car rate--in approach 1. On the other hand, these combined accidents are accounted for in the third category in approach 3.

Regarding Chatfield's comment on why "all failures in the third group occur in multivehicle accidents," the third vehicle category itself is the multivehicle category that includes accidents involving trucks and passenger cars and is therefore the logical category in which these combined accidents could be considered. As Equations 5 and 6 in the main body of the text show, accidents involving trucks only and passenger cars only are captured in the first two rates. Furthermore, in each of the three rates in approach 3, the VMTs used in the denominators represent our best estimate of the exposure attributable to the accidents included in the corresponding numerator. Further insights into and better understanding of the exposure phenomenon through future research could lead to better estimates in this regard.

Chatfield suggests that approach 2 may be more promising when one considers the assumption that passenger cars and trucks are both traveling in the same environment. We fully agree with the comment and believe that further research is indeed necessary before a complete evaluation of approach 2 can be made. Our decision to discard approach 2 was made primarily on intuitive grounds. Specifically, it was believed that the use of vehicles (involvement rate) in the numerator would tend to overexaggerate the adverse role of passenger cars in highway accidents simply because of the vast majority of passenger cars in the distribution of the entire vehicle population. One could also argue that, because passenger vehicles represent the vast majority, the corresponding accident rate should be inflated accordingly. Again, approach 2 requires further investigation before one can justify the rationale of computing the rates for the purpose of comparison.

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The Promise of New Technology: Implications for Traffic Record Systems

WILLIAM W. STENZEL

Despite the technological revolution that is occurring with the availability of easy-to-use, low-cost, small computers, the development of automated traffic record systems for small police agencies will be a difficult task. The history of data-processing use by law-enforcement agencies over the past 15 years is reviewed, and it is concluded that the record is less than remarkable. Police data-processing projects usually take longer than predicted, cost more than estimated, and produce less than expected. Unrealistic expectations, infatuation with equipment, and the absence of quality software are identified as key factors contributing to these failures. A dramatically changing data-processing marketplace will produce future problems for small agencies that plan to automate traffic record systems. In an analogy between books and their contents and computers and software, it is noted that, just as the major production cost of every book today is the cost of authorship, the major cost of automation has become the development of quality computer programs and not the machines they are designed to run on. Faced with a marketplace that will be cluttered with dozens of data-processing vendors who may not offer adequate service after a sale, the acquisition of appropriate software and support will continue to be difficult for small agencies getting into data processing for the first time.

The electronic revolution is upon us. From digital watches to video recorders, cordless telephones, programmed microwave ovens, and diagnostic readouts in the dashboards of cars, a new and sometimes overwhelming, sometimes frightening technology is with us at every turn. Like it or not, it is a technology on which we are quickly becoming dependent. For example, without microprocessors, the U.S. telephone system as we know it today could not operate.

Perhaps the most exciting and remarkable innovation of this age is the development of general-purpose programmable microprocessors or microcomputers. I am using the word computer in the way that many people have always thought of computers--that is, large, oversized pieces of equipment. In reality, the basic characteristics of room-sized mainframes can not be constructed into briefcase-sized personal computers. Those characteristics include a central processing unit (CPU), data input-output devices, and some form of off-line data-storage capability. The Timex Sinclair Z100, which sells for about $100, is generally identical to the CDC Cyber 205. Both have the ability to follow a sequence of instructions supplied by the user as long as the instructions are formulated according to a precise set of rules. The only limitation to what can be accomplished by these instructions (code) is the imagination and programming skills of the user. (My purpose at this point is to stress the functional similarities of large and small computers. Functional similarity, of course, is not synonymous with performance similarity. The Cyber 205 is capable of billions of arithmetic operations per second; the capability of the Sinclair is much less.)

Despite their current performance limitations, small computers are rapidly becoming as common as hand-held calculators because of their low cost and small size. For the first time, a computer is a practical reality for almost everyone. If the past few years have taught us anything, it is that nothing is more uncertain than long-range forecasts of new technology. Despite the difficulty of tracking future trends, a few cautious predictions can be made. New technology over the next few years will succeed in cramming more and more circuitry into smaller and smaller volumes for remarkably little increase in cost. One tangible fallout of this trend will be the increased capability and use of hand-held computers that are no larger than the calculators people now carry in their vest pockets or purses. In fact, it is becoming increasingly evident that the only true limits to further size reductions may be human characteristics (e.g., finger size).

Equally important will be the accessibility of virtually unlimited off-line storage capacities at extremely low cost. In fact, it is possible that

the use of storage capacity as an indicator of the capability of a computer system may soon lose its meaning completely. Once megabyte levels of storage become available, how significant will another 10 or 20 million bytes be? These advances will represent a continuation of the technology breakthroughs that started in the mid-1960s, became visible to most people by the mid-1970s, and are continuing today. The question is not when this technology will occur; it is happening now. The questions are: How will this new technology affect our lives and our society? What social impacts will the widespread use of computers have on our society? How will it alter the way in which we perceive the world around us? Will it alter how we communicate with one another and how we design solutions to social and economic problems?

The word used most often in discussing the new technology of microprocessors is promise--the promise of less work, more productivity, more information, more leisure time, and so on. The promise of small computers has also been advanced for traffic safety. One scenario sounds something like this: Low-cost computers will be used to support comprehensive traffic record systems to provide administrators, planners, engineers, and enforcement personnel with information to administer programs, design roadways, and enforce traffic laws in the most effective ways possible. Information about roadway characteristics, accident types, and enforcement activities will be instantly retrievable in whatever form is desired. Just push the right buttons and all knowledge is possible. Clerks, file cabinets, and report delays will be things of the past.

But is all what it appears to be on the surface?

PURPOSE AND ASSUMPTIONS

The focus of this paper is on the emerging use of small computers for automated traffic record systems. The purpose is to highlight and examine some of the issues that may significantly affect the manner in which traffic record systems are implemented and used on small computers. A small computer is arbitrarily defined here as any system that sells for less than $20 000. It is assumed that agencies (or subunits within agencies) that use small computers have limited in-house data processing (DP) experience to draw on or limited access to such experience within the agency. This assumption is based on my experience with many small law-enforcement agencies. In addition, the following assumptions are made:

1. Most small agencies are unprepared for the technological changes that will occur throughout the remainder of this decade.
2. New technologies are being promoted and sold (and bought) as solutions rather than as components or tools to be used in finding solutions.
3. Appropriate attributes and characteristics for traffic record systems for small agencies are still largely undefined. The concept, much less the use, of decision support systems for traffic records within law-enforcement agencies is virtually an unexplored area.
4. The availability of federal support for the development of systems and purchase of equipment will be limited throughout this decade.

HISTORY OF POLICE USE OF DATA PROCESSING

It will be useful to draw on several lessons from the history of computer implementation and use by law-enforcement agencies in the 1970s. The applicability of these lessons to traffic records stems from several similarities between what has happened in the recent past and what will occur over the next few years.

Except for a few departments, the vast majority of police agencies in this country are quite small. (The average department in the United States has only 10 or 11 officers.) The promise of computerization in the late 1960s and early 1970s had the same Camelot-like quality that is perceptible today. Fifteen years ago, few departments had seriously examined their information needs in terms of overall department objectives. Most often, manual record systems reflected years of patchwork evolution with little direction or documented rationale. The emergence and growth of the Law Enforcement Assistance Administration (LEAA) was marked by a parallel growth in the availability of federal dollars for equipment, including computers. Although some departments implemented automated systems with few problems, honest appraisals of the experiences of most agencies have led many observers to the following conclusions about the implementation and use of automated record systems within police agencies: (a) it takes longer than expected; (b) it costs more than estimated; and (c) it produces less than promised.

In a recent article in Police Magazine (1), I noted the following:

> Some [police] departments have spent millions of dollars buying and installing elaborate data processing machinery, but have spent years trying to get their systems...in operating order. Others bought the systems with federal funds, and never even attempted to make efficient use of them.

A number of reasons have been identified for the slow pace of automation within the police community. The following are the most frequently cited:

1. Unrealistic expectations--Perhaps more than any other reason, a basic lack of knowledge among senior-level officers about what computers can and cannot do has contributed to the underlying problems.
2. Infatuation with equipment--Also contributing to the failures of the past was the ability of computer vendors to capitalize on the fascination and trust exhibited by many law-enforcement officials regarding new types of equipment and hardware. Some of the most damaging stories cited by critics of the LEAA are related to instances of equipment "overkill" made possible by abundant federal dollars (e.g., the purchase of an antiriot vehicle by a small department in central Iowa). These actions reveal a belief (or hope) in the simple answer neatly packaged in the "right" piece of equipment--that is, a belief that "if I only had the right tool, I could do the job." It does not take a gigantic leap of imagination to see the consequences of such attitudes for data processing.
3. Inadequacy of police-specific software--Although there are thousands of police agencies in the United States, the total market represented by law enforcement is relatively small. There are, for example, more than 5 times as many hospitals and more than 50 times as many hotels in this country as there are police agencies. As a result, the law-enforcement community has never attracted, and likely never will attract, significant commercial interest. In addition, support for the few software packages that were developed was often marginal at best. To fill this gap, many larger departments and regional information systems developed their own software, financed largely with federal dollars. In general, however, acquisition and use of software by

the law-enforcement community have been haphazard at best.

ANALOGY OF INFORMATION TRANSFER

Many of the foregoing problems with the implementation and use of small computers can be more easily seen by using an analogy that relates computer hardware and software to books and their contents. A book can be thought of as consisting of two parts. One part consists of the materials that make up its physical components--that is, paper, ink, covers, glue, etc. Collectively, these parts can be called the hardware of a book. The second part of a book is obvious but more difficult to define: it consists of symbols and diagrams and the sequence of their presentation, which completes the transfer of information from author to reader. These symbols and their sequence represent the software of a book. Different written languages and dialects are paralleled in the world of computers by different programming languages and dialects within generic programming languages.

With this analogy in mind, it is useful to trace briefly the history of the production and use of books in order to understand better the management and social issues that may accompany the democratization of computer use in the 1980s. The pivotal event was the invention of movable type by Johann Guttenberg in the 15th century. Before that time, the production of each book--the hardware--was an enormously expensive operation. Each volume was created by copying one page at a time by hand. As a result, few books existed and each was highly valued. Because there was little access to books, literacy was not considered an important survival skill and only a small portion of the population could read or write. In Western civilization, most books contained religious themes and the clergy assumed the role of interpreting the meaning of the written word for the general population.

Following Guttenberg's invention, the nature of book production and authorship changed dramatically. Because multiple copies of identical pages could now be produced in a fraction of the time that it used to take, the cost of producing individual books dropped sharply. Books became more widely available and literacy more common. However, literacy was still restricted primarily to wealthy. Barriers to universal literacy were the absence of public education and resistance of religious and government leaders, who feared that placement of books directly in the hands of the people would lead to misinterpretation of important works.

The next phase began in the mid-19th century and continues today. The dominant features are universal literacy and the mass availability of low-cost books. Key stimulants in this phase have been the availability of publicly supported education and continued reduction in production costs with the use of soft-cover books.

The latter phenomenon deserves special comment. Although soft-cover books, mostly in the form of pamphlets, first appeared shortly after the invention of movable type, their distribution was limited. Pamphlets were used primarily for the distribution of information on current political and religious issues. In the last half of the 19th century, as more people learned to read, enterprising publishers quickly filled the public's appetite for entertainment by producing penny novels and adventure stories. The low-brow quality of these pulp booklets and magazines became associated with soft-cover books in general. It has only been in the past 20 years that the distinctions between soft cover and hard cover have disappeared. Today, almost every book is available in either form.

One final dramatic change over the past 500 years of book production should be noted. Before the invention of movable type, almost all publishing costs were for the production of the hardware of books. Today, the overwhelming cost item of every book is the cost of authorship, the software.

With this brief history as background, we can now examine the development of computer systems over the past 40 years. The early years, up to the 1960s, were characterized by the development of large, expensive computers. Few were built and each required special installation and maintenance. Few people knew how to operate them or how to write programs for them. Rapidly, a new class of technicians emerged with a variety of titles--e.g., programmers, systems analysts, and information specialists. They became the human link, the interpreters, between the computers and the end users.

Beginning in the early 1960s, the development of transistors and other new technologies produced dramatic changes. Computers became smaller, less costly, and more powerful. More and more applications and users emerged as small agencies found that they could, for the first time, afford data processing. Although computer literacy slowly increased among users, data-processing professionals continued to serve as the key link between the hardware and the user.

The third phase of development began in the mid-1970s and continues today. This period is characterized by the development of microprocessors, chip technology, and low-cost portable computers; a rapid growth in computer literacy among users; and the proliferation of new programming languages designed for user-programmers. The most significant change, however, has been the dramatic change in the relative costs of hardware and software. In the future, software costs will represent the major component of every automated record system.

Whereas the history of book production and use and that of data-processing development exhibit many similarities and in turn suggest many generalizations, the following observations are most important:

1. The data-processing industry has undergone tremendous changes. In a development that parallels the dramatic changes that occurred as universal literacy and low-cost soft-cover books became realities, the DP industry will soon find itself serving marketing dictates driven by the proliferation of millions of low-cost personal and small business machines.
2. The management of data-processing resources will change. Because more end users will have direct access to computing power through microcomputers and intelligent terminals, the interpreter role of the data-processing center will diminish and the need for information centers to facilitate user programming and processing will grow.
3. Market imperatives will relegate discussions about quality languages and efficient operating systems to the background. The driving forces will not be controllable by DP professionals, who criticize the widespread use of primitive languages.
4. Despite claims to the contrary, more quality programs and applications will emerge. Although personal computers purchased from discount electronic and department stores will be described as mere toys, the availability of useful home and desktop planning tools will legitimize the use of machines that cost less than $1000.

IMPACT OF SMALL COMPUTERS ON DEVELOPMENT OF TRAFFIC RECORD SYSTEMS

The issues raised above suggest several factors that

will influence how automated traffic record systems will be used on small computers:

1. The complete service orientation of the relatively small number of hardware vendors of the past decade will change significantly. Consumers will find that, as more computer services and equipment are offered through retail stores and mail-order houses, the warning, "buyer beware," will be more relevant than ever.
2. Most user agencies that attempt to automate their record systems in the future will be small and will have little data-processing experience or on-staff expertise.
3. The rapid development of new technology will precipitate organizational pressures within many agencies that will be aggravated by differences in education and experience such as those characterized in the table below:

Position	Age (years)	Decade in Which Education Was Completed
Senior management	50-60	1950s
Middle management	40-50	1960s
Senior staff	30-40	1970s
Junior staff	20-30	1980s

Whatever the pace of technology change, the management structure of most organizations still evolves on roughly a 40-year cycle. As technological advances occur at a rate that is significantly more rapid than this, organizational pressures are produced as entry-level personnel view upper management as outdated. It is important to note that pressures induced by rapid technological change are in addition to the normal push-pull relationship that always exists between senior management and junior staff members.

To catch a glimpse of the unexpected turns in the road ahead, we must examine the implications of small agencies, organizational generation gaps, a consumer-driven marketplace, and a rapidly changing technology. What do these hazards portend for agencies that will attempt to implement traffic records on a small computer? It will probably mean a number of problems exacerbated by unrealistic expectations about the implementation process and the final benefits of the system, a significant reduction in vendor support, and a haphazard process of software development.

Unrealistic Expectations

The problem of unrealistic expectations was identified earlier as having been a major factor in the lackluster history of computer development in the law-enforcement community. It is not unreasonable to believe that the staffs of many small agencies will encounter problems in the future because of unrealistic expectations about the implementation and uses of an automated traffic record system. A number of indicators support this view.

Staff Experience

Ideally, in an agency that is implementing a record system, the process will be coordinated by individuals who are familiar with the operations and needs of the agency and who have specific training and experience in the design, implementation, and operation of an automated system. However, as the number of agencies considering automation increases, the likelihood that such specialists will be found on staff decreases. As a result, it will be necessary to assign these responsibilities to regular staff persons who, while knowledgeable about traffic records, often have limited knowledge about data processing. This scenario will become increasingly common as more and more small police agencies attempt to implement automated systems.

In an article cited earlier (1), I examined the state of the art of data processing in policing and concluded that, in most cases, police do not fully utilize the computers they have because they do not understand what computers can do. The article quotes the chief of a large eastern police department as follows: "A lot of law enforcement agencies have little or no idea what computers can do for them and don't even know what questions to ask." When this lack of understanding is coupled with an abiding faith in equipment (such as computer hardware) to solve problems, the opportunities for unrealized expectations become obvious.

Vendor Oversell

As the computer market becomes more diverse and directed toward mass commercial operations, the number of retail distributors will increase dramatically. This, in turn, will result in greater competition between vendors. Although such competition will keep prices down, it will also require novice buyers to deal with vendors who increasingly may be willing to promise whatever is necessary to sell the product. Oversell tactics will also be encouraged by the increasing number of novice users and the decrease in vendor follow-up support (discussed further below).

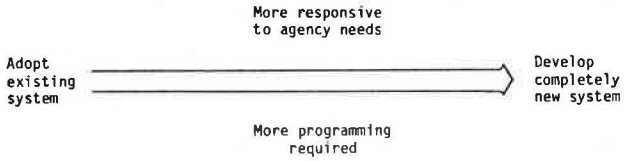
Need for Automation

In many smaller agencies, manual record systems have evolved haphazardly without any overall plan or direction. Automation is often mistakenly viewed as a way to fix record system problems. In many agencies, however, the most pressing need is not to implement an automated system but rather to make a realistic assessment of what problems exist in the current system, what the system is used for, and what alternative solutions (including automation) exist. Preliminary investigations by the Northwestern University Traffic Institute suggest that well-designed manual systems can handle the traffic record needs for approximately 80 percent of all police agencies in the United States. For another 15 percent of departments, the decision whether to automate depends on a number of factors, including the number and kinds of reports wanted, the availability of existing hardware, and anticipated growth patterns for the jurisdiction. The recommended methods of accident data collection for police agencies, based on the volume of accident data reporting, are cited below:

No. of Accidents and Citations Reported per Year	Estimated Percentage of Agencies	Recommended Techniques	
		Manual	Automated
0-3999	80	X	
4000-9999	15	X	X
≥10 000	5		X

What is important to note is that for these agencies the benefits derived from automation are not likely to include significant cost savings. As a result, even the most successful implementations will have to be evaluated on the basis of measures that are traditionally difficult to capture quantitatively ir service-oriented agencies, such as productivity, efficiency, access to more data, and increased accuracy. This suggests that, for these

Figure 1. Alternatives of software development expressed as a continuum of possibilities.



agencies, automating record systems is a venture in which tangible measures of success will be difficult to document.

Less Vendor Support

The changing market for computer sales will cause fundamental changes in the traditional form of support that end users have learned to expect from hardware vendors. The days of IBM-type cradle-to-grave care are over for all but a few large customers. The decreasing margin on unit sales will drive most hardware vendors to emphasize high-volume sales tactics with minimum support. Although warranties will still provide hardware maintenance, traditional vendor support for planning implementation, software development, and operator training will be increasingly less common or will only be available at additional cost.

Although the number of full-service vendors will decrease, consumers will have no problem finding vendors. The proliferation of new businesses in the data-processing industry will be one of the major business stories of the 1980s. This growth will be a mixed blessing for buyers. Although increased competition holds down costs, prospective users will be faced with a virtual army of sellers from which to select. Unlike more established industries, the data-processing field has established a disturbing pattern of volatility in which companies fail and new ventures arise on a monthly basis. It has been estimated (2) that two out of every three vendors in business in 1981, representing all facets of the DP industry, will be out of business by 1985.

Perhaps the most telling commentary on the changing nature of the customer-vendor relationship is the fact that the fastest-growing facet of the industry is client-vendor litigation. Discussing this phenomenon in a June 1981 article in ComputerWorld, Johnson (2) offered several reasons for increased litigation:

1. Disagreements based on the expectations of the customers--an increasing problem because vendors are offering less support and customers are less knowledgeable;
2. Machine reliability--a growing problem because of the proliferation of small machines used in uncontrolled environments;
3. System performance--user expectations based on vendor oversell;
4. The nature of the computer industry--numerous small, under-capitalized companies; and
5. The fact that the industry is not renowned for its sales ethics (questionable ethics are not restricted to vendors; widespread software piracy by microcomputer users is an insidious industry problem).

Complexities of Software Development

The decade of the 1980s will require extensive retraining for most persons who have grown up envisioning a piece of equipment whenever computers are discussed. In the years ahead, the importance of hardware will diminish for most users. Although paper computers have not been predicted yet, throwaway computers have. It has been forecast that the low cost of computer hardware will produce a more calculator-oriented approach to system acquisition; that is, the primary question will be whether the machine can support the software applications package that has been selected. If it cannot, a different machine will be considered.

The reason for this change is quite simple: the cost of computer hardware will become increasingly insignificant compared with the cost of software development. For this reason, it will become increasingly important for users to understand the complexities and difficulties of software acquisition. Returning to the book analogy presented earlier, it will require that users learn to look between the covers of the book before they buy; the outside cover (i.e., the hardware) will become increasingly less important.

Who will develop small-computer software in the future? Although programming and systems analysis skills will still be needed, the DP professional may not be. The skills of the programmer and systems analyst will be used by increasing numbers of non-DP professionals. These skills will include the activities described briefly below.

Learning to Describe Agency Software Needs

It is not enough to say that the agency needs a traffic record system. To describe adequately the kinds of software required, it is necessary to articulate the goals and objectives of the system--that is: What is it supposed to do and why? The process of answering these questions will stimulate the examination of several other issues:

1. What are the problems with the current system?
2. What alternatives are available to correct these problems?
3. What are the likely costs of and payoffs from implementing each alternative?
4. Why is automation the preferred alternative?

Learning to Shop for Software

There are several approaches that can be used to acquire software. Each represents certain risks and disadvantages. As expected, minimizing the risks requires that an agency be willing to compromise on the final product it obtains. The alternatives of software development can be conceptualized as a continuum of possibilities characterized by the use of an existing system with no changes at one end and the development of a completely new system at the other end, as shown in Figure 1. As the diagram indicates, more programming effort is required in moving from left to right on the continuum. It is also true that programming is expensive and time-consuming and that it involves greater risk because the end product may not be what was expected. The advantages associated with various alternatives are discussed below.

Adopt an Existing System

The first alternative, adopting an existing system, assumes that virtually no programming changes are made. It has the significant advantages of low cost and--if the system can be observed in operation in another agency--minimum risk. The major drawback is the fact that there is no capability to tailor the system to the particular needs of the department. In fact, if the new system requires significantly

different kinds of information, the implementation process may require considerable redefinition of data collection forms and procedures.

Modify an Existing System

Like the first alternative presented above, the second approach, modifying an existing system, assumes that a system is modified to satisfy department needs. Tailoring, of course, requires programming additions, deletions, and changes. The extent of these changes determines the cost and risk incurred. A key decision is who will do the programming. Options include using in-house personnel or contracting with a software consultant.

Again, both options present unique problems. In-house personnel may be knowledgeable about the agency but may not be as technically competent as a consultant. In turn, consultants may have considerable data-processing experience but may lack specific knowledge about traffic records. Another potential disadvantage with consultants may be total cost if the project takes longer than expected, a common (almost certain) occurrence in software development.

Tailor a Generic Records System

At the price of losing some flexibility, it is possible to adapt a generic data base management system to the terminology and format required for a traffic record system. This tailoring may not involve as much risk as modifying an existing system because generic record systems are usually designed to be user-tailored when first implemented. A more risky approach is modification of a data base management system originally designed for a different application. Often these systems are promoted by management consulting firms that tend to minimize the actual programming required for the modifications. Effective use of a consulting firm requires that the user agency and the consultant specify in written form what the final system must be able to do, the schedule for completion of the project, and the total cost.

Develop a New System

The most ambitious approach is the development of a new system. This alternative offers the greatest opportunity to obtain a product that is consistent with the needs of the agency. Although this may be an important issue, its value must be weighed against the risks and costs involved. The key issues to be considered are how closely the automated system should emulate the current manual system and who should design and program the new system. On the surface, using an existing manual system as the model for an automated system seems simple. But it must not be assumed that an inadequate manual system will be miraculously corrected when it is automated. The usual result of such an approach is an ill-designed system that makes the same mistakes as the manual system but at a much faster rate. To be successful, this approach requires that an agency objectively assess the strengths and weaknesses of its manual system and aim to retain the strengths and redesign the weak points. The creation of a completely new system represents risks that few agencies should take. The uncertainties involved in the design, cost, and schedule of any software project make this an extremely risky approach. An agency should not consider in-house development unless it has highly capable, experienced personnel who can be committed to the project.

CONCLUSIONS

It is clear that within the next decade most agencies concerned with the use of accident and law-enforcement records will, regardless of their size, have access to computers for the storage and analysis of data. What is also likely is that the process of acquiring and using these automated systems will not be as easy as advertised. The lack of data-processing experience among the personnel of small agencies, coupled with dramatic changes in the marketplace, will make the automation of record systems a risky and difficult process for many agencies. However, if agency administrators are alert to the pitfalls cited in this paper, the task of automation can be accomplished with realistic expectations and maximum payoff to the agency.

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Notice: The Transportation Research Board does not endorse products or manufacturers. Trade and manufacturers' names appear in this paper because they are considered essential to its object.

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Application of Small Computers to Traffic Records Systems in Small Communities

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The application of small computers to traffic records systems in small communities is investigated. The study is based on an assumption that small computers (micros) are useful for the management and analysis of traffic records in communities of 5000-100 000 population. Factors bearing on the apparent hesitancy of small communities to use small computers for traffic records are examined. It is concluded that the volume of traffic records generated by small communities is within the capacity of present small computer systems and that the systems are adequate in terms of secondary storage, primary memory, speed, and input-output devices. Costs are modest. It is suggested that available generic software has not been exploited for traffic records management and that, with some exceptions, there is a lack of specialized applications software for traffic analysts. Remaining barriers to the use of small computers include data-quality concerns, organizational issues, justification of purchase, acceptance of the equipment by agency personnel, and management problems. Adoption of small computers for traffic records systems will depend on how these issues are resolved.