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EVALUATING THE FEASIBILITY AND UTILITY OF FORMS-SCANNING SOFTWARE FOR STREAMLINING CRIME MAPPING DATA COLLECTION & ANALYSIS

FINAL FINAL REPORT

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EXECUTIVE SUMMARY

Crime analysis and crime mapping using geographic information systems (GIS) technology have become increasingly useful tools for targeting resources to combat crime and for assessing the effectiveness of various policing strategies. Yet analyzing crime or applying crime mapping at more than a rudimentary level requires quality data entry, computer systems, mapping expertise and analysis by professional researchers—a commitment of personnel, equipment and money that simply is beyond the capacity of a large proportion of law enforcement agencies.

This project focused on the most basic of the requirements for serious analysis, quality data entry, by assessing the utility, feasibility and cost effectiveness of using the leading forms-recognition software to input data directly from police reports and then export the data to a standard PC-based database. By helping streamline crime data entry, such a capability might help bring quality crime mapping and analysis within the reach of many more police agencies.

Five criteria were used to evaluate TELEform, the leading forms-scanning software which currently is used by nearly 20,000 insurance companies, health care organizations, businesses and governmental entities around the world: user friendliness, stability in a desktop computing environment, functional utility, speed and accuracy when compared with manual data entry and cost effectiveness. The evaluation indicated that TELEform could be used successfully to scan data directly from police reports into a crime analysis and mapping database and that such use could be cost effective in certain circumstances. In brief, the results were:

- **User-friendliness:** The software is as user friendly as common PC database programs and the learning curve for TELEform operators and reviewers is similar to that for such programs. Both the user interface and error-checking routines are intuitive. Any reasonably computer literate person probably could learn to use TELEform's features

by attending a three-day training course.

- **Stability:** The software appears to be stable and reliable when used in conjunction with what presently is considered a moderately powerful PC and a scanner equipped with a document feeder. TELEform was stable when used with the MS Office software suite, ARCView, SPSS and SCAS—all of which commonly are used for crime analysis and mapping as well as reporting.
- **Utility with police reports:** In experimental trials using three police field incident report forms from different agencies that contained various types of common data-entry fields, TELEform was able to scan data directly from batches of reports that had been filled out by police officers who hand-printed the entries in each data field.
- **Superiority to manual entry and error correction:** Forms that took longer to enter manually also tended to take longer for TELEform to input—but the forms-scanning software was nearly 13 percent faster than manual data entry. Forms scanning was as accurate as manual data entry by experienced operators; neither method produced any significant errors out of 313 forms entered in the experiment.
- **Economy:** TELEform appears to present a potentially cost-effective method for entering data into a computerized database from paper police report forms. Actual cost effectiveness for a specific organization will be primarily a function of price paid for the TELEform software and training, local overhead costs for the platform on which it is run, average number of forms processed and how long the software will be used. For example, the computer model used to explore this question indicated that the software probably could be cost effective for a department that processed around 25,000 forms each year if the software was used for five years.

Despite the utility and potential cost-effectiveness of forms-scanning software such as TELEform, it may not be the *best* solution to the data-entry problems faced by most policing organizations. Unlike many of the organizations that use TELEform to process forms which have been filled out by people outside the organization and then transmitted back to them, police reports usually have been filled out by officers or clerical staff. This means that police agencies have the option of entering data directly into their databases—an option that is likely to be even easier and more cost effective than forms scanning.

Instead of having officers fill out forms in the field and then having the forms entered separately into a computerized database, the data could be entered directly in the first place. Two alternatives for direct data entry currently being used or tested by police agencies in the United States include filling out forms on laptop computers that later are downloaded into a centralized database, or entering data on patrol cars' mobile data terminals for direct transmission to such a database. Newer technologies such as personal data assistants (PDAs) also offer opportunities for streamlining data input.

However, forms-scanning software may provide a viable alternative for police agencies that are unready or unable to convert to a paperless reporting environment in the near future. In fact, the process of developing and refining both the core database and the error-checking criteria for each field into which data would be exported from the forms-scanning software might ease the transition toward direct data entry.

Streamlining data collection in local police agencies could be cost effective in its own right. It also could make crime mapping and analysis available to more agencies so long as streamlined data entry were wedded to a standardized policing database that, in turn, was linked to a well-designed reporting and mapping front end such as the Department of Justice's SCAS. Streamlining the process and making more powerful analyses available could improve the timeliness and utility of crime data. Making the data police collect more useful and accessible could multiply the productivity of police officers and thus help communities get more return from their policing dollars. Proliferation of a standardized policing database also could make regional, state and national data collection and analysis efforts less cumbersome by minimizing database incompatibilities.

Given the potential benefits to be gained from streamlining the collection and analysis of crime data, it seems worthwhile for the U.S. Department of Justice to assist and encourage local agencies to improve how they collect, process, store and analyze crime data.

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THE POTENTIAL OF CRIME DATA ANALYSIS

Crime mapping data analysis can act as a "force multiplier" that improves the efficiency or effectiveness of police personnel by boosting their ability to identify problem areas, assess the impact of prevention, control and enforcement efforts and target scarce resources. Properly constructed maps also provide an effective tool for presenting analyses to community groups and local government in a readily-understood format. And increased understanding can bolster support for police programs (Meeker and Vila 2001; Meeker, Vila and Parsons 2001).

Force multipliers like crime mapping and analysis are critical from a management standpoint because the efforts of one crime analyst or geographic information systems (GIS) specialist can increase the effectiveness or efficiency of many other people in an organization. As the computations below illustrate, if a police department with 100 officers assigned to patrol and community-oriented policing efforts hired one analyst at a cost equivalent to the average journeyman-level police officer and if the analyst's efforts boosted the productivity of each of the 100 officers just 5 percent, the payoff would be four dollars for every dollar invested in analysis.

Illustrative Force-Multiplier Calculations

Where productivity is defined as output per unit of cost, and where productivity increase from analysis = 5%:

Output without an analyst / 100 salaries = 100 units

Output with analyst / 101 salaries = 100 units + (100 X .05) = 105 units

Net productivity gain = 105 units /101 salaries = 1.04 = 4%

compared with

Increase salary cost for adding analyst = 1/100 = 0.01 = 1%

Although there are no guarantees that the addition of a qualified crime analyst would boost productivity by 5 percent, and I am aware of no solid productivity research in this area, that figure is consistent with the PI's experience with Orange County, California agencies (see Meeker and Vila 2001; Meeker, Vila and Parsons 2001). A 5 percent productivity improvement also seems very conservative compared to the impressive returns from recent Compstat efforts in New York City and elsewhere (Silverman 1999:97-124), or when compared with results from data-driven tactical patrol efforts that have been evaluated since the mid-1970s (Cordner and Kenney 1999 provide an excellent review). Even more complex GIS-based analytical efforts such as Rossmo's geographic profiling of serial offenders (2000) hold the promise of even greater returns on investment in the future.

OVERVIEW OF CRIME MAPPING

Historically, studies that used spatial analysis or took location into account have provided a number of important insights regarding crime. European studies of the social ecology of crime began with the work of Guerry in France (1833), Quetelet in Belgium (1833) and Greg in the Netherlands (1835). These researchers combined the study of aggregated social, demographic and judicial data with the use of rudimentary statistical analysis and topographic maps in an effort to test hypotheses about the causes of crime (Morris 1957). They soon were followed by British researchers such as J. Fletcher (1850) and H. Mayhew (1862) (see Levin and Lindesmith 1937). But it was not until Darwin captured the imagination of the western world late in the 19th century that concepts from biological ecology began to be applied systematically to the study of crime and other social problems (e.g., Bagehot 1873). By the early 1900s, Robert E. Park, an American, began following the suggestions of plant ecologists (Clements 1916; Clements and Shelford 1939) and started using ecological principles to organize the social sciences (1936a:15).

The pioneering work of researchers and philosophers such as Bagehot (1873), Barrows (1923), Park (1926, 1936a,1936b), Burgess (1925), Wirth (1938), Shaw and McKay (1942) and Hawley (1950) inspired two generations of scholars to study the social and environmental forces in urban areas that create criminal interactions and opportunities. These studies examined the ways that human behavior can be influenced by mundane interactions between people and the ways that those interactions are affected by, and affect, the physical environment. In contrast to many other social science approaches that relied upon highly abstract and diffuse social, political or economic forces to explain changes in human behavior, social or human ecologists focused on causal variables that were both easier to measure and more directly amenable to manipulation by policy-makers and reformers. This combination of empirical accessibility and practical utility undoubtedly contributed to the success and longevity of the ecological approach which, in more recent times, has guided the sophisticated work of researchers such as Clarke (1977, 1980, 1995), Cohen and Felson (1979), Brantingham and Brantingham (1981), Bursik (1984), Bottoms and Wiles (1986), Sampson and Groves (1989), and Sampson et. al. (1997).

The advent of powerful GIS and spatial analysis software, coupled with the ready availability of increasingly powerful personal computers in the mid-1980s, opened up an important realm of analytical possibilities for studying the ecology of crime. For example, much of the early work by Shaw (e.g., Shaw 1929; Shaw and McKay 1942) describes the distribution of crime as having two important attributes: 1) crime rates generally decrease as one moves away from a city's central business district; and 2) areas that have high crime rates tend to remain high crime areas despite population changes. Lebeau (1985), however, used GIS techniques to show that serial offenders tend to display a different form of geographic dispersion, and that the activity of a few such offenders could be responsible for a higher concentration of crime in a particular area.

Many other studies focusing on community characteristics and social structure, using both official and self reported crime data, also have shown that area or spatial attributes play an important role in understanding patterns of criminal activity (See Boggs 1966; Cohen and Felson 1979; Felson and Cohen 1980; Harries 1974, 1989; Hedstrom 1994; Jackson 1984; Ley and Cybriwsky 1974; Roncek 1981; Sampson 1983, 1985, 1987; Sampson and Castellano 1982; Sampson and Groves 1989; Sampson and Wooldredge 1987). Additionally, demographic and structural changes appear to play roles that are important for understanding changes in crime patterns within a community (Bursik and Webb 1982; Laub 1983; Roncek 1981; Roncek and Maier 1991).

A growing number of police agencies are exploring the ability of geographic information systems to increase their efficiency and help meet public demands for increased safety (e.g., Block and Block 1995; Rich 1996). An essential feature of GIS is the ability to examine spatial or geographic relationships. Spatial analysis can identify patterns of crime and areas where resources would be best utilized. With GIS, crime data can be combined at a variety of scales with data from other sources such as business license grantors, the census, transportation agencies and property records. This can enable agencies to track crime across multiple jurisdictions and analyze relationships with associated area characteristics such as geography, demographics, liquor licenses, and vehicular traffic flow patterns (Alexander and Xiang 1994, Harries 1974; Roncek and Maier 1991).

Despite the potential utility of this type of analysis for efficiently targeting criminal justice system resources, a number of technical and analytical issues make it difficult for police agencies to develop full-blown internal crime analysis and GIS capabilities.

BARS TO THE PROLIFERATION OF CRIME DATA ANALYSIS AND MAPPING

If crime data analysis capabilities in general—and GIS capabilities in particular—have so much to offer as force multipliers, why doesn't every police agency employ one or more analysts and maintain a GIS capability? Several bars to adoption of this technology are discussed below, some of which might be dealt with through improvements in technology or training, or through collaborative agreements. But at least one of the limits, jurisdiction size, seems likely to be permanent.

Analytical Issues Associated with Crime Analysis and Mapping

Jurisdiction size probably presents a very real lower-limit boundary beyond which crime data analysis and the use of GIS technology are not practical. Small, geographically isolated police agencies such as often are found in rural areas of the western United States may have crime data collection and reporting needs (e.g., for UCR, NIBRS, SHR or regional obligations), but they are unlikely to gain much additional insight from formal analyses. This is because crime analysis is an essentially statistical process and thus its utility is limited as the number of cases to be analyzed declines. Therefore the potential payoffs from data analysis will tend to be larger in jurisdictions with large numbers of crimes to analyze. Crime data analysis may have little or no benefit for very small jurisdictions where crimes are rare and each officer has an intimate knowledge of each crime that occurs. However, regional approaches to collecting and analyzing crime data may be practical where small jurisdictions lie near to one another, where a number of municipalities are contiguous, or in the case of specialized broad-scale crimes such as drug trafficking.

A lack of methodological expertise also can hinder police agencies attempting to use GIS or other advanced analytical techniques. For example, one of the strengths of GIS analysis is the ability to handle aggregate and individual level data simultaneously along with geographical attributes. Unfortunately, this can lead users without strong backgrounds in social science research and spatial analysis into analytical errors. For example, they may be tempted to use aggregate community characteristics to explain individual behavior—the so-called 'ecological fallacy'. A number of studies using geographic analysis also have pointed out potential problems with failing to integrate non-crime data with official crime data (Hagan, Gillis and Chan 1978; O'Brien 1983). For example, Hagan, Gillis and Chan (1978) suggest that police conceptions of high crime areas can differ significantly from areas where self-reported delinquency is high, and that their understanding of changes in crime rates may be flawed by a failure to consider area and community characteristics, as well as behavioral attributes associated with different types of crimes. These characteristics include urban pathology, social disorganization, family disruption and socio-economic status. Some authors have voiced concerns about these problems and suggested possible solutions (Alba and Logan 1992; Johnston and Pattie 1992; Rotton and Frey 1985; Slatin 1969, 1995). As few law enforcement personnel have had substantial, graduate-level research training in these areas, the risk of basing enforcement decisions on erroneous findings often may be substantial. Perhaps the best example of current levels of interest in crime mapping—and the problems GIS users encounter—is the high volume of messages on the National Institute of Justice's "crimemap" e-mail list-server, many of which are from officers and crime analysts in law enforcement agencies who are attempting to implement GIS-based crime mapping systems. Although geographic information systems software is becoming increasingly user friendly, researchers and practitioners are continually faced with limitations of data and limitations imposed by the time required for data preparation. For example, one of the major reasons why the Orange County, California Gang Incident Tracking System (GITS) was transferred to the University of California, Irvine Focused Research Group on Orange County Street Gangs was the inability of the local sheriff's department to enter data, another was that it was too costly to re-program their database to accommodate new forms. Moreover, geographic information systems software was too difficult for the department's limited mainframe computer staff to operate.

These problems aren't surprising because GIS users often must have expertise in a number of different areas, including database management and development, statistics and mathematics, the use of drafting and drawing software such as AutoCAD, and software programming. This expertise is required because it often is too expensive to purchase canned map data, and because data often are unavailable and therefore must be collected and structured by hand. Even when data are available, differences between formats or data table structures in the different software packages required to enter, structure, analyze statistically, analyze geographically, and prepare visual and verbal reports can create substantial difficulties even for computer-literate researchers.

One of the best approaches to dealing with these concerns is the establishment of partnerships between researchers and police agencies (see Anderson 1990; Alexander and Xiang 1994; BJA 1997; Harries 1990; Meeker and Vila 2001; Meeker, Vila and Parsons 2001; Vila and Meeker 1997). Partnerships of this type enable university researchers to help law enforcement officers structure their inquiries in a standardized and methodologically appropriate manner as well as improve the ease with which they can conduct GIS-based analyses. Web-based forums such as the National Institute of Justice's Crime Mapping Resource Center (CMRC) and its e-mail listserv provide an excellent way for officers and analysts in policing agencies to connect with professional researchers and to obtain expert technical assistance in a timely manner. The annual CMRC conference also provides a matrix in which connections can be made and professional capabilities can grow.

Technological Bars to Implementing Crime Analysis and Mapping

Another set of hindrances to adoption of crime data analysis and mapping in many police departments have to do with outdated or outmoded management information systems (MIS) present in many police agencies. As often has been the case in the past, police agencies often lag far behind the technology curve, either not using readily available technologies, or misusing them. For example, until recently one of the largest police departments in the country did not have adequate numbers of personal computers to handle even routine administrative needs (Independent Commission on the Los Angeles Police Department 1991). Even one of the more progressive large departments in the country, which long has participated in major research studies, still does not have an integrated data collection and management system. In that department, reports are scanned into a computerized system but then each report must be hand entered rather than being read by optical character recognition software. And when reports need to be used again for uniform crime reports or GIS analysis, they once again must be entered by hand. This means that some reports are entered as many as three times—each time by hand (Faggiani 2001). Nationally, according to the 1999 Law Enforcement Management and Administrative Statistics report (LEMAS), 22 percent of law enforcement agencies with more than 100 officers reported not having access to the internet, 45 percent neither map nor even geocode either arrests, calls for service, or crime incidents. And 12 percent do no computerized crime analysis at all (Reaves and Hart 2001: calculated from table 14a).

Internal police department problems with management information systems are not limited to a lack of computers. Many departments also have inappropriate or outmoded MIS systems. For example, it is not uncommon to find small jurisdictions using minicomputers or even mainframe computers to handle MIS needs. As a consequence, every change in reporting format or need can require expensive custom reprogramming, and even routine hardware or software problems require calling in a service technician.

Uses of inappropriate computer technology can limit the usefulness of MIS data. For example, the Orange County, California Gang Incident Tracking System originally depended on a mainframe computer system. Even though the police agencies spent nearly $1 million putting the system together, they were told that they could not collect address data at a finer scale than a Thomas Guide map page. Why? Because the mainframe data field could handle only eight characters. Thus, the agencies involved in this effort were paying to collect all the information needed for fine-scale GIS analyses, but were able to obtain only a coarse-scale output. On top of that, they had to manually convert precise address data to map-page data for each gang incident.

Discussions with police MIS personnel and executives across the country suggest that reliance on vendors for expert advice is a source of many of these problems for law enforcement agencies. As a consequence, many agencies pay dearly for custom software and unnecessarily complex hardware when off-the-shelf software and hardware could give superior results.

An offshoot of these sorts of internal police agency problems with data collection management and reporting is that it often is difficult to share data across jurisdictions. Some areas, such as San Diego, have addressed this problem by creating a centralized unit that collects and maintains law enforcement data countywide. This form of data collection requires that all of the municipal agencies in the county use a single, standardized form. Although standardized forms are a laudable goal, in many other parts of the country they are politically unrealistic and cost prohibitive. Moreover, changing to standardized forms makes it difficult to retain backward compatibility with existing data structures, it requires significant training, and information often is lost due to human and computer errors while switching to a new information management system.

The following section describes a proposal for streamlining crime data entry analysis and mapping that was intended to help address many of the problems described above. The weak link in that proposal—and the focus of this report—is the use of forms-scanning software for data input in order to make data entry more efficient and thus to improve the utility of crime data for analysis and mapping.

2. HISTORY AND EVOLUTION OF THE SCRAM PROPOSAL

In June of 1998, Professor James Meeker at the University of California, Irvine and I submitted a proposal to NIJ for development of an affordable, user-friendly, reliable, flexible and powerful streamlined crime reporting analysis and mapping program (SCRAM) designed to run on high-end personal computer systems. As we envisioned it, SCRAM would:

- streamline entry of data from police report forms by scanning them directly into an analytical database using TELEform forms scanning software;
- make crime reporting more timely, useful, and comparable between agencies;
- expand analysis capabilities to include conventional descriptive techniques such as pin maps and hot-spot analyses, as well as custom algorithms to identify hotter- and colder-than-expected areas;
- standardize mapping and generate reports that are menu-driven, readily understood and meaningful.

As we envisioned it, SCRAM would dramatically enhance police departments' analytical capabilities by building upon the spatial crime analysis system (SCAS) developed by the U.S. Department of Justice criminal division's GIS staff using ARCView GIS software. We would add sophisticated analytical algorithms developed on the Orange County, California Gang Incident Tracking System project (GITS) to SCAS and standardized output menus that would generate the kinds of crime incident reports that law enforcement agencies participating in the GITS project had found most useful. We thought that wedding form-scanning software to an improved SCAS would bring high-quality mapping and analysis within the reach of almost any law enforcement agency.

The benefits from a system such as SCRAM, we thought, would accrue at the local, regional, state and national levels. At the local level, police agencies, policy makers, community groups and citizens would be able to obtain more timely, accurate and detailed information about crime patterns. This would help police and the community understand crime-related problems and respond to them efficiently. At the regional, state and national levels, developing a standardized system through which law enforcement agencies across the country could generate detailed, mutually compatible reports on the spatial and temporal distribution of crime incidents was expected to facilitate cross-jurisdictional analyses. Even though almost every police agency in the country uses different forms for crime reporting, all of these forms collect essentially the same information. If forms-scanning software were used to input data from these forms, the result could be a commonly compatible database structure. For example, even though each department's forms locate data like victim name or home address or incident location in a different place, those data could be routed from the forms-scanning software to the same field in a database. Thus, although the form-scanning software addresses the most mundane aspect of a crime mapping and data analysis effort—data entry—it provides the foundation for the SCRAM concept.[1]

[1] The need for forms scanning software could, of course, be avoided by using a "paperless office" approach to crime reporting. If data for reports were entered directly into a computer, there would be no need to again input them by hand. However, since two-thirds of the local police agencies in the United States still rely heavily on paper forms (Reaves and Hart 2001: calculated from table 14a), we felt that a forms-scanning approach still was necessary.

3. EVALUATION OF FORMS-SCANNING SOFTWARE

RESEARCH GOALS AND KEY QUESTIONS

The forms-scanning software was evaluated according to the following criteria:

- **User-friendliness:** Is the time required for a person with basic database skills to learn to set up and successfully use TELEform similar to the time required for other PC-based database programs such as MS Access? Are the software's user interface and error-checking routines intuitive and reliable?
- **Stability:** Is the software stable and reliable when used in conjunction with a high-end desktop PC operating under Windows98 in conjunction with a document feeder-equipped scanner that meets the specifications of the software? Is it stable when used with MS Access, ARCView and SCAS?
- **Utility with Police Reports:** Can the software scan data directly from crime incident forms that have been filled out by hand?
- **Superiority to Manual Entry & Error Correction:** Are the speed, accuracy and reliability of input, character recognition, and error checking routines superior to manual data entry and error correction? Is the TrueAddress address verification and correction module useful, accurate and reliable?
- **Economy:** How cost effective is the software when compared with manual entry?

DESCRIPTION OF SOFTWARE

The basic task to be performed by the software evaluated in here was interpretation of information from police incident reports (e.g., case number, address, type of crime, suspect data, victim data and miscellaneous check-offs). Ideally, the software should make it possible to collect the same types of crime incident data from different places on various departments' native forms and then enter those data onto a standardized database.

TELEform V6.1 Elite software is well established and widely used by government, business and nonprofit organizations in the United States and abroad (see Appendix B). There does not appear to be a competing brand of forms-scanning software on the market that is as widely used, versatile or broadly capable. During the past two years, the number of users has increased from 15,000 to almost 20,000. Common applications for TELEform include scanning sales orders for mail-order companies, tracking medical records and billing, processing employment applications, and tabulating customer surveys as well as credit card and loan applications.

The software[2] claims to enable quick and efficient processing of information from existing paper forms (or fax transmissions) by using multiple recognition engines. Each of the three recognition engines examines the characters on a form and then makes a determination about which is correct using sophisticated algorithms and artificial intelligence routines.

Key TELEform features that are relevant for scanning in police forms include:

- Automatically identifying scanned forms without sorting and then correcting for skew, stretch and image distortion;
- The ability to read hand-print entries (IMR), machine print entries (OCR), mark sense recognition entries (OMR) and unconstrained hand print;
- The ability to perform cross totals, read circled response fields, checked boxes and bubbles;
- The availability of validation routines including dictionary look-ups, database comparisons, required entry fields, character-specific fields and custom mathematical checking;

[2] See Appendix A for a more detailed description of the software and how it functions.

- Verification features such as multi-mode corrections of characters, fields and forms; user-defined confidence levels and statistical performance reports; and
- Image enhancement features such as removal of form lines from scanned images, regeneration of broken characters, and other enhancement routines such as deskew/despeckle, half-tone removal and line thickening.

The TrueAddress module which is included with TELEform automatically compares address data with a comprehensive database developed by the U.S. Postal System that is updated quarterly and contains all known street addresses in the United States. This enables users to readily find and replace incorrect street names and numbers. This feature may be important because address checking is a time intensive aspect of GIS data entry. For example, in GITS a fairly large proportion of the forms received from police contained incomplete or incorrect address information. Experienced research assistants manually verifying and entering GITS data into MS Access often were able to enter only about 50 one-page forms per day because of the time required to verify each address against a local street atlas and correct apparent errors—a process that tended to take from three to 15 minutes. For example, an officer might have entered 1600 Pennsylvania Boulevard, Street, Court, Circle, or Place instead of Avenue. Although these errors sometimes could be corrected during data entry by referencing a street atlas, if a record was out of range—say, 16000 Pennsylvania Avenue when the street doesn't run that far—forms had to be returned to the police agency for correction.

Problems such as these are particularly difficult in regional data collection efforts. For example, a report of a drive-by shooting in Santa Ana may list an address on Indiana Street, which is out of range for that city but does exist on a different Indiana Street that is in Anaheim. If the software—which triangulates on addresses by street name, number, and zip code—is effective, it could save a substantial amount of time.

EVALUATIONS AND EXPERIMENTS

A series of experiments and evaluative exercises were conducted in order to test the ability of TELEform software to meet the success criteria described previously. The methods and results from each of the experiments and evaluation exercises is described below.

User Friendliness

Success criteria: The time required for a person with basic database skills to learn to set up and successfully use TELEform will be similar to the time required for other PC-based database programs such as MS Access. The software's user interface and error-checking routines are intuitive and reliable.

The PI attended TELEform 101 training, which is the basic three-day course designed to quickly teach new users of TELEform products how to build successful automated forms solutions. The course, which cost $1,295, was conducted at the Cardiff Software headquarters in San Marcos, California. The course was professionally conducted in a well-equipped computer lab and covered all of the information necessary to begin using TELEform software. A copy of the training agenda is provided on the following page.

The PI, who had never used TELEform before this training session, is familiar with—but far from expert with—databases. At the completion of the training program, the PI had reviewed all of the information in the user's manual in detail, and practiced with each of the modules described in Appendix A that are necessary for preparing forms for scanning, scanning and validating forms, and then exporting data to a database. Once the training was completed, the PI was able to immediately set up TELEform on a personal computer, scan in the forms presented in Appendix C, and prepare them for scanning. This portion of the training appeared to be effective.

TELEform 101 Training Agenda

Day One:

Lesson 1: Introduction to TELEform, TELEform installation

Lesson 2: Overview of TELEform

Exercise 1: Quick tour of the TELEform process

Lesson 3: Building your form: adding objects, adding and configuring data entry fields, form attributes and export routines, activating the form, when to use a given field type

Exercise 2: Create a contest registration form

Day Two:

Question and answer review

Lesson 4: Finalize contest registration form

Lesson 5: Print and fill out contest form

Lesson 6: Input form using Reader module

Lesson 7: Verify form using Verifier module, security issues, forwarding images, using TELEform notes

Exercise 3: Correct form

Lesson 8: Advanced TELEform Verifier techniques

Lesson 9: Using TELEform Stats

Lesson 10: Working with existing forms

Exercise 4: Finalize, scan and evaluate contest registration form

Day Three:

Question and answer review

Lesson 11: Advanced form design (SKFI, multi-page forms, etc.)

Lesson 12: Form optimization, managing images, using TELEform Stats

Exercise 5: Optimize a form

Lesson 13: Field optimization

Exercise 6: Optimize fields on scanned-in form

Lesson 14: Configuration options

Lesson 15: TELEform maintenance

TELEform's user interface and error-checking routines were intuitive to use because they followed standard Windows design, placement and functionality. The software also was reliable and did not hang or crash.

However, some of the more sophisticated features of the software may not be as easy to use or learn. A post-doctoral researcher with extensive experience in database development and set-up on person computers, and who also was competent in Avenue, the programming language for ARCview software, and Microsoft's Visual Basic, attended the TELEform 301 two-day training program entitled "Customizing with Basic Script." This course focused on concepts needed to use Basic Script effectively. Features covered included the TELEform object model, entry points and system/form/export scripts that can be used to enhance forms processing. Although the course description stated that it was designed for those with "familiarity with structured programming concepts and a basic understanding of the flow of data through TELEform," he found the Basic Script course to be quite complex and had difficulty using the language.

Stability

Success criteria: The software is stable and reliable when used in conjunction with a high-end desktop PC operating under Windows98 in conjunction with a document feeder-equipped scanner that meets the specifications of the software. It is stable when used with MS Access, ARCView and SCAS.

During the experiments described in the following section, 313 forms were scanned into TELEform Elite 6.1 using a Hewlett Packard SJ 6250Cxi scanner equipped with an automatic document feeder with a 200-page capacity. The scanner was connected to a Dell Dimension XPS desktop PC with a 500MHz Pentium III CPU (512K cache), 256MB of SDRAM, and a 22.6GB UltraATA hard drive operating on Windows98 second edition. A hardware key provided with the TELEform software was connected to the computer's LPT1 parallel port; the software will not function without this key and only one key is provided with each license. Output was directed to the GITS database (MS Access 2000), ARCView, SPSS, and Excel software packages as well as various ink-jet and laser printers. In all instances, the software was stable and reliable. No system hangs or crashes were experienced while using TELEform alone or in conjunction with any of these software packages.

Utility with Police Reports and Comparison to Manual Data Entry

Success criteria: The software can scan data directly from crime incident forms that have been hand-printed. The software's speed, accuracy and reliability of input, character recognition and error checking routines are superior to manual data entry and manual error correction. The TrueAddress address verification and correction module is useful, accurate, and reliable.

Testing data entry using TELEform: In order to evaluate the utility of the forms-scanning software and compare it with manual data entry, three report forms—each from a different police department—were used. Seventy-five percent size copies of the forms are included in Appendix C. In a process explained in more detail in Appendix A, the forms first were scanned to produce visual images, and then the TELEform form design module was used to locate data fields and specify their characteristics. Each field was configured according to the appropriate type of data and relevant recognition issues. Once the TELEform forms had been developed, six police officers—two from each of the departments from which the forms had been obtained—were asked to fill out the forms using hypothetical suspects and victims, and real address and penal code information. Each officer filled out approximately 50 forms. In keeping with standard TELEform procedure, sample forms for each department then were scanned through and analyzed using TELEform and the field sizes, data types and sensitivities were adjusted in order to optimize the software's ability to recognize each different form.

Once the TELEform software had been optimized, all of the forms for each department were scanned in and interpreted using a scanner equipped with a sheet feeder. Then the forms scanning, recognition, input and verification processes were completed and the data were exported to a standard database that had been developed for the GITS system. Throughput time for each of the forms was tracked using TELEform Stats.

As was described previously, TELEform software appeared to be very stable and worked well with the hardware components. It also routed data reliably to the appropriate fields in the GITS database, which was developed using Microsoft Access.

Testing manual data entry: The 313 forms from all three police departments then were given to six undergraduate research assistants, each of whom had extensive experience inputting data from police forms onto the GITS database. In order to facilitate manual data entry, a background template first was created using Microsoft Access 2000; this is the same procedure used to enter regular GITS data. This involved scanning in the original police form and superimposing the fields for database entry over the form image. This enabled students to have some reference to the form they were entering from and tab easily between fields as they entered the data.

Before the time trials, each data entry person was given forms to practice with. Approximately 10 forms were given initially. Data enterers who wanted more practice were given additional forms until they said they were comfortable with the location of the fields, and until their data entry times began to stabilize. The students then began the data entry process, and the start and end times for entering the data on each form were tracked in Microsoft Access.

Once the data from a form had been entered completely, the data entry person stopped and reviewed each of the fields to make sure they matched the original form. Once the error checking had been completed, the data were uploaded into the database and a total time for throughput was recorded.

Evaluating data-entry accuracy: Accuracy of the two methods was evaluated by comparing TELEform and manual data sets inside the database using a text character equivalence test. Non-matches were evaluated by the post-doctoral researcher managing this phase of the project. No significant errors (e.g., misspelled street or person names, inaccurate ID or address numbers, or type of crime or *modus operandi* information) were detected with either method. Manual data entry resulted in five missed check boxes from the Fountain Valley report form. TELEform resulted in three missed check boxes, two from the Fountain Valley form and one from the Anaheim form.

Data on the time it took for each report to be entered manually and using TELEform then were compiled for statistical analysis (see Appendix D for raw data). Results of these analyses are reported after a brief discussion of findings about the TrueAddress software's capabilities.

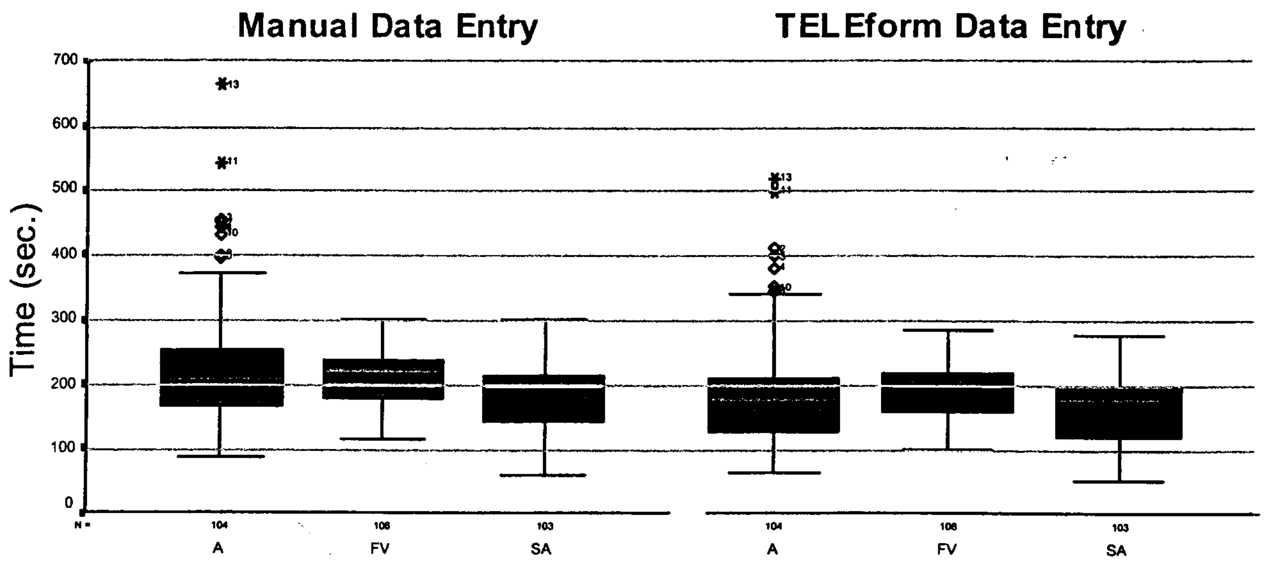
True Address capabilities: The TrueAddress module, which is included with TELEform, automatically compares address data with a comprehensive database developed by the U.S. Postal System, which is updated quarterly and contains all addresses in the United States. This enables users to readily find and replace incorrect street names and numbers. Initially, it was anticipated that this software feature would increase the efficiency associated with forms scanning and potentially could trim GIS-related data collection significantly. This was because one of the most fundamental problems faced by GIS users is ensuring the accuracy of address information. Unfortunately, although the TrueAddress software handles actual street addresses, it cannot handle intersections, which often are referenced as locations for crime incidents. As a consequence, we were not able to integrate the TrueAddress feature into the comparison of the forms scanning and manual data entry process. Thus, the analyses that follow may underestimate the full potential of TELEform software. A test run of the TrueAddress feature on 20 of the report forms that contained full street addresses showed that the software appears to work as advertised. When address confirmation is required in the TELEform verifier module, the form that has been opened for correction first goes through the standard character mode and field mode correction and then to True Address.

Data analysis: The primary question when comparing the speed of manual data entry with TELEform data entry is: Which tends to be faster, and by how much? A more subtle question is whether one method is superior for some sorts of problems. There was a consistent pattern of results when manual data entry was compared to TELEform data entry for each of the three different types of report forms—the same forms that were more challenging for data entry personnel also tended to take more time for TELEform. But TELEform was almost always faster. Table 1 below provides summary results for the tests. Figure 1 uses box-and-whisker plots to compare summary data for the two data entry methods. In these types of plots, the box represents the interquartile range, which contains 50 percent of all values. The whiskers are lines that extend from the box to the highest and lowest values, excluding outliers. The line across the box indicates the median. (See Appendix D for raw data). As table 1 and figure 1 show, TELEform data entry tended to be 12.8 percent faster on average than manual data entry. And it was faster for all but five of the 313 report forms that were entered.

TABLE 1 Comparison of Data Entry Throughput for Manual Data Entry and TELEform Data Entry for Three Types of Police Report Forms (N=313)

	Time (seconds)
Mean manual data entry time	204.2
Mean TELEform data entry time	178.1
Difference between means	26.1
TELEform average percent faster	*12.8%*
TELEform maximum seconds faster	143
TELEform maximum seconds slower	28
TELEform speed difference range	171
Number of times TELEform faster	308
Number of times TELEform slower	5
% time TELEform faster	*98.4%*

FIGURE 1 Box-and-Whiskers Plots Comparing Summary Information for Manual and TELEform Data Entry



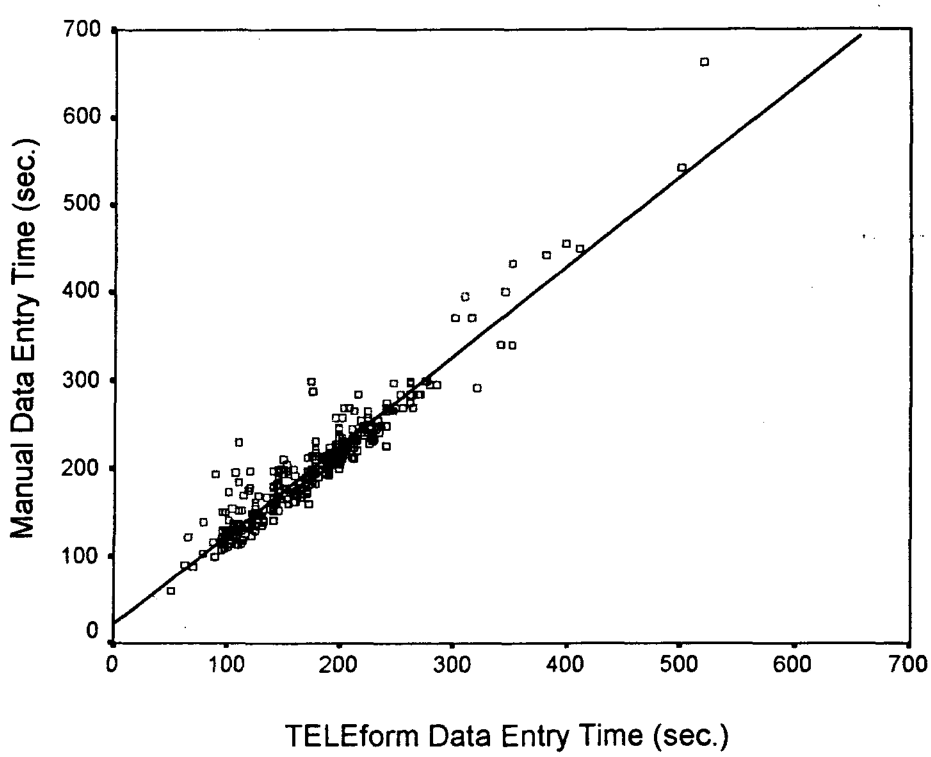
Paired-samples t-test: The paired-samples t-test is a statistical procedure used to compare the means of two variables (in this case, manual and TELEform data entry) for a single group (the report forms used in the experiment). This test tells us whether the means of the two different modes for entering are significantly different. A high correlation would indicate a strong linear relationship between the two data entry modes. This is germane to the question of whether there were some sorts of data entry problems for which manual data entry was superior and others for which TELEform was superior. As table 2 below shows, the means of the data entry trials were highly correlated and the probability that the correlations occurred by chance alone was exceedingly small ($p < .001$). This result applied for each of the different forms and for the aggregate data as well.

TABLE 2 Paired-Samples t-Tests for Manual and TELEform Data Entry on Three Different Types of Police Report Forms (* $p < .001$)**

	Anaheim Form (N=104)		Fountain Valley Form (N=106)		Santa Ana Form (N=103)	
	Manual	TELEform	Manual	TELEform	Manual	TELEform
Paired-Samples:						
Mean entry time (sec.)	223.21	186.02	206.44	187.76	182.72	160.17
Std. deviation	94.02	86.74	46.94	46.25	47.96	46.31
Correlation	.946***		.980***		.970***	
Paired-Differences Test:						
Mean	37.19		18.67		22.54	
Std. deviation	30.51		9.44		11.57	
Lower 95% confidence interval	31.26		16.87		20.28	
Upper 95% confidence interval	43.13		20.51		24.80	
t-value	12.43***		20.37***		19.78***	
df (2-tailed)	103		105		102	

A graphic approach may make it easier to understand the relationships described by the paired-samples t-test intuitively. Figure 2 below plots the times for entering each police report form manually against the TELEform times. The closeness of almost all of the 313 cases to the linear regression line (95 percent prediction interval, $R^2 = .9055$) demonstrates that both data entry techniques tend to have difficulty with the same sorts of cases. Note that the regression line would divide the plot area evenly—running from the x-y intercept to the upper right-hand corner of the area—if the two data entry methods were equally efficient. The fact that it runs somewhat above this hypothetical divide shows that the TELEform data entry method is somewhat faster. Given that the characteristics of the three different police report forms used for this analysis seem representative of most police incident report forms, it is likely that TELEform would function better than manual data entry on most police agency's native forms.

FIGURE 2 Scatterplot of Manual Data Entry Time as a Function of TELEform Data Entry Time for the Same Report Forms (all departments, N=313)



Forms-Scanning Cost Effectiveness

Success criteria: The software is cost effective when compared with manual data entry.

On average, TELEform data entry times were 12.8 percent faster than manual entry times for the same police report forms. And TELEform was faster 98.4 percent of the time. It also appeared to be reliable for use with a desk-top PC system and reasonably easy to learn to use. This suggests that it would be cost effective for a police agency that depended on paper report forms to use this kind of forms-scanning software if the following conditions were met:

- It had sufficient volume of paper forms to be entered to warrant training two or more clerks to use TELEform and starting up the system at regular intervals;
- Properly-trained clerical personnel find forms-scanning data entry less onerous than manual data entry; and
- The annual costs of hardware, software, and training multiplied by the increase in data entry productivity was less than the annual costs of entering the forms manually.

In order to explore cost-benefit issues, the PI constructed a spreadsheet model in MS Excel that made it easy to evaluate cost effectiveness under different workload, wage, price, amortization, workload and efficiency regimes. The spreadsheet model is provided in electric form along with the data file for this project[3]. It's parameters may be modified readily to obtain a custom cost-effectiveness evaluation for any department. The example provided in the following inset illustrates the results of such a cost-benefit analysis using hypothetical parameters. Hypothetical values are used because there is wide variation in personnel salaries and benefits among different police jurisdictions, and because the costs of computers and peripherals such as printers and scanners continue to decline steadily while their performance and capabilities grow.

[3] Appendix E shows the equations used to operationalize the model.

The educational-institution price for TELEform software purchased for this evaluation, which did not appear to differ substantially from the usual institutional-user license, is used because the price that can be negotiated for the software, training and technical support vary substantially depending on volume.

Base assumptions:

Initial TELEform software/training/technical support cost = $6,499
Forms scanning will be used for (amortized over) at least 5 years
Subsequent software upgrades/training/support cost = $1,000/year
PC with appropriate hardware and software cost = $1,200/year[4]
Clerical personnel salary plus fringe benefits cost = $24,000/year[5]
TELEform average speed = 178 seconds/form
Manual data entry average speed = 204 seconds/form

Forms-scanning software could be cost effective if the average number of forms to be processed exceeded:

24,230 per year
2,019 per month
67 per day

If forms-scanning software was used for(amortized over) only 3 years, it could be cost effective if the average number of forms to be processed exceeded:

30,229 per year
2,519 per month
83 per day

[4] This assumes a base cost of $3,600 and a functional life of three years. Maintenance and technical support costs are not accounted for here—nor are the benefits of using the platform for other purposes when forms are not being scanned. Also ignored is the fact that manual data entry also requires some sort of computer input device.

[5] This assumes 200 data-entry work days per year maximum to allow for training, vacation, administration, etc. and no more than 45 minutes per work hour of actual data-entry time in order to avoid repetitive stress injuries. Agencies with a high volume of reports would need to hire additional data-entry personnel when they exceeded the daily data -entry limit. Using the experimental average data-entry rates of 178 seconds per form for TELEform and 204 seconds per form for manual data entry, an extra person would have to be hired if more than 44,201 forms per year or 121 forms per day needed entry using TELEform, or if more than 38,568 forms per year or 105 forms per day needed entry using manual techniques similar to those described in the experiments.

As the above inset shows, TELEform does appear to present a potentially cost-effective method for entering data from paper police report forms into a computerized database. Whether TELEform actually is cost effective for a specific organization is primarily a function of negotiated price for the TELEform software, local overhead costs for the platform on which it is run, average number of forms processed, and how long the software will be used. This last issue must be taken into account because it affects amortization of initial purchase costs. For example, a department that anticipated moving into a paperless reporting environment within the next two years likely would not find that the benefits of using TELEform outweighed the cost of the initial investment. But the cost-benefit ratio might favor using forms-scanning if the software was going to be used for four or more years.

4. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes project findings regarding the feasibility and utility of forms-scanning software for streamlining the entry of crime data into computerized databases.

CONCLUSIONS

TELEform software is as user friendly as widely-used PC-based database programs and the learning curve for TELEform operators and reviewers is similar to that for such programs. Both the user interface and error-checking routines are intuitive. Any reasonably computer literate person probably could learn to use TELEform's features by attending the TELEform 101 course. However, more complex TELEform programming tasks using Basic Script may be beyond the capabilities of those who do not have substantial experience programming databases.

The software appears to be stable and reliable when used in conjunction with what presently is considered a moderately powerful PC operating under Windows98 in conjunction with a scanner equipped with a document feeder. TELEform also was stable when used with the Microsoft Office software suite, ARCView, SPSS and SCAS—all of which commonly are used for crime analysis and mapping as well as reporting.

Once the forms design process had been completed for existing paper police report forms, TELEform was able to scan data directly from batches of forms on which police officers had hand printed entries in various types of frequently-used data-entry fields. Forms that took longer for manual data entry because, for example, they contained more information or had been filled out more sloppily also tended to take longer for TELEform to input. In fact, the data throughput times on individual forms for the two methods were very highly correlated ($R^2 = .9055$). But the forms-scanning software was nearly 13 percent faster than manual data entry and error checking. This result held for each of the three different types of incident report forms used in the evaluation experiment—and TELEform was faster on more than 98 percent of all forms that were used in the experiment. Both methods for entering and verifying data entry appeared to be highly accurate. The TrueAddress address verification and correction module appeared to be accurate and reliable, but its utility was limited by the fact that it could not check intersection-based locators that often are used in police reports.

Whether TELEform is a cost-effective method for entering data from paper police report forms into a computerized database is primarily a function of what price is negotiated for the software, how long the software will be used, local overhead costs for the platform on which TELEform is run, and the average number of forms processed annually. When this issue was explored using a spreadsheet model, it appeared that the software could be cost-effective for departments that processed more than 70 forms per day on average and would use TELEform for five or more years.

RECOMMENDATIONS

Despite the utility and potential cost-effectiveness of using TELEform software for scanning in information received on paper forms or via fax from a wide variety of sources, it may not be the *best* solution to the problems faced by most policing organizations. Unlike many of the insurance companies, hospitals, and government organizations which use TELEform to process forms that have been filled out by members of the public or business organizations and then transmitted back to them, police reports usually have been filled out by police officers or employees. This means that police agencies have a technological option open to them that is likely to be even easier and more cost effective than forms scanning: entering the data directly into electronic form.

Instead of having officers fill out a standardized paper form in the field and then either bring it back to the station to have it entered in some manner into a computerized database, the data could be entered directly in the first place. A number of alternatives for accomplishing this are being used or tested in departments around the United States. According to the 1999 LEMAS report, 34 percent of local police agencies with more than 100 officers report using computers to complete police reports in the field (Reaves and Hart 2001: computed from table 14a). In some departments, officers fill out report forms on the mobile data terminals in their patrol cars. Other departments have issued laptop computers to officers which they can take, for example, into a house when filling out a burglary or theft report. Newer technologies such as personal data assistants (PDAs) also offer streamlined opportunities for data input. For example, a Palm Pilot or similar instrument could be programmed with a decision-tree structure that leads an officer through the reporting process and collects data in check-off boxes or brief, hand-entered fields. When the officer returns to the station or to a patrol car, the PDA then could be put in a cradle and the data uploaded automatically into one or more databases. Direct data entry methods such as these also probably could include error-checking functions such as True Address—perhaps even with the ability to verify intersection locator information using a dictionary created using ARCView or other similar GIS software.

However, police agencies that are unready or unable to convert to a paperless reporting environment for at least the next three to five years may want to consider forms scanning as a way to streamline data entry for crime analysis and mapping so long as they generate enough forms per year to make it cost effective. In fact, the process of adopting forms-scanning software and integrating the flow of information from TELEform into a database that is useful for crime analysis and mapping might be used as an intermediate step toward a long-term goal of developing a paperless reporting environment. The process of developing and refining both the core database and the error-checking criteria for each field into which data would be exported from the forms-scanning software would resolve many of the same issues for direct data entry.

At a local level, streamlining data collection in police agencies could be cost effective in its own right. It also could make crime mapping and analysis available to more agencies if streamlined data entry were wedded to a standardized policing database that, in turn, was linked to a well-designed reporting and mapping front end such as the Department of Justice's SCAS. The timeliness—and therefore tactical utility—of analyses also could be improved by streamlining the process and making more powerful analyses available. Making the data police collect more useful and readily available could multiply the productivity of police officers and thus help communities get more return from their policing dollars.

From an analytical standpoint, an additional bonus of increasing the utility of crime data is that officers putting information into the system are likely to be more conscientious and thorough if the information is useful to them personally. Official police data are the foundation for much of what we know, or think we know, about crime. Thus, improving the utility of official police data for the people who collect it in the field also can improve the accuracy and completeness of the data—and the knowledge we draw from them.

If a standardized policing database were widely adopted, it would be much easier for agencies to share and analyze data because database incompatibilities would be minimized. This means that regional, state, and national data collection and analysis also could become less cumbersome.

Given the potential benefits to be gained from streamlining the collection and analysis of crime data, it appears worthwhile for the U.S. Department of Justice to assist local agencies and encourage them to improve how they collect, process, store and analyze crime data. Based on the PI's experience as a police officer and manager as well as a researcher, it seems that progress in this area is being impeded by a lack of technical expertise and a lack of standardization. Hardware itself is no longer the limiting factor because inexpensive desktop PCs have become powerful enough to handle most departments' data analysis and processing needs. All police agencies collect much the same sorts of information about crimes, victims and perpetrators. DOJ could help make those data much more useful at the local, regional, and national levels by:

- Supporting development of a standard policing database that could manage these data efficiently on a PC;
- Making the database available at a reasonable cost and helping to keep it up to date; and
- Providing technical assistance to departments that wanted to adopt the database in order to help them integrate the new system with existing management information systems.

Force-multiplier initiatives such as this that can improve police productivity are especially important right now because police agencies across the United States are struggling with understaffing problems. Demands for police services have increased steadily during the past two decades—partly in response to community policing initiatives. And now, a combination of demographics and a strong economy are making it harder and harder for police departments to hire and retain qualified people. Many departments anticipate losing 20 percent or more of their baby boomer officers to retirement in the next few years and most departments have unfilled vacancies. The potential force-multiplier effects of streamlining crime data entry and increasing the availability of crime mapping and analysis present an important opportunity that should be exploited vigorously.

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APPENDIX A: How TELEform Forms-Scanning Software Operates[6]

TELEFORM MODULES

TELEform Elite consists of three separate program modules: TELEform Designer, Reader and Verifier. Each serves a distinct function.

TELEform Designer can be used to create and edit forms, scan and configure existing forms, set form attributes and export options, schedule forms for delivery, define data validation options, import and export forms, print and fax forms, write scripts and access the TELEform phone book.

TELEform Reader receives and interprets incoming faxes, scanned images and electronic form data. If Reader finds illegible entries or mismarked data on the form, the form is marked for review and passed along to TELEform Verifier for operator review.

Forms that were marked for review during interpretation are manually checked for mismarked or illegible entries in TELEform Verifier. After confirming and/or correcting the interpreted data, the form is saved and the data are stored or exported.

COLLECTING DATA FROM FORMS

TELEform attempts to minimize the amount of human intervention required to collect data from forms and input those data into a database. The degree to which data collection may be automated is a function of 1) the physical layout of the form and fields; and 2) how the objects and data entry fields on each form page have been configured and the recognition options chosen

[6] The following discussion is drawn from Chapter 3 of the *TELEform Elite User Guide* (Cardiff Software, Inc. 1998:1-25).

within the software. Thus, TELEform provides each data entry field on a form with a set of instructions about how data within the field are to be processed, evaluated and exported.

TELEform Elite processed data from forms in several steps: form design, form processing, data verification and data storage. Each of the steps in this process is discussed below.

Form Design

The TELEform Designer module is used to create and maintain form templates. These templates may be created from scratch, as in the case of a new form, or developed using existing forms. The research reported here focused primarily on the latter application because it was focused on ways to handle extant unique police report forms. However, this evaluation should constitute a conservative test of the software's capabilities because it tends to be more difficult to collect hand-entered data from existing forms which often fail to provide optimal spacing between fields or make use of the ideal type of format to collect a particular form of data.

In order to prepare an existing form for processing with TELEform, the form first is scanned into Designer and then appropriate types of fields are overlaid onto the form. The form's horizontal and vertical lines, along with bitmaps and text blocks, are used to help locate fields on the form. In some instances, it is possible to use unique text on a page to create a form ID. The use of form IDs makes it possible to scan mixed batches of forms because it enables TELEform to select the appropriate template from a set that have been constructed previously.

TELEform uses more than a dozen different types of form-design objects, many of which can be customized to create even more specialized objects. Some of those objects are data entry fields that can store and receive data, while others are shapes that enable one to create lines, borders and circles to improve the appearance of forms. Different data entry fields handle different types of data input more efficiently. For example, date fields provide fewer interpretive possibilities for handwriting recognition software than print fields because they contain only numeric data. Similarly, bubble-, blank underline- or box-style fields also constrain choices—as do response-style (circle-the-answer) choice fields.

As new data fields are constructed for a form, attributes are defined for each field. As with most databases, many field attributes are quite basic. These include field name, length and data type (e.g., alphabetic, numeric or alphanumeric). Other, more complex, field attributes specify verification options or which field validations are to be performed on data collected from a field when its data are evaluated.

In addition to individual field attributes, TELEform also allows form attributes to be set that affect how the entire form is processed. Among these form attributes are automatic export settings that specify where data are to be sent once a form has been interpreted and verified. More than one export setting can be used in cases where data from different fields need to be sent to different databases (e.g., to a gang incident database and to a reported crime database). If a primary auto export is not set up, then TELEform automatically stores the data in an internal data file. Internally stored data can be exported manually at a later time. And all exports can be done in a wide range of popular database formats.

Form Processing

Form processing includes events that affect a form's image and the data that are extracted from that image. In brief, once a user has filled out a form and submitted it for automated data entry, the form is scanned,[7] then evaluated by the Reader module. Unless the verification step is bypassed—for example if data precision was not important—the form content then is held in a

[7] Forms also can be submitted via fax, but that input mode seems less likely to be useful for most police departments or policing applications. In any event, the basic process is the same for both scanned and faxed forms.

temporary file for review and processing with the Verifier module. Data then flow to the internal data file and/or specified databases.

The processing phase involves a number of custom TELEform features once a paper form has been converted to an image file by a scanner or fax and sent to the Reader module for processing. These include:

- **Image preprocessing** to correct skewing that may have occurred during scanning/faxing and to remove noise, fax headers and other unwanted marks from the form. These features are set using the Designer or Reader modules' preprocessing options.
- **Form identification** using TELEform's patented technologies which match fields or other features on the form template image.
- **Data extraction** is accomplished using TELEform's Tri-CR recognition engine which, according to the vendor, "combines the interpretation results of several recognition engines and applies complex algorithms and artificial intelligence routines to determine which result is the most accurate" (Cardiff 1998:A-8). Other recognition aids include dictionaries and context checking that attempts to distinguish between easily confused characters (e.g., zero, "O" and "D" or "1" and "I") in alphanumeric fields by analyzing the surrounding characters.
- **Field validation** routines check each field to determine if the data match validation settings specified on the form template. Data that don't match the specifications then are either changed to pass validation or held for manual review depending upon field settings.

TrueAddress™ is another recognition aid that bears separate discussion because of its relevance for GIS-related data entry and analysis. TrueAddress™ is a comprehensive database of all valid addresses in the United States which operates like an "address dictionary" to increase the accuracy of fields containing address information. Address fields that have been defined as address groups are automatically compared to the TrueAddress database for accuracy during evaluation by the Reader module. The TrueAddress database comes on a separate CD from the TELEform Elite software with a free 60-day trial. Annual subscriptions include quarterly updates.

Data Verification

Forms that have been evaluated by the Reader module as requiring manual verification are stored in a temporary file. The Verifier module, which tracks the status and date and time received for each of these files, then is used to view and manually correct those forms. Before data from any of these temporary files can be exported or stored in a permanent database, the file first must be opened and manually corrected. Verifier enables the person doing the review to proceed from one problematic character or field to the next in an intuitive manner. If corrections are required, the reviewer can enter a new character for a field. If the field character is correct, the reviewer can tab directly to the next problem field.

The verification process proceeds through four sequential modes:

1. **Character mode** correction presents the reviewer with a window containing all of the uncertain characters detected on the form being corrected. A "best guess" option can be used to allow the reviewer to quickly review, confirm, correct or bypass each character. Any characters that are not corrected in the Character mode pass along to the Field mode.
2. **Field Mode** correction automatically follows Character mode if any problematic characters remain in the form. In this mode, the characters can be seen in the context of their field so that the reviewer can, for example distinguish between a zero and an "O" or

an "I" and a "1". Fields that have not been completely cleared of problematic characters—or those that are designated as "always review" fields are viewed in the final Form verification mode.

3. **Selective Key From Image (SKFI) mode** enables the reviewer to manually enter data from any SKFI zones[8] that were set on the form into fields displayed at the bottom of the Verifier window. (Reviewers also have the option of bypassing this mode and entering SKFI data during the final Form correction mode.)
4. **Form correction mode** is entered automatically after the previous correction levels have been completed. This gives the reviewer a final opportunity to view the entire form and make any corrections that may be necessary. Once Form mode is completed, the reviewer is prompted to save the corrections so that the data can be exported.

Data Storage

Once a form has been evaluated and corrected, its data are exported automatically in accord with specifications set when the form was designed. If there is a database export error, the data are stored automatically in TELEform's internal database so that they can be exported manually at a later time. Unless manually removed during forms design, the TELEform export file for each form includes data fields that track when the form was evaluated, its source and other detailed data about its processing.

Predefined Virtual Fields

In addition to the data that physically exist on a form, TELEform makes available for export a variety of predefined virtual fields that track the time the form was evaluated, the name/fax number from where it was sent and a lot of other detailed information about the form's

[8] SKFI zones are useful for capturing data from free-form dialogue boxes, narrative boxes, or other areas of a form where several lines of text have been hand written without constraint.

processing. These fields are part of a form's data, but are not seen on the form. They are automatically included in the default export list unless manually removed.

Data from TELEform may be exported to a wide variety of popular formats such as comma-separated (CSV) and delimited or Open Database Connectivity (ODBC) and many others that can be used readily by PC and mainframe database programs.

APPENDIX B: PARTIAL LIST OF MAJOR TELEFORM USERS

Cardiff Software

1782 La Costa Meadows Drive
San Marcos, CA 92069
Tel: 800•659•8755 Fax: 760•752•5222
E-mail: Loakes@cardiffsw.com
http://www.cardiffsw.com/~cardiff

August 12, 1998

Bryan Vila
University of Wyoming
Administration of Justice Program
Arts & Sciences
Laramie, WY 82071-3197

Dear Bryan,

As discussed, please find below a sampling of companies who are successfully using TELEform. With over 15,000 installations of the software this is really a short list of companies.

American Express
CitiCorp
Mayo Clinic
Phoenix Fire Department
GMAC
State of Montana, Department of Revenue
Olsten Temporary Services
United Way
American Red Cross
L'Oreal
Tupperware
Sears
Bank of America
PageNet
Walt Disney World
Honeybaked Ham
Pfizer
US Office of Personnel Management
Army & Air Force Exchange Service
University of Wyoming
University of Oregon
University of Las Vegas
Most US Universities

Please do not hesitate to call me if I can be of further assistance.

Best regards,

Lisa Marie Oakes
Regional Account Manager

APPENDIX C: Police Forms Used in Experimental Comparisons

The police report forms used in this test were drawn from three police departments in Orange County, California: Anaheim Police Department, Fountain Valley Police Department and Santa Ana Police Department. Output images from each of the scanned-in forms is provided on the next three pages. Full-sized images were used for the experiment but those on the following pages are 75 percent of the original so that they will fit in this report.

Anaheim Police Department Standard Incident Report (75 percent size)

DR # ____________ PAGE 2 of ________ PAGES

SUSPECT INFORMATION

HAIR LENGTH/TYPE 8	HAIR STYLE 9	FACIAL HAIR 10	COMPLEXION 11	APPEARANCE 12	DEMEANOR 13	SPEECH 14
1 SUSPECT 2	1 SUSPECT 2	1 SUSPECT 2	1 SUSPECT 2	1 SUSPECT 2	1 SUSPECT 2	1 SUSPECT 2
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Bald	Afro/Nat	Clean Shave	Light	Dirty	Angry	Accent
Receding	Braided	Fuzz	Medium	Disguised	Apologetic	Lisps
Short	Bushy	Mustache	Dark	Flashy	Calm	Loud
Neck	Crewcut	#	Freckled	Military	Disorganized	Mumbles
Collar	Greasy	Goatee	Tanned	Unkempt	Irrational	Quiet
Shoulder	Recruit	#	Other	Unusual Odor	Nervous	Rapid
Long	Ponytail	Lower Lip		Well Groomed	Polite	Slow
	Processed	Beard	Acne	Other	Professional	Stutters
Coarse	Straight	#	Pocked		Stupor	Other
Fine	Wavy/Curly	Sideburns	Ruddy	Cap/Hat	Violent	
Thick	Wig	#	Clear	Glasses	Obscene/ Profane	
Thinning	Part #	Unshaven	Other	Gloves	Talkative	
Wiry	Other	Other		Mask	Other	
Other				Other		

MO INFORMATION

PREMISES 15

BUSINESS
- Bank/Sav Loan
- Bar
- Cleaners
- Const. Site
- Entertainment
- Fast Foods
- Gas Station
- Hotel/Motel
- Dept/Dis Store
- Drug Store
- Gun/Sport Goods
- Jewelry Store
- Liquor Store
- Photo Stand
- Quick Stop Market
- Restaurant
- Supermarket
- TV/Radio/Appl Store

BUILDING
- Church
- General Office
- Medical/Dental
- School
- Warehouse

RESIDENCE
- Apartment
- Camper
- Carport
- Condo
- Garage
- House
- Mobile Home
- Trailer

OTHER
- Alley
- Coin Op Machine
- Parking Lot
- Sidewalk
- Storage Lot
- Street
- ______

CONDITION
- Inhabited
- Occupied
- Unoccupied
- Vacant

VICTIM VEHICLE DESCRIP

Year ______
Make ______
Model ______
Color/Color ______
Lic. ______
State ______
Add'l info (Damage, Etc.)

METHOD OF ENTRY 16

DOOR
- Knob Twist
- Kicked In
- Open/Unlocked
- Pried
- Other ______

DOOR TYPE
- Delivery
- Garage
- Glass
- Pet
- Regular
- Sliding
- Other ______

WINDOW
- Broke
- Cut
- Open/Unlocked
- Pried
- Removed
- Taped/Broke
- Other ______

SCREEN
- Cut
- Pried
- Removed
- Other ______

LOCK
- Broke
- Cut
- Forced
- Forced Hasp
- Pried
- Removed
- Other ______
- Remain on Premises
- Tunneled
- Other ______

POINT OF ENTRY
- Adjacent Premises
- Balcony
- Floor
- Front
- Rear
- Side
- Interior Hall
- Roof
- Wall
- Unknown
- Other ______

VEHICLE ENTRY
- Door/Locked Force
- Trunk Forced
- Window Broken
- Window Forced
- Window Open
- Unlocked
- Unknown
- Other ______

WEAPONS/TOOLS 17

1 GUNS/WEAPONS 2
- Blue Steel
- Nickel/Chrome
- Automatic
- Revolver
- 2"
- 4"
- 6"
- ______ Caliber
- Poss. Toy
- Rifle
- Shot Gun
- Sawed Off
- Rusty/Defective
- Simulated
- Bodily Force
- Chemical/Poison
- Club
- Explosive
- Intimidation
- Knife
- Threats
- Other ______

TOOLS
- Axe
- Bar
- Bodily Force
- Bolt Cutter
- Drill
- Explosive
- Hammer
- Pipe
- Rock/Block
- Saw
- Vice Grips
- Wire
- Other ______

BURGLARY ONLY 18

Is Member of Operation Ident. ☐ Yes ☐ No
Request Inspection by P.D. ☐ Yes ☐ No
Had Home Business Inpection ☐ Yes ☐ No
When? ______

VICTIM INJURED 19
- Taken to Hospital
Name ______
- Taken to Doctor
Name ______
- Taken Home
- Coroner
- Refused Aid
- Other ______

Extent of Injuries:

TRADEMARKS 20

SUSPECT ACTIONS
- Changed Window Cover
- Arson/Attempt
- Ate/Drank on Premises
- Attempt to Purchase
- Brings Own Container
- Cat Burglary
- Cut/Dis Phone
- Demanded $ in Safe
- Forced Way into Vehicle
- Had Gun
- Hid in Building
- Hid in Rear Seat
- Jumped Counter
- Malicious Act
- Pick Pocket
- Prepared Exit
- Pretended to be ______
- Purse Snatch
- Ransacked
- Selective in Loot
- Shoplift
- Shots Fired by ______
- Smoked on Premises
- Threaten to Kill
- Threaten Vict Family
- Took Vict Vehicle
- Took Loot in Vict's ______
- Turned Lights Out/On
- Used Driver
- Used Lookout
- Used Matches/Candles
- Used/Left Note
- Used Toilet
- Other ______

VICTIM WAS
- Blindfolded
- Bound
- Choked
- Cut/Stabbed
- Forced into Vehicle
- Gagged
- Kidnapped
- Searched
- Struck with ______
- Other ______

VICTIM FORCED TO
- Disrobe
- Enter Cooler
- Enter Restroom
- Enter Vehicle
- Lie on Floor
- Open Register
- Open Safe
- Rear of Building
- Other ______

GUN CARRIED IN
- Bag
- Briefcase
- Newspaper
- Pocket
- Shoulder Holster
- Waistband
- Other ______

SUSPECTS TOOK
- Auto Accessories
- Auto Parts

ALARMS 21
- None
- Tripped
- Bypassed
- Defeated
- Silent
- Audible

SEX CRIMES ONLY 22

SUSPECT ACTIONS
- Suspect Climaxed
- Suspect Masturbated
- Unknown if Climaxed
- Victim Bound/Tied
- Other ______
- Child Molest
- Child Annoying
- Lewd Conduct
- Indecent Exposure
- Assault With Intent to Commit Rape
- Other ______

SUSPECT COMMITTED
- Rape
- Oral Copulation
- Sodomy
- Sexual Battery (Foreign Object)
- Unlawful Intercourse (Juvenile Only)

SUMMARY/ UNIDENTIFIABLE PROP.

ITEM	QTY	ARTICLE NAME	MISCELLANEOUS DESCRIPTION	VALUE $

Fountain Valley Police Department Standard Incident Report (75 percent size)

PREMISES

BUSINESS Q3
- [] 1 BANK/SAV. LOAN FINANCE/CRED UNION
- [] 2 BAR
- [] 3 CLEANERS/LAUNDRY
- [] 4 CONSTRUCTION SITE
- [] 5 THEATER
- [] 6 FAST FOODS
- [] 7 GAS STATION
- [] 8 HOTEL/MOTEL
- [] 9 DEPT/DISC STORE
- [] 10 DRUG/PHARM STORE
- [] 11 GUN/SPORT STORE
- [] 12 JEWELRY STORE
- [] 13 LIQUOR STORE
- [] 14 PHOTO STAND
- [] 15 CONVENIENCE STORE
- [] 16 TIRE STORE
- [] 17 RESTAURANT
- [] 18 SUPERMARKET
- [] 19 VIDEO/TV/RADIO
- [] 20 AUTO PARTS
- [] 21 BICYCLE SALES
- [] 22 CLOTHING STORE
- [] 23 HARDWARE
- [] 24 MEDICAL
- [] 25 OFFICE BUILDING
- [] 26 SHOE STORE
- [] 27 WAREHOUSE
- [] 28 ENTERTAINMENT
- [] 29 STORAGE FACILITY
- [] 30 OTHER:

RESIDENCE
- [] 31 APARTMENT
- [] 32 CONDO/TOWNHOUSE
- [] 33 DUPLEX/FOURPLEX
- [] 34 GARAGE ATTACHED
- [] 35 GARAGE DETACHED
- [] 36 HOUSE
- [] 37 MOBILE HOME
- [] 38 RETIREMENT HOME
- [] 39 OTHER:

PUBLIC
- [] 40 CHURCH
- [] 41 HOSPITAL
- [] 42 PARK/PLAYGROUND
- [] 43 PUBLIC BUILDING
- [] 44 SCHOOL
- [] 45 SHOPPING CENTER
- [] 46 STREET/HWY/FWY
- [] 47 OTHER:

VEHICLE
- [] 48 PASSENGER CAR
- [] 49 MOTORCYCLE/MOPED
- [] 50 PICKUP TRUCK
- [] 51 TRAILER
- [] 52 TRUCK
- [] 53 VAN
- [] 54 CAMPER
- [] 55 MOTOR HOME
- [] 56 OTHER:

POINT OF ENTRY

Q4
- [] 0 UNKNOWN/NA
- [] 1 FRONT
- [] 2 REAR
- [] 3 SIDE
- [] 4 NORTH
- [] 5 SOUTH
- [] 6 EAST
- [] 7 WEST
- [] 8 WINDOW
- [] 9 DOOR
- [] 10 SLIDING GLASS DOOR
- [] 11 BASEMENT
- [] 12 ROOF
- [] 13 FLOOR
- [] 14 WALL
- [] 15 DUCT/VENT
- [] 16 GARAGE
- [] 17 ADJ. BUILDING
- [] 18 GROUND LEVEL
- [] 19 UPPER LEVEL
- [] 20 OTHER:

METHOD OF ENTRY

Q5
- [] 0 UNKNOWN/NA
- [] 1 NO FORCE USED
- [] 2 ATTEMPT ONLY
- [] 3 BODILY FORCE
- [] 4 BOLT CUT/PLIERS
- [] 5 CHAN LOCK/PLIERS WRENCH/VICE GRIPS
- [] 6 SAW/DRILL/BURN
- [] 7 SCREWDRIVER
- [] 8 TIRE IRON
- [] 9 UNK. PRY BAR
- [] 10 COAT HANGER/WIRE SLIM JIM
- [] 11 KEY SLIP/SHIM
- [] 12 PUNCH
- [] 13 REMOVE LOUVERS
- [] 14 WINDOW SMASH
- [] 15 BRICK/ROCK
- [] 16 HID IN BUILDING
- [] 17 LOCK BOX
- [] 18 UNLOCK DOOR/WINDOW
- [] 19 OTHER:

VEHICLE ENTRY

Q6
- [] 0 UNKNOWN/NA
- [] 1 DOOR/LOCK FORCED
- [] 2 CONV/T-TOP FORCED
- [] 3 TRUNK FORCED
- [] 4 WINDOW BROKEN
- [] 5 WINDOW FORCED
- [] 6 WINDOW OPEN
- [] 7 UNLOCKED
- [] 8 OTHER:

PROP. ATTACKED

Q7
- [] 0 UNKNOWN/NA
- [] 1 CASH/NOTES
- [] 2 JEWELRY/METALS
- [] 3 CLOTHING/FURS
- [] 4 OFFICE EQUIPMENT
- [] 5 TV/CAMERA/STEREO
- [] 6 FIREARMS
- [] 7 HOUSEHOLD GOODS
- [] 8 CONSUMABLE GOODS
- [] 9 LIVESTOCK
- [] 10 MISCELLANEOUS
- [] 11 CAR RADIO/SPEAKERS
- [] 12 NARCOTICS/DRUGS
- [] 13 TOOLS
- [] 14 OTHER:

PHYS SECURITY

Q8
- [] 0 UNKNOWN/NA
- [] 1 AUDIBLE ALARM
- [] 2 SILENT ALARM
- [] 3 SECURITY PATROL
- [] 4 DOG
- [] 5 STANDARD LOCKS
- [] 6 AUXILIARY LOCKS DEADBOLTS/WINDOWS
- [] 7 WINDOW BARS/GRILL
- [] 8 OUTSIDE LIGHTS ON
- [] 9 INSIDE LIGHTS ON
- [] 10 GARAGE DOOR LOCK
- [] 11 OBSCURED INT VIEW COMM/BUSINESS
- [] 12 SECURITY SIGNS
- [] 13 OTHER:

SEX CRIMES

Q9
- [] 1 SUSPECT CLIMAXED
- [] 2 UNKNOWN/CLIMAXED
- [] 3 VICT BOUND/TIED
- [] 4 VICT INJURED
- [] 5 COVERED VICT FACE
- [] 6 PHOTOGRAPHED VICT
- [] 7 VICT ORAL COP SUSP
- [] 8 SUSP ORAL COP VICT
- [] 9 RAPE BY INSTRUMENT
- [] 10 SODOMY
- [] 11 SUGGESTED VICT COMMIT SEX ACT
- [] 12 INSERTED FINGER
- [] 13 FORCED VICT TO FONDLE SUSPECT
- [] 14 SUSP FONDLED VICT
- [] 15 MASTURBATED SELF
- [] 16 EXPOSED SELF
- [] 17 SEX CRIME W\ MINOR
- [] 18 OTHER:

MODUS OPERANDI

SUSPECT ACTIONS Q10
- [] 1 ALARM DISABLED
- [] 2 ARSON
- [] 3 ATE/DRANK AT SCENE
- [] 4 BLINDFOLDED VICT BOUND/TIED
- [] 5 CAT BURGLAR
- [] 6 DEFECATED/URINATED
- [] 7 DEMANDED MONEY
- [] 8 VICT DISROBE FULLY
- [] 9 VICT DISROBE PART
- [] 10 FIRED WEAPON
- [] 11 FORCE VICT TO MOVE
- [] 12 FORCE VICT IN VEH
- [] 13 HAD BEEN DRINKING
- [] 14 POSS MULTI SUSP(S)
- [] 15 INFLICTED INJURY
- [] 16 KNEW LOCATION OF HIDDEN PROPERTY
- [] 17 MADE THREATS
- [] 18 PLACED PROP IN SACK/POCKET
- [] 19 PREPARED EXIT
- [] 20 RANSACKED
- [] 21 RIP/CUT CLOTHING
- [] 22 SELECTIVE IN LOOT
- [] 23 SHUT OFF POWER
- [] 24 SMOKED
- [] 25 SEARCHED VICTIM
- [] 26 STRUCK VICTIM
- [] 27 SUSP ARMED
- [] 28 THREAT RETALIATION
- [] 29 ONLY CONSUMABLES
- [] 30 TOOK VICT VEHICLE
- [] 31 TORTURED
- [] 32 POSS DRUG USAGE
- [] 33 USED DEMAND NOTE
- [] 34 USED LOOKOUT
- [] 35 USED DRIVER
- [] 36 USED MATCH/CANDLE
- [] 37 USED VICT NAME
- [] 38 USED PILLOWCASE
- [] 39 USED VICT TOOLS
- [] 40 VEH FOR PROPERTY
- [] 41 DISCONNECT PHONE
- [] 42 CASED LOCATION
- [] 43 DISABLED LIGHTS
- [] 44 OTHER:

BURGLARY ONLY

IS VICTIM MEMBER OF NEIGHBORHOOD WATCH? Q11
[] YES [] NO

INTERESTED IN NEIGHBORHOOD WATCH?
[] YES [] NO

HAD HOME/BUSINESS INSPECTION?
[] YES [] NO

INTERESTED IN INSP?
[] YES [] NO

DR#

SUSP PRETENDS TO BE Q12
- [] 1 CONDUCTING SURVEY
- [] 2 CUST/CLIENT
- [] 3 DELIVERY PERSON
- [] 4 DISABLED MOTORIST
- [] 5 DRUNK
- [] 6 EMPLOYER/EMPLOYEE
- [] 7 FRIEND/RELATIVE
- [] 8 ILL/INJURED
- [] 9 NEED PHONE
- [] 10 POLICE/LAW
- [] 11 RENTER
- [] 12 REPAIRMAN
- [] 13 SALE ILLICIT GOODS
- [] 14 SALES PERSON
- [] 15 SEEK ASSISTANCE
- [] 16 SEEK DIRECTIONS
- [] 17 SEEKING SOMEONE
- [] 18 SOLICIT FUNDS
- [] 19 OTHER:

VICTIM PROFILE

RELATIONSHIP TO SUSPECT Q13
- [] 0 UNKNOWN
- [] 1 HUSBAND
- [] 2 WIFE
- [] 3 MOTHER
- [] 4 FATHER
- [] 5 DAUGHTER
- [] 6 SON
- [] 7 BROTHER
- [] 8 SISTER
- [] 9 OTHER FAMILY
- [] 10 ACQUAINTANCE
- [] 11 FRIEND
- [] 12 BOYFRIEND
- [] 13 GIRLFRIEND
- [] 14 NEIGHBOR
- [] 15 BUSINESS ASSOCIATE
- [] 16 STRANGER
- [] 17 OTHER:

VICTIM'S PHYSICAL CONDITION Q14
- [] 0 NO IMPAIRMENT
- [] 1 UNDER INFLUENCE
- [] 2 SICK/INJURED
- [] 3 SENIOR CITIZEN
- [] 4 BLIND
- [] 5 HANDICAPPED
- [] 6 DEAF
- [] 7 MUTE
- [] 8 MENTALLY IMPAIRED
- [] 9 OTHER:

PG OF FVPD CRI-2 (REV 1/93) NCIC# CA0300700

Santa Ana Police Department Standard Continuation Report (75 percent size)

SANTA ANA POLICE DEPARTMENT CONTINUATION	PAGE OF	Case #

A Arrestee S Suspect JD Juvenile Detention

D

CODE	#	NAME LAST, FIRST, MIDDLE										CHARGE		
RACE	SEX	☐ ADULT	☐ JUV.	AGE	DOB	HEIGHT	WEIGHT	HAIR	EYES	BUILD		SAPD BOOKING # / CITE #	BOOKING DATE	BOOKING TIME
HOME ADDRESS NUMBERS, DIRECTION, STREET, CITY, STATE, ZIP CODE													HOME PHONE	
OCCUPATION & BUSINESS ADDRESS													BUSINESS PHONE	
LOCATION ARRESTED ☐ SAME AS LOCATION OF CRIME													DT ARRESTED	TIME ARRESTED
DRIVERS LIC. #/STATE		SOCIAL SECURITY #			CII #			SAPD MUG #				OCJ BOOKING #	☐ UNDOCUMENTED PERSON	
AKA'S					TATOOS, MARKS, SCARS, ODDITIES & LOCATIONS							CLOTHING AT TIME OF ARREST		
BAIL AMOUNT					TIME RELEASED LOCATION HELD							OUTSTANDING WARRANTS/PAROLE OR PROBATION HOLDS		

CODE	#	NAME LAST, FIRST, MIDDLE										CHARGE		
RACE	SEX	☐ ADULT	☐ JUV.	AGE	DOB	HEIGHT	WEIGHT	HAIR	EYES	BUILD		SAPD BOOKING # / CITE #	BOOKING DATE	BOOKING TIME
HOME ADDRESS NUMBERS, DIRECTION, STREET, CITY, STATE, ZIP CODE													HOME PHONE	
OCCUPATION & BUSINESS ADDRESS													BUSINESS PHONE	
LOCATION ARRESTED ☐ SAME AS LOCATION OF CRIME													DT ARRESTED	TIME ARRESTED
DRIVERS LIC. #/STATE		SOCIAL SECURITY #			CII #			SAPD MUG #				OCJ BOOKING #	☐ UNDOCUMENTED PERSON	
AKA'S					TATOOS, MARKS, SCARS, ODDITIES & LOCATIONS							CLOTHING AT TIME OF ARREST		
BAIL AMOUNT					TIME RELEASED LOCATION HELD							OUTSTANDING WARRANTS/PAROLE OR PROBATION HOLDS		

CODE	#	NAME LAST, FIRST, MIDDLE										CHARGE		
RACE	SEX	☐ ADULT	☐ JUV.	AGE	DOB	HEIGHT	WEIGHT	HAIR	EYES	BUILD		SAPD BOOKING # / CITE #	BOOKING DATE	BOOKING TIME
HOME ADDRESS NUMBERS, DIRECTION, STREET, CITY, STATE, ZIP CODE													HOME PHONE	
OCCUPATION & BUSINESS ADDRESS													BUSINESS PHONE	
LOCATION ARRESTED ☐ SAME AS LOCATION OF CRIME													DT ARRESTED	TIME ARRESTED
DRIVERS LIC. #/STATE		SOCIAL SECURITY #			CII #			SAPD MUG #				OCJ BOOKING #	☐ UNDOCUMENTED PERSON	
AKA'S					TATOOS, MARKS, SCARS, ODDITIES & LOCATIONS							CLOTHING AT TIME OF ARREST		
BAIL AMOUNT					TIME RELEASED LOCATION HELD							OUTSTANDING WARRANTS/PAROLE OR PROBATION HOLDS		

CODE	#	NAME LAST, FIRST, MIDDLE										CHARGE		
RACE	SEX	☐ ADULT	☐ JUV.	AGE	DOB	HEIGHT	WEIGHT	HAIR	EYES	BUILD		SAPD BOOKING # / CITE #	BOOKING DATE	BOOKING TIME
HOME ADDRESS NUMBERS, DIRECTION, STREET, CITY, STATE, ZIP CODE													HOME PHONE	
OCCUPATION & BUSINESS ADDRESS													BUSINESS PHONE	
LOCATION ARRESTED ☐ SAME AS LOCATION OF CRIME													DT ARRESTED	TIME ARRESTED
DRIVERS LIC. #/STATE		SOCIAL SECURITY #			CII #			SAPD MUG #				OCJ BOOKING #	☐ UNDOCUMENTED PERSON	
AKA'S					TATOOS, MARKS, SCARS, ODDITIES & LOCATIONS							CLOTHING AT TIME OF ARREST		
BAIL AMOUNT					TIME RELEASED LOCATION HELD							OUTSTANDING WARRANTS/PAROLE OR PROBATION HOLDS		

☐ MORE NAMES LISTED ON CONTINUATION SHEETS

E

FACTUAL CIRCUMSTANCES SUMMARY (NO NARRATIVE)

PER CPC 293, the victim was advised and they do/do not want the report to be public information.

APPENDIX D: Time Data from Manual and TELEform Comparisons

Record Number	Agency ID	Manual Time	TELEform Time	Record Number	Agency ID	Manual Time	TELEform Time
1	A	341	351	158	FV	119	97
2	A	449	410	159	FV	122	105
3	A	456	398	160	FV	126	115
4	A	442	380	161	FV	154	137
5	A	371	300	162	FV	135	124
6	A	396	310	163	FV	153	141
7	A	370	315	164	FV	115	102
8	A	341	340	165	FV	129	105
9	A	401	345	166	FV	205	189
10	A	432	351	167	FV	169	158
11	A	542	500	168	FV	297	245
12	A	292	320	169	FV	198	189
13	A	663	520	170	FV	152	145
14	A	210	150	171	FV	181	145
15	A	159	125	172	FV	121	108
16	A	88	70	173	FV	129	106
17	A	185	110	174	FV	199	187
18	A	90	62	175	FV	182	165
19	A	198	140	176	FV	245	221
20	A	258	195	177	FV	299	275
21	A	179	120	178	FV	229	206
22	A	229	110	179	FV	241	223
23	A	197	120	180	FV	227	198
24	A	193	89	181	FV	270	248
25	A	288	174	182	FV	215	197
26	A	215	180	183	FV	210	195
27	A	232	178	184	FV	212	193
28	A	220	214	185	FV	257	224
29	A	199	158	186	FV	237	221
30	A	219	200	187	FV	207	178
31	A	213	210	188	FV	248	232
32	A	195	190	189	FV	226	201
33	A	140	132	190	FV	232	228
34	A	137	121	191	FV	210	212
35	A	148	125	192	FV	206	200
36	A	177	164	193	FV	211	199
37	A	169	145	194	FV	224	212
38	A	178	152	195	FV	193	178
39	A	156	140	196	FV	200	198
40	A	225	240	197	FV	182	178
41	A	190	180	198	FV	194	189

Record Number	Agency ID	Manual Time	TELEform Time	Record Number	Agency ID	Manual Time	TELEform Time
42	A	163	143	199	FV	211	186
43	A	172	158	200	FV	205	188
44	A	167	140	201	FV	215	201
45	A	161	160	202	FV	249	240
46	A	192	145	203	FV	212	201
47	A	174	170	204	FV	245	219
48	A	183	143	205	FV	209	197
49	A	224	205	206	FV	218	192
50	A	195	170	207	FV	254	218
51	A	174	101	208	FV	223	205
52	A	179	140	209	FV	295	284
53	A	155	103	210	FV	178	158
54	A	151	98	211	SA	60	51
55	A	139	78	212	SA	115	112
56	A	169	114	213	SA	223	198
57	A	131	110	214	SA	168	135
58	A	124	121	215	SA	162	125
59	A	135	130	216	SA	136	117
60	A	117	95	217	SA	129	108
61	A	113	110	218	SA	143	121
62	A	147	130	219	SA	129	113
63	A	130	124	220	SA	160	142
64	A	142	101	221	SA	125	101
65	A	150	95	222	SA	128	98
66	A	123	65	223	SA	119	114
67	A	142	122	224	SA	122	102
68	A	180	141	225	SA	126	97
69	A	160	171	226	SA	154	140
70	A	194	150	227	SA	135	108
71	A	192	160	228	SA	153	109
72	A	172	165	229	SA	115	97
73	A	165	140	230	SA	129	95
74	A	200	150	231	SA	205	153
75	A	269	207	232	SA	169	127
76	A	196	106	233	SA	297	260
77	A	299	173	234	SA	198	170
78	A	270	203	235	SA	152	112
79	A	266	240	236	SA	181	145
80	A	254	232	237	SA	121	95
81	A	233	212	238	SA	129	99
82	A	285	260	239	SA	199	145
83	A	249	240	240	SA	182	175
84	A	216	204	241	SA	245	198
85	A	247	198	242	SA	299	260
86	A	235	199	243	SA	229	201
87	A	210	200	244	SA	228	197

Record Number	Agency ID	Manual Time	TELEform Time	Record Number	Agency ID	Manual Time	TELEform Time
88	A	222	178	245	SA	227	196
89	A	285	215	246	SA	270	241
90	A	245	210	247	SA	215	188
91	A	275	240	248	SA	210	185
92	A	265	211	249	SA	212	184
93	A	212	170	250	SA	257	201
94	A	223	189	251	SA	237	212
95	A	198	145	252	SA	207	189
96	A	175	119	253	SA	248	235
97	A	188	170	254	SA	226	204
98	A	218	200	255	SA	232	214
99	A	265	224	256	SA	210	198
100	A	285	252	257	SA	206	189
101	A	233	230	258	SA	211	188
102	A	241	234	259	SA	211	201
103	A	219	198	260	SA	193	174
104	A	138	105	261	SA	200	180
105	FV	160	154	262	SA	182	144
106	FV	194	187	263	SA	194	154
107	FV	192	190	264	SA	211	178
108	FV	172	170	265	SA	205	184
109	FV	165	154	266	SA	215	175
110	FV	215	198	267	SA	249	221
111	FV	200	178	268	SA	212	200
112	FV	269	254	269	SA	213	198
113	FV	196	187	270	SA	209	189
114	FV	299	274	271	SA	218	202
115	FV	270	264	272	SA	254	232
116	FV	232	201	273	SA	223	209
117	FV	266	224	274	SA	295	278
118	FV	254	223	275	SA	178	157
119	FV	233	213	276	SA	245	231
120	FV	285	270	277	SA	217	199
121	FV	249	231	278	SA	223	202
122	FV	220	209	279	SA	214	191
123	FV	216	198	280	SA	184	168
124	FV	247	219	281	SA	128	95
125	FV	235	227	282	SA	198	154
126	FV	210	195	283	SA	175	170
127	FV	222	201	284	SA	148	122
128	FV	199	175	285	SA	103	78
129	FV	285	261	286	SA	117	88
130	FV	245	227	287	SA	142	140
131	FV	275	261	288	SA	100	89
132	FV	265	243	289	SA	148	128
133	FV	212	199	290	SA	111	100

Record Number	Agency ID	Manual Time	TELEform Time	Record Number	Agency ID	Manual Time	TELEform Time
134	FV	219	189	291	SA	108	95
135	FV	223	201	292	SA	119	102
136	FV	198	175	293	SA	197	175
137	FV	175	162	294	SA	182	168
138	FV	188	145	295	SA	216	191
139	FV	218	178	296	SA	192	172
140	FV	213	198	297	SA	162	158
141	FV	265	245	298	SA	141	131
142	FV	285	268	299	SA	170	162
143	FV	233	210	300	SA	196	170
144	FV	241	218	301	SA	204	190
145	FV	219	192	302	SA	235	201
146	FV	195	178	303	SA	228	225
147	FV	138	110	304	SA	187	174
148	FV	140	121	305	SA	205	191
149	FV	137	108	306	SA	179	164
150	FV	148	123	307	SA	109	98
151	FV	177	151	308	SA	137	119
152	FV	129	109	309	SA	152	140
153	FV	143	128	310	SA	167	165
154	FV	129	98	311	SA	146	129
155	FV	160	143	312	SA	166	147
156	FV	125	108	313	SA	174	156
157	FV	128	99				

APPENDIX E: Spreadsheet Cost-Effectiveness Model with Equations in Lieu of Parameter Values

Note that equations have been substituted in cells that contain calculated parameters. The equations are identical to those used in the model itself with the exception that a left-hand quotation mark has been inserted in front of the equals sign in order to cause the equation to show in the spreadsheet. Model steps from 21 to 39,999 have been truncated in the illustration below.

	A	B	C	D	E	F	G	H	I	J
1	IMPORTANT: In order to preserve model integrity, only modify data in GREEN boxes!									
2	Purpose: Calculate cost effectiveness of manual vs. forms-scanning technology given the following:									
3		*The assumptions stated in the report apply and*:							Parameters	Units
4							Initial TELEform software/training/technical support cost =		$ 6,499	(initial cost)
5							Scanning software amortization period =		5	year
6							Subsequent software upgrades/training/support cost =		$ 1,000	$/year
7							PC with appropriate hardware and software cost[1] =		$ 1,200	$/year
8							Clerical personnel salary plus fringe benefits cost[2] =		$ 24,000	$/year
9							TELEform average increase in throughput over manual entry =		"=1-(I10/I11)	
10							TELEform mean data entry seconds/form data entry speed =		178	seconds/form
11							Manual data entry mean seconds/form data entry speed =		204	seconds/form
12										
13			Model Specification:							
14			Cost/form = (cost/second)*(METHOD mean second/form)							
15			Total cost/year = (initial costs/amortization period + annual costs/year) + (cost/form * N forms)							
16										
17	To calculate which data entry method is more cost effective:									
18		1) Choose an amortization period (cell I5) and modify any parameters in green cells as appropriate								
19		2) Scroll down column L from row 24 onward until you find the row with the number of reports to be entered annually								
20		3) Check the cost-effective mode result in the same row of column K								
21										
22	Calculations:									
23		Base Personnel Costs:			Units					
24			Salary:	"=I8	year					
25			Work days/year (net):	200			Base Cost/N Forms		Cumulative Cost/N Forms	
26			Hours/day:	8	hour	N Forms	Manual	TELEform	Manual	TELEform
27			Base cost/hour:	"=D20/(D21*D22)		0	"=$F23*$D$29*$I$11	"=$F23*$D$29*$I$10	"=G23	"=((D34/I5)+D35+D36)
28			Max minutes/hour worked:	45	minutes	1	"=$F24*$D$29*$I$11	"=$F24*$D$29*$I$10	"=G24	"=$H24+J$23
29						2	"=$F25*$D$29*$I$11	"=$F25*$D$29*$I$10	"=G25	"=$H25+J$23
30		Manual Entry Costs:				3	"=$F26*$D$29*$I$11	"=$F26*$D$29*$I$10	"=G26	"=$H26+J$23
31			Cost/hour manual entry:	"=D23/0.75		4	"=$F27*$D$29*$I$11	"=$F27*$D$29*$I$10	"=G27	"=$H27+J$23
32			Cost/minute manual entry:	"=D23/D24		5	"=$F28*$D$29*$I$11	"=$F28*$D$29*$I$10	"=G28	"=$H28+J$23
33			Cost/second manual entry:	"=D28/60		6	"=$F29*$D$29*$I$11	"=$F29*$D$29*$I$10	"=G29	"=$H29+J$23
34			Cost/day manual entry:	"=D27*D22		7	"=$F30*$D$29*$I$11	"=$F30*$D$29*$I$10	"=G30	"=$H30+J$23
35			Cost/year manual entry:	"=D30*D21		8	"=$F31*$D$29*$I$11	"=$F31*$D$29*$I$10	"=G31	"=$H31+J$23
36						9	"=$F32*$D$29*$I$11	"=$F32*$D$29*$I$10	"=G32	"=$H32+J$23
37		TELEform Costs:				10	"=$F33*$D$29*$I$11	"=$F33*$D$29*$I$10	"=G33	"=$H33+J$23
38			TELEform software purchase:	"=I4	(initial)	11	"=$F34*$D$29*$I$11	"=$F34*$D$29*$I$10	"=G34	"=$H34+J$23
39			Upgrades/training/support:	"=I6	$/year	12	"=$F35*$D$29*$I$11	"=$F35*$D$29*$I$10	"=G35	"=$H35+J$23
40			PC hardware & software:	"=I7	$/year	13	"=$F36*$D$29*$I$11	"=$F36*$D$29*$I$10	"=G36	"=$H36+J$23
41			Amortization period:	"=I5	year	14	"=$F37*$D$29*$I$11	"=$F37*$D$29*$I$10	"=G37	"=$H37+J$23
42						15	"=$F38*$D$29*$I$11	"=$F38*$D$29*$I$10	"=G38	"=$H38+J$23
43		TELEform Entry Personnel Costs:				16	"=$F39*$D$29*$I$11	"=$F39*$D$29*$I$10	"=G39	"=$H39+J$23
44			Cost/hour TELEform entry:	"=D27-(I9*D27)		17	"=$F40*$D$29*$I$11	"=$F40*$D$29*$I$10	"=G40	"=$H40+J$23
45			Cost/minute TELEform entry:	"=D28-(I9*D28)		18	"=$F41*$D$29*$I$11	"=$F41*$D$29*$I$10	"=G41	"=$H41+J$23
46			Cost/second TELEform entry:	"=D29-(I9*D29)		19	"=$F42*$D$29*$I$11	"=$F42*$D$29*$I$10	"=G42	"=$H42+J$23
47			Cost/day TELEform entry:	"=D30-(I9*D30)		20	"=$F43*$D$29*$I$11	"=$F43*$D$29*$I$10	"=G43	"=$H43+J$23
...			Cost/year TELEform entry:	"=D31-(I9*D31)		...	...	...	...	...
40000						40,000	"=$F40023*$D$29*$I$11	"=$F40023*$D$29*$I$10	"=G40023	"=$H40023+J$23
40001										

Footnotes attached to spreadsheet:

[1] This assumes a base cost of $3,600 and a functional life of three years. Maintenance and technical support costs are not accounted for here—nor are the benefits of using the platform for other purposes when forms are not being scanned. Also ignored is the fact that manual data entry also requires some sort of computer input device.

[2] This assumes 200 data-entry work days per year maximum to allow for training, vacation, administration, etc. and no more than 45 minutes per work hour of actual data-entry time in order to avoid repetitive stress injuries (this parameter may be modified in the model). Agencies with a high volume of reports would need to hire additional data entry personnel when they exceeded the daily data-entry limit. Using the experimental average data-entry rates of 178 seconds per form for TELEform and 204 seconds per form for manual data entry, an extra person would have to be hired if more than 44,201 forms per year or 121 forms per day needed entry using TELEform--or if more than 38,568 forms per year or 105 forms per day needed entry using manual techniques similar to those described in the experiments.