, the questions to be faced regarding the use of computers as planning tools may go beyond computers themselves. Financial resources, political climate, the perception of informational needs, and the status of the planning function within the governmental heirarchy may influence the amount of consideration given to the development of computer applications related specifically to planning.

Computers, then, can play an important role in planning even with consideration of numerous constraints. More quantitative techniques can be adopted to help formulate plans based on the creation and development of an ever increasing number of options. "The need for more systematic planning . . . based on a fuller understanding of

impacts and consequences—grows more rather than less urgent."[5] Computer applications properly developed can help provide this needed fuller understanding of impacts and consequences. Ultimately, the benefits of such computer systems to planning can be great. Computer systems allow shorted planning time; faster, more accurate calculations; instant answers to "what if" questions; the ability to evaluate more alternatives and to develop contingency plans; improved communications; and an integration of planning and control.[6] These capabilities of computers can be successfully exploited only if planners are able to increase their understanding of urban systems and of the world around them and are able to improve the means by which it is represented and manipulated inside the computer.[7]

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[5]Darwin G. Stuart, Systematic Urban Planning (New York: Praeger Publishers, 1976), p. 1.

[6]James B. Boulden, Computer-Assisted Planning Systems (New York: McGraw-Hill Book Company, 1975), pp. 17-18.

[7]Britton Harris, "Computation is not Enough," Socio-Economic Planning Sciences 4 (March 1970): 1.

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