AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS: THEIR ACQUISITION, MANAGEMENT, PERFORMANCE AND ORGANIZATIONAL IMPACT

A Report to the National Institute of Justice

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ABSTRACT

Results of a national survey of installations of automated fingerprint identification systems (AFIS) are presented along with descriptive commentary and discussion. The overall project objective was to provide documentation and analysis of the current status of automated fingerprint identification systems in the United States, creating a resource to assist in the procurement and management of these systems, and to guide further research.

Agencies housing AFIS databases were identified and an initial survey contact form was sent to each. This brief, single page questionnaire served to identify contacts at each agency and to obtain any existing documentation regarding their system. information. A survey instrument was developed and each agency contact was mailed a survey together with a cover letter containing assurances and explaining that the survey would be taken over the telephone. Responses to the mail surveys were augmented by telephone interviews, on-site visits and information collected at user conferences.

Apart from the presentation and analysis of the survey data, recommendations are made regarding key issues uncovered through site visits and interviews.

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CHAPTER 1. PROJECT BACKGROUND

A. Introduction

Over the past ten years automated fingerprint identification systems have proven to be feasible and cost-effective both in high volume identification bureaus and in the police departments of major cities [1]. Two long-standing needs are addressed by these systems: (1) automated classification and comparison of fingerprint records and (2) single-fingerprint classification and searching. Addressing the first need has resulted in radically more efficient, high-volume record processing, with exceptional savings in labor costs. Addressing the second need has made feasible the intensly ardorous task of searching fingerprint records for correspondence to individual crime scene prints. These "cold searches", conducted without specific suspects being selected for comparison, have resulted in clearance of many otherwise unsolvable crimes.

The success of automated fingerprint identification systems has made it inevitable that over the next ten to twenty years, most, if not all fingerprint filing and searching operations in the United States will become automated. Acquisition of the systems is a major capital expenditure (some 3 to 11 million dollars), but it is also a major operational change, requiring new policies which effect the training and allocation of personnel and alter or intensify the relationships among criminal justice agencies.

Little resource material exists to help plan for acquisition of an automated fingerprint identification system, or to develop policies regarding its use. Available resources are of two major types: those documenting the technical evaluation of system performance [2-6] and those that document the effect of the system on agency workloads and costs [1,7,8]. These resources help in justifying the capital expenditure for an automated fingerprint system and in choosing which system to purchase, but there is only very general, piecemeal information regarding the broader organizational and policy issues that each agency must confront [1,9-12]. At the same time there is a growing amount of experience, some of which it would be quite costly and reckless to overlook.

This project addresses part of this need through a comprehensive survey and analysis of the use of automated fingerprint identification systems in the United States. There have been many such surveys attempted, initiated by vendors of the computer systems, individual agencies and professional organizations. Various difficulties have confronted these efforts: perceptions of bias, lack of confidentiality, and length of the survey instrument itself are among them.

In Chapter 1 this report continues with a brief description of the fingerprint classification and comparison process for those needing a basic introduction, followed by a history of the use of computerized fingerprint systems. Chapters 2 and 3 present our Methods and Data, respectively. Chapter 4 is the Discussion. The Appendicies contain copies of the survey instrument and cover letters, along with a listing of the agencies surveyed.

B. Fingerprint Classification and Identification: Basic Processes

The purpose of this section is to describe the basic aspects of fingerprint classification and identification. It is important to understand these processes, and how they have traditionally been performed, in order to appreciate the issues arising during this period of transition to automated systems. Those familiar with these issues can skip this section with no loss in continuity.

Delicate patterns of finely ridged skin are found on the human palmar an plantar surfaces. The ridges are formed by the alignment of sweat glands which open their ducts onto the crests of the ridges. Perspiration, body oils and foreign matter are continually present on these ridges. When contact is made with a suitable surface, some of this material is transferred, and there is a potential for transferring a print which shows the ridge pattern. With such a transfer a latent fingerprint is formed. These latent fingerprints can be made visible and collected by various physical, optical and lifting processes. Alternatively, standard, reference fingerprints can be obtained by inking the skin surfaces and carefully rolling or pressing a print onto a fingerprint "card." These cards become permanent, physical records of the patterns on a person's fingers: patterns that do not change in their essential features with age and that are so detailed as to allow certain identification to be made with subsequently encountered inked prints or recovered latent prints.

Organization and maintenance of collections of these standard fingerprint cards has been one of the most labor intensive functions of scientific police work. When a person is booked following an arrest, the arresting agency will typically make at least three inked cards: one to be retained by the local agency, one to be sent and filed at the state level, and one to be sent to the Federal Bureau of Investigation. These cards are coded with respect to the grosser features of each finger's pattern and a combined code is made up for the whole card, representing that person's fingerprint classification. At each governmental level the cards are filed according to their classification and are available for two major functions. The first of these is a check on a person's identity. After an arrestee, job applicant, or unidentified person is fingerprinted, the existing files at the local, state and federal levels can be checked to see if there are cards on file with the same

fingerprint classification. If so, these cards can be compared with the newly-recorded prints to check on the identification of the individual. In this way, along with cooperation in the exchange of related information, a variety of investigative problems can be rapidly solved. These include identification of the dead, determination of prior arrest records and notification of outstanding arrest warrants. This process is dependent on one standard, inked fingerprint record being compared with another. The cards can be compared initially through their classification codes, but final identification rests with a fingerprint examiner verifying the identification through a visual comparison. visually. The process discussed above is called a fingerprint "verification" and uses "10-print to 10-print comparison." This is one of two major functions of organized fingerprint records.

The other major function of fingerprint records is to furnish standard prints that can be made available for comparison with fingerprints that are recovered from crime scenes. Suppose that a number of fingerprints are recovered from a crime scene. If investigative information develops specific suspects, then fingerprints for these individuals may be obtainable from existing fingerprint files. Alternatively, even without these files, the suspects could be arrested and fingerprint records could be made locally. A fingerprint examiner can then compare the standard, inked fingerprint records with the fingerprints recovered from the crime scene to determine if the prints were made by the same person. This second function, "latent fingerprint identification," requires selection of candidate records for comparison with the crime scene fingerprints.

Traditionally the selection of candidate records depended on investigators developing one or more suspects in a case. A labor intensive, and usually impractical, alternative was to select a larger group of records (hundreds) consisting of persons who might possibly be involved in the crime (given the type of offense, geographical location and other investigative factors). In the extreme an entire, local set of records might be searched in cases of sufficiently high priority. When records are chosen in this fashion the comparison process is referred to as a "cold search." Rather than testing particular candidates against the crime scene print, the print is being tested against a set of fingerprint records. Until the computerization of these records, such cold searches could not be routinely performed.

There are thus two distinct fingerprint processes: classification and identification. Classification of fingerprints allows organized storage and retrieval of fingerprint records that fit pre-defined form criteria. In contrast, fingerprint identification involves the comparison of two fingerprints in order to determine if they were made by the same person.

Automated fingerprint identification systems (AFIS) have dramatically changed the processes of fingerprint storage and

retrieval and have altered our concept of "classification." As noted above, traditional classification was performed manually and involved coding of the relatively coarse features of fingerprint patterns. With AFIS technology the criteria for "classification" extends to the positions of ridge discontinuities (fingerprint minutiae) and the more precisely defined ridge positions and orientations. A new type of fingerprint record has also emerged: one made up of digitized codes and/or optical imaging linked with a database of the more conventional information. The inked cards are still necessary for final comparisons, but these will eventually be supplanted as the technology advances and "live-scan" systems prevail, where patterns are recorded electronically, directly from a person's fingers.

Fingerprint identification itself cannot be performed by a computer because the subtleties of this process make it dependent on expert opinion. Although AFIS does not directly enter into this final process, it has a dramatically effective auxiliary role: the astoundingly selective retrieval of candidate records from large databases. This allows cold searches to be conducted routinely.

C. History of AFIS

A detailed history of AFIS is available [13]. A short history emphasizing major technological developments is presented here to provide insight into the present circumstances. Table 1 (directly following this description) lists the major milestones in the development and implemenation of AFIS systems.

The earliest applications of computers to fingerprint operations simply used the computer as a tool for searching of 10-print records, relying on the traditional, manually-derived codes and information. This was a natural response to new computer capabilities. Noteworthy efforts included agencies in Kansas City and Atlanta where microfilm retrieval systems were used [14] and the early Royal Canadian Mounted Police System that used a video tape indexing system.

The real precursors to modern AFIS systems were methods developed for single fingerprint classification. These methods relyed on more detailed description of patterns of individual prints, rather than a code dependent on all ten prints. There are a variety of options for classifying single prints. At the two extremes are methods based entirely on the overall ridge flow, ignoring the minutiae, and those based exclusively on the minutiae. Early work on AFIS systems included coding algorithms analogous to both extremes, but minutia-based systems were found to be necessary to accomdate the distortions in rolled prints and the contingencies in the appearance of latent prints.

Among the earliest work on automating fingerprint identification was performed at Baird Atomics in 1963 [14]. Fingerprint minutiae (the branchings and endings of individual ridges) were located relative to one another using a grid system that could be digitized. A similar theory was used beginning in 1965 at the New York State Information and Identification System (NYSIIS). In this system minutiae were located manually using overlays on photographic enlargements of fingerprints. These were coded and stored on the computer.

There are four primary types of automated fingerpint systems used in the United States. Three of these are commercially available: the Printrak, NEC and Morpho systems. Additionally, the Federal Bureau of Investigation has a custom-built system, designed for 10-print searching and verification. The early history of each of these four systems is summarized below. The FBI system has recently been reviewed in some detail [15].

In 1963 the FBI began to design an AFIS system in cooperation with the National Bureau of Standards (NBS). Two key processes were identified as critical to the develpment of AFIS. The first was a means to scan inked fingerprints, resulting in a digitized record of the fingerprint minutiae, including both their relative position and their orientation (the direction that the fork or ridge ending points). The second need was software that would allow the automatic comparison of these digitized records. Automatic fingerprint readers were developed over the period of 1967 to 1972 by Cornell Aeronautics Laboratory, Inc. (now Calspan Corporation) and systems analysis was conducted by the Autonetics Division of North American Aviation, Inc. (now Rockwell International).

In 1976 fingerprint readers and high-speed matching software were installed at the FBI. Automatic reading used for high quality inked prints and operator-assisted reading for prints of poorer quality. Operators could view enlarged prints on-screen and select identifiable minutiae. The matcher was designed soley for 10-print comparisons and was not suitable for single, latent fingerprints.

Input and digitization of the FBI's fingerprint 14.3 million fingerprint cards took two and a half years and was completed in September 1980. A pilot study with parallel manual and computer assisted searches was conducted, demonstrating improved accuracy and labor efficiency. By March 1983 all routine searches were performed automatically and the total fingerprint file was on-line.

As a result of its contract work for the FBI, Rockwell Internationalcreated a Printrak Division and began marketing products to state and local police agencies. Federal money was avialable to many of these agencies through the Law Enforcement Assistance Administration and 90% of the cost of these early

systems was paid for from Federal funds.

Rockwell installed a prototype system in California at the San Jose Police Department in 1978 and after initial successes the following systems were sold and installed (1978-1981):

- the Royal Canadian Mounted Police
- the State of Minnesota (Minneapolis Police Department, St. Paul Police Department and the Minnesota State Crime Bureau)
- the Montgomery County and Prince Georges County Police Departments (Maryland)
- the Houston Police Department
- the government of Brazil
- Miami, Florida
- the California State Department of Justice

When federal funding for these systems became unavailable the market for the systems collapsed, resulting in no new sales for several years. The Printrak Division of Rockwell was dissolved and operations were turned over to the Thomas DeLaRue Company of London in 1980.

The NEC system was developed for the National Police Agency of Japan (NPA). Developmental work began in 1969 and in 1975 NEC received a contract for implemenation of a system. As this system developed it included not only the location of fingerprint minutiae, but their relative location to their neighbors, as judged by the number of intervening ridges from one minutia to the next. This "relational" data does not vary with the typical distortions encountered in latent fingerprints and in poorly rolled inked prints. The NEC system was installed at the NPA in September, 1981.

In 1983 NEC sold its first system in the United States to the San Francisco Police Department. The State of California also switched to an NEC system, going on to become the largest system in the United States.

North American Morpho Systems of Tacoma, Washington installed its first AFIS in Pierce County/Tacoma, Washington in 1986. It has remained the samller of the three major vendors in the United States' market.

The NEC system in San Francisco was purchased with local funds after a public appeal. The success of this system created a model validating the local financing and procurement of these systems. During the mid- to late 80's over a hundred AFIS systems were sold and installed by the three major vendors.

More sophisticated search algorithms developed in the 1980's are used in new AFIS systems, which convert minutiae data, ridge direction and other fingerprint data into a binary code for

searching. Other technological developments included fingerprint image storage and retrieval capabilities, whereby digitized fingerprint images stored on optical disk can be retrieved for comparing candidates with search fingerprints. The sharing of AFIS data, or networking among agencies, is a major issue area and is only possible if AFIS systems are from the same vendor; where the vendor has the technical capability to allow two systems to communicate. If two AFIS systems are not from the same vendor they cannot communicate because the technology (ie. algorithms) is incompatible.

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Table 1. Major Milestones in the Development and Implementation of AFIS systems

1963: Some of the first research for automating fingerprint searches begins at Baird Atomics, Inc.[1]

1963-1966: Study of the overall problem of automatic fingerprint identification undertaken jointly by the FBI and NBS.[3]

1965-1970: One of the earliest research efforts by a state identification bureau to investigate the use of automated fingerprint identification; at the New York State Information and Identification System (NYSIIS).

1966: Research begins in London by the Police Scientific Development Branch of the Home Office on automating the latent print searching process.

1967: Prepoposal Conference at FBI Headquarers leads to contracts to Cornell Aeronautics Laboratory, Inc. (now Calspan Corporation), and the Autonetics Division of North American Aviation, Inc. (now Rockwell International) for development of engineering model fingerprint readers.

1969: Cornell Labs and North American Aviation introduce engineering model automatic fingerprint readers. Researchers at NBS successfully demonstrate computerized procedures for matching fingerprint data produced by both readers and begin to devise automatic procedures to find the center and orientation of fingerprints.[3]

1969: The National Police Agency (NPA) of Japan begins development effort with a request to NEC, a large Japanese electronics and computer firm, to study the problem of automatic fingerprint recognition.

1970: The FBI awards contract to Cornell Labs to build the first prototype automatic fingerprint reader.[3]

1970: The RCMP automation efforts begin with an Ampex Videofile fingerprint classification system.

1971-1974: NYSIIS Criminalistics Research Bureau contracts with General Dynamics to develop a computer controlled semiautomated fingerprint encoding system that will interactively obtain minutiae data.

1972: The FBI automated record keeping system known as AIDS-I is started, and the prototype fingerprint reader from Cornell Laboratories is installed at the Identification Division in

Washington [3]. Decision is made to develop minutiae based fingerprint identification system because it allows 10-print and latent systems to use the same technology [3].
Table 1 (continued)

1972: The Carnahan Conference is held in Louisville, Kentucky; one of the first sessions in which competing fingerprint identification systems could be compared, and the various approaches to fingerprint reading and matching debated [3].

1973: The first stage of the FBI automation work ends and the FBI moves out of research and into development[3].

1973-1974: Researchers at NBS develop an automatic classification technique using the data produced by the prototype reader from Cornell Laboratories [3].

1973: Calspan Corporation leaves its status as not-for-profit research laboratory; president sets up commercial venture called Calspan Technology Products to sell fingerprint reader systems to state and local governments.

1974: FBI awards contract to Rockwell International to build the required five production-model automatic fingerprint readers [3], to be delivered over the next two years.

1974: An executive at Rockwell establishes the Printrak Division to define and sell fingerprint products to state and local police agencies.

1974: The Home Office in London sponsores the first such international conference specifically for latent prints and automation.

1975-1978: FBI decides to augment the NBS work in automatic classification by starting a parallel effort at Rockwell [3]. Due to work loads involved for FBI's work, the goal is not achieved, but a semiautomatic 10-print searching system that uses the National Crime Information Center classification for conversion is designed [3].

1975-1977: The first production model Automatic Fingerprint Reader Systems are delivered to the FBI by Rockwell. These same readers, with different software, would also be used to read latent fingerprints.

1975: The NPA issues a directive in 1975 for implementation of a an NEC system.

1976: The Calspan Corporation delivers a high speed prototype fingerprint matcher for comparing minutiae data from ten print cards only.

1976: The Home Office work is evaluated in a pilot test at NSY, which leads to the procurement of a system from the Logica Company of London for operational use in London.

Table 1 (continued)

1977: Large scale file conversion begins at the FBI, using the production fingerprint readers to convert fingerprint data to digital form.

1977: Calspan decides to get out of the fingerprint business when it cannot obtain any contracts against the much larger Rockwell, and sells its remaining prototype equipment to Fingermatrix, Inc., a live scan (direct electronic fingerprinting) vendor.

1978: The RCMP upgrades their operations in 1978 to a Rockwell system.

1978: Rockwell installs a prototype system in the San Jose California Police Department, later upgraded by Printrak.

1978: Minnesota becomes the first state to install an AFIS system, which becomes operational in early 1979 at the Minneapolis Police Department, the St. Paul Police Department and the Minnesota State Crime Bureau. This system was developed by Rockwell International and its Printrak Division and it became the first domestic, fully operational AFIS system outside the FBI.

1978: Officials at Montgomery County Police Department invite all buyers of Printrak systems to an open forum designed to help educate users and outsiders. It is the first AFIS users conference of its kind.

1979: FBI begins succcessful Automated Technical Search Pilot System to prove accuracy and viability of automated searching.

1980: FBI large scale file conversion completed after converting approximately 14.3 million fingerprint cards to a digital data base.

1980: Rockwell transfers the Printrak operation to Collins Division of Rockwell, then to Thomas DeLaRue Company of London.

1981: The first NEC minutiae based system is installed at the NPA.

1983: NEC sells its first system in the United States to San Francisco Police Department, and State of California Department of Justice, the most technologically advanced (networkable) and largest operational AFIS in the United States.

1985: The RCMP receives a digital image retrieval system from Printrak.

Table 1 (continued)

1986: North American Morpho Systems of Tacoma, Washington, installs its first AFIS in Pierce County/Tacoma, Washington.

1986: The first truly Federal system is implemented in Australia by NEC, and becomes operational in 1987.

1990: First installation of electronic fingerprinting ("live scan") system at St. Paul Police Department by Digital Biometrics, Inc. (DBI).

1990: EDS/Cogent of Alhambra, CA, enters American law enforcement AFIS market and expands AFIS market to welfare management (LA County).

1991: FBI acceptance of electronic fingerprinting technology ("live scan"), first of DBI, then Identix and Fingermatrix.

CHAPTER 2. OBJECTIVES

The overall project objective is to provide documentation and analysis of the current status of automated fingerprint identification systems in the United States, creating a comprehensive resource to assist in the procurement and management of these systems, and to guide further research.

Six specific areas require documentation and analysis to achieve this objective: current usage, system selection, initial effects, impact, policies and procedures and future plans.

A. Current usage

Although a listings of current users are available, further documentation is necessary to determine the levels and types of use at existing installations, to identify which police agencies are served, and to assess how these agencies are served.

1. User Profiles

Users may be conveniently divided into three classes: controlling user, when an agency is in control of operations and maintains a database; network user, when an agency is connected through a computer link as part of another's service network; and remote user, when an agency can submit hard-copies of prints to a network or controlling user.

Systems have been acquired at the city, county and state levels. The details of how agencies cooperate with one another, and which agencies are served is important to the planning of future systems. A profile of user classes is useful to identify options for networking and to identify agencies that have no existing services or who are in early stages of procurement. The user profile is also necessary to properly analyze the bulk of the information resulting from this study.

2. Capabilities and Requirements of the System

For the controlling users, representing actual installations, system capabilities are of interest, including both qualitative and quantitative features. Of particular importance are optical storage capabilities, storage capacity, rates of matching, networking options, expansion capability and the extent of manual operations that are necessary.

Requirements of the system include space, running costs, and service/maintenance costs.

3. Levels of Use

Levels of use are indicated by the sizes and types of

databases and by the rates of various operational tasks. Considered in relation to the system capabilities, one can evaluate the ability of the system to meet existing, desirable and projected operating level requirements.

A number of separate databases are usually maintained for automated fingerprint operations, including criminal, employment, and juvenile files. Subsets of these general databases are maintained to compare with crime scene prints. These may be defined on the basis of age, date of arrest or geographical area. The size and type of each database is of interest and is necessary in order to interpret the rates of operations in relation to system performance.

Key operational tasks are divided into two groups: those related to the input and searching of 10-finger cards and those related to matching crime scene prints.

B. System Selection and Planning

The process of system selection must be documented beyond the more technical benchmark programs that have been the principal available resource. The goal is to document the various approaches to system selection and to identify information that would be useful to those beginning the selection process. Key areas of interest are: the initiation of the process, who made the selection, the source of initial budgetary support, the nature of the technical evaluation and any further, non-technical evaluation.

C. Initial effects

Despite the fairly short-term dramatic benefits of an automated fingerprint identification system, implementation of the system will disrupt long-standing, high-volume operations. Knowledge regarding these initial effects is important so that, inasmuch as possible, they can be anticipated and adequate preparations can be made. Initial effects center around issues related to organizational changes, vendor cooperation, unexpected costs and unexpected problems.

Organizational changes must occur, requiring training of personnel and defining the extent of new positions. Models for personnel roles vary greatly. One agency may have specialized departments for each computer function and another may have each fingerprint examiner follow cases from the crime scene through the final computer search.

The vendor's experience and helpfulness during the initial setup period is of critical importance. Strategies to ensure cooperation and support after the sale may emerge from the study.

Unexpected costs, planning failures and unanticipated problems are a rich source of practical advice for those seeking to acquire systems. We would like to define as well as possible what resource materials would have helped to anticipate these problems and ease the initial effect of the system.

D. Impact

Where systems have been installed, rates of use and performance statistics are of interest. Use rates include the number and types of requests that are processed, and how the requests are fulfilled. The basic categories of requests are ten-finger searches and latent searches. The rates of requests of each type are of interest, together with how the request was resolved (e.g. successful or unsuccessful name or technical searches.

E. Policies and Procedures

We are interested in both the overall administration and organization of AFIS operation and in case-specific policies and procedures.

Major categories of overall administration are: the overseeing administrative body, the organizational structure, monitoring of system and personnel performance and the maintenance of the databases.

The evaluation of system and personnel performance is of importance, including what statistics are kept on the operation, the criteria used for evaluation, and the goals.

The sizes of these databases, restrictive features, how they are used, their maintenance, backup and quality control for incoming data all represent important aspects of policy making.

Policies governing the sharing of information with other jurisdictions, or running of crime scene print searches for outside jurisdictions is of interest.

F. Future Plans

Of interest are the agency's future implementation and expansion plans, any specific improvements that are underway and any that are on hold or subject to budgetary contingencies. Of particular note will be the identification of unmet needs, remaining inefficiencies and factors limiting current case throughput.

CHAPTER 3. METHODS

A. Overview

Agencies housing AFIS databases were identified and an initial survey contact form was sent to each. This brief, single page questionnaire served to identify contacts at each agency and to obtain any existing documentation regarding their system. information. A survey instrument was developed following the objectives outlined in Chapter 2. Each agency contact was mailed a survey together with a cover letter containing assurances and explaining that the survey would be taken over the telephone. The survey was pre-tested on ten agencies and modified prior to the general mailing. Responses to the mail surveys were augmented by telephone interviews, on-site visits and information collected at user conferences.

B. The Initial Survey Contact

For the initial survey contact form we attempted to identify all agencies in the United States with operational AFIS databases. This was done by working from personal knowledge, existing user lists, consultations with System Vendors and with resources provided by contacts at the International Association of Identification and the Search Group.

Each agency with an operational database was sent the initial survey contact form along with a cover letter describing the scope and nature of the study, our expertise and the purpose of the contact form (see Appendix A). In addition to the return of the contact form, the cover letter requested any existing summary information or statistical data regarding the system. The contact form itself simply asked for the name, address and telephone number of the appropriate person to contact, the make and model of AFIS, the month and year that the system when operational and the number and addresses of any remote sites.

The purpose of this mailing was primarily to establish contact with appropriate personnel in each agency. The very basic system information helped to verify our lists and to select candidates for site visits. We specifically avoided requesting the preparation of any new summary material.

C. The Survey Instrument

The reluctance to respond to lengthy written surveys led us to adopt a telephone-survey approach where surveys would be mailed two weeks or more before the initial telephone contact. In addition to guaranteeing a high response rate, this approach would let agencies gather data in advance of the call and allow

direct clarification of any ambiguities in the survey. Subjective responses and underlying issues could also abe more easily explored.

A cover letter (see Appendix A) accompanied the survey which cited the high response rate to our initial survey contact letter, thanked the participants, and explained the telephone procedure that would follow. The letter also gave assurances that all responses would be held in confidence and that participants would receive a copy of the survey results.

The survey instrument itself (see Appendix A) was developed after conducting several site visits and consulting with users. We followed the general outline of issues discussed in Chapter 2, grouping questions into ten categories, listed below:

Agency Information
System Selection
Cost
Ten Print to Ten Print Searching
Ten Print Searching
Latent Print Searching
User Satisfaction
Effects
Quality Assurance
Networking

In selecting questions we attempted to minimize the effort required of the agencies, while still allowing collection of the desired data.

The survey was pretested using ten agencies selected to represent the different levels of government, the three major system vendors, and the range in system size. Agencies were requested to complete and return the questionnaire to the project office with comments and suggestions. Project staff telephoned respondents to work out appropriate modifications. The modified survey was sent to 64 agencies, representing all known AFIS installations in the United States at the time (8/90).

Supplementary telephone interviews collecting the data were conducted as planned with 62 agencies, taking an average of 45 minutes to one hour to complete each questionnaire.

D. AFIS Site Visits

Fifteen site visits were conducted in the course of this study. These were selected to represent the range of user classes, system size, system vendor and level of government. The selection was in part based on the locations of user conferences and the preference for locations where personnel showed active participation in user groups or where they extended specific

invitations to our staff.

E. Conferences Attended

During the research period five national user conferences were attended by project staff.

F. Data Analysis

Surveys were reviewed by the staff for completeness and supplementary telephone calls were made when necessary to clarify ambiguities. Routine data processing methods were used to code, assemble and cross-check quantitative information. Following the entry of the data, a series of frequency runs was completed summarizing responses to variables. In addition to basic frequencies, cross-tabulations and other appropriate analyses of the data were conducted.

CHAPTER 4. DATA

A. Overveiw

Questionnaire results are presented in this chapter, along with descriptive summaries of the data itself. The chapter is divided into the ten sections of the survey instrument itself: Agency Information, System Selection, Cost, Ten Print to Ten Print Searching, Ten Print Searching, Latent Print Searching, User Satisfaction, Effects, Quality Assurance and Networking.

A total of 62 agencies were identified as housing AFIS data bases. (Shared AFIS systems were identified as one system.) Sixty-one agencies received our initial contact letter. Of these 56 (92%) responded. All sixty-two agencies received the final (primary) survey. Of these 53 (86%) responded in full, another 5 (8%) gave partial responses, and 4 (6%) did not respond.

B. Agency Information

Table 2 indicates that 50% of the 62 respondents to the questionnaire are agencies located at the city/county level of government. The other principal group includes agencies at the state (or commonwealth) level, making up 42% of the respondents; about 8% are either regional or private operations. No federal agencies are included in these results.

Table 2. Agencies Surveyed by Level of Government: (n=62)

city, county, city/county systems	50% (n=31)
state and commonwealth systems	42% (n=26)
regional and private systems	8% (n=5)

Organizationally, almost 60% of the AFIS systems are positioned within either identification bureaus or criminal records divisions (see Table 3). The other major organizational units include investigations, data processing and technical services divisions. In about three-quarters of agencies, the ten print identification and latent print AFIS programs are located in the same organizational unit. Besides being placed in identification bureau/criminal records units, the other primary location for the latent print operation is within a forensic laboratory, making up about 15% of these operations.

Table 3. Location of AFIS Systems (Organizationally)

Ten Print Systems: (n=61)

Identification Bureau/Criminal Records.....59%
Investigations Division.....12%
Information/Data Processing Services.....10%
Technical Services.....10%
Other.....10%

Latent Print Systems: (n=58)

Identification Bureau/Criminal Records.....48%
Forensics/Crime laboratory.....14%
Investigations Division.....10%
Technical Services.....9%
Other.....19%

Same Location for Ten Print and Latent System?: (n=58)

Yes.....76%
No.....24%

The three major vendor groups providing the AFIS technology to law enforcement agencies and represented in this survey are MORPHO, NEC and Printrak, having 7 (11%), 26 (42%), and 29 (47%) systems in place, respectively. With regard to the distribution of these various systems among different levels of government, Table 4 shows that NEC and Printrak each have an equal (45%) share of the systems in county government while MORPHO has only 10% of the systems at this level. At the State and commonwealth level, Printrak has 50% of systems, NEC has 35% and MORPHO 15%. NEC and Printrak have 60% and 40%, respectively, of the regional/private systems.

Table 4. Level of Government by Vendor: (n=62)

City, county, city/county: (n=31)
MORPHO.....10%
NEC.....45%
Printrak.....45%

State and commonwealth: (n=26)
MORPHO.....15%
NEC.....35%
Printrak.....50%

Regional and private: (n=5)
MORPHO.....0%
NEC.....60%
Printrak.....40%

We also inquired as to the availability and actual use of the ten print and latent print systems. Ninety percent of the ten print and eighty percent of the latent systems are available for inquiries on a twenty-four hour basis. As Tables 5 and 6 indicate, however, only 43% of ten print systems are actually used on a 24 hour basis and about 11% are used an average of 8 hours or less per day. With respect to latent print systems, a much higher percent (42%) are used 8 hours or less per day, and only about one-quarter are used on a 24 hour basis. Clearly, the ten print systems are the most heavily used.

Table 5. Availability and Use: Ten Print Systems

Ten print system availability: (n=57)

24 hours/day.....90%

Ten print system use: (n=54)

0-8 hours/day.....11%
9-16 hours/day.....33%
17-23 hours/day.....13%
24 hours/day.....43%

Table 6. Availability and Use: Latent Print Systems

Latent print system availability: (n=57)

0-8 hours/day.....7%
9-23 hours/day.....12%
24 hours/day.....81%

Latent print system use: (n=52)

0-8 hours/day.....42%
9-23 hours/day.....35%
24 hours/day.....23%

We also asked about remote sites and found that about half (47%) of the responding agencies have none. Of those that have remote sites, about half have 1 or 2 such locations (see Table 7).

Table 7. Number of remote sites: (n=62)

None.....47%
1-2.....24%
3 or more.....29%

C. System Selection

One of our principal objectives was to explore the underlying problems and conditions which motivated agencies to acquire an AFIS, as well as the basis for selection of a particular vendor. We asked agencies to provide up to three problems/conditions leading to procurement of an AFIS system. We found that the quest for improved personal (ten print) identification - encompassing the desire for increased speed, accuracy, and accommodating an ever-expanding caseload - was the most frequently cited reason (36% of respondents mentioned this) of those described (see Table 8). A very close second, mentioned by 33% of respondents, was the need to improve the latent print search and identification process. In fact, the latent search function was, by far, the most cited first reason mentioned. Aside from these two primary reasons, a general desire to keep up with the latest technological advancements was the third most commonly stated reason, mentioned in 13% of the responses. Other reasons, including those regarding understaffing, cost-savings and high-crime rate were given 17% of the time.

Table 8. Initial Problems/Conditions that Leading to AFIS Acquisition (n=129)

personal identification	36%
latent/unsolved latent cases	33%
technological advancement	13%
other	17%

We also asked agencies the basis for the selection of their present vendor over the competition (see Table 9). Agencies could supply up to three reasons. The most frequently cited reason was "benchmark testing," representing 25% of the responses. The next most cited reason was "cost,", and the third most mentioned reason was that the vendor selected was the "only system available" at the time they made their purchase. The other reasons cited included the AFIS system's compatibility with other information systems, particular system features, contract requirements and political considerations.

Table 9. Basis for Agencies Selecting their Present Vendor over the Competition

All Users (n=113)

benchmark testing	25%
cost	20%
only system available	11%
other	44%

Table 9. (continued)

MORPHO Users (n=13)
cost.....39%
contract/RFP met.....23%
other.....39%

NEC Users (n=53)
benchmark testing.....36%
compatibility (networking capabilities).....13%
other.....51%

Printrak Users (n=47)
only system available.....26%
cost.....26%
other.....49%

The great majority (95%, n=62) of respondents reported that their current AFIS is the only system their agency has ever had. Table 10 shows the years in which these various AFIS systems were installed in agencies. It can be seen that the majority (about 75%) of AFIS systems have been (or are scheduled to be) installed after 1985. More than 50% of systems were installed between the years 1986 and 1989. The table also shows the years in which the three principal vendors installed their first sytems, with Printrak the earliest in 1978.

Table 10. Installation Years (n=62)

	All Systems	MORPHO	NEC	Printrak
1978-1979	4	0	0	4
1980-1981	1	0	0	1
1982-1983	3	0	0	3
1984-1985	8	0	2	6
1986-1987	18	1	9	8
1988-1989	17	3	11	3
1990	9	3	3	3
Projected	2	0	1	1

D . Costs

The survey inquired as to the initial start-up costs incurred by agencies in establishing their AFIS systems. Although not all agencies responded completely to this question, a majority (46) did supply total cost figure estimates. These agencies reported spending a total of approximately $193 million, or an average of about $4.2 million per agency. The range in expenditures varied greatly, from a low of $105,000 (1979) to a high of $27,000,000.

Table 11 shows the system costs partitioned into major categories of hardware/software, conversion and site preparation. By far the major costs are with the system purchase, amounting to 78% of the total.

Table 11. Average Costs of Hardware/Software, Conversion and Site Preparation

Hardware/Software (n=27).....	$ 4,540,000
Conversion (n=22).....	$ 925,000
Site Preparation (n=31).....	$ 383,000

As shown in Table 12 the greatest investments, on average, for AFIS systems were from agencies implementing the seven MORPHO systems, spending on average $10.9 M (range - $1.9 M to $27 M). The reader should keep in mind all of the MORPHO systems have been implemented since 1986. Initial start-up costs for the twenty-six NEC systems averaged about $4.5 million (range $745 K to $19 M), while the average Printrak system cost about $2.9 M (range $105 K to $10.3 M).

Table 12. Average Initial Start-up Cost by Vendor System Since 1986:

MORPHO.....	$10,957,000	(n=7)
NEC.....	$4,522,000	(n=24)
Printrak.....	$2,936,000	(n=15)

The various agencies represented in the survey basically funded their AFIS systems via the unit of government where they are housed. There were exceptions, however, a common one being where the state government joined in with a city and/or county unit to support the program. Agencies in California are a prime example of this mechanism in which the state funded local participation on a 70/30 percentage basis (the state picking up 70% of costs while the city or county provided the remaining 30%). Two other combinations worth mentioning were four agencies which received federal (LEAA) assistance to acquire their AFIS's and four others that charged participating agencies in their jurisdiction a "user" fee, based on the population/crime rate of the user. State governments, proved to be the leading financer of AFIS systems, being either the exclusive or partial funder of more than 40% of the systems.

We also asked agencies the annual operating costs (FY 1990) for their systems. A total of 25 agencies responded to this question. In aggregate, these agencies spent more than $22 million operating their AFIS systems in 1990; on average, agencies are spending about $890K annually. Very few of the

agencies could break out these expenditures by category, i.e., personnel, equipment, and maintenance, so reliable information in this regard is unavailable.

E. Automated Ten Print Systems

We asked agencies a series a questions regarding their ten print searching procedures and capabilities. We found the majority (60%) of respondents must have an operator manually classify the pattern types of fingers entered from ten print cards. Eighty percent of systems provide for optical storage of an image of the ten fingers on the cards. The great majority (86%) of ten print systems are still relying upon inked fingerprint cards of arrestees/suspects, with only 14% reporting they have implemented electronic (live scan) procedures. About two-thirds of agencies report they have the ability to register ten print information into their data bases from remote locations. Only slightly more than half (55%), however, indicate they can conduct ten print searching from remote sites. Almost two-thirds (63%) report they have dedicated matchers for ten print searching. About the same percent (60%) report their systems can automatically conduct reinquiries to search additional data bases.

We also inquired as to what criteria agencies employ to select records for conversion of their manual fingerprint files to the AFIS data base (see Table 13). The most common criterion, mentioned by 30 (48%) agencies, was date of birth. The next most common criterion, amounting to 22% of responses, was that the fingerprints on the card in question were classifiable. The third most mentioned criterion (18% of responses) was that the offender had been arrested after a particular year. Other criteria used to select fingerprint cards for conversion included that the subject was a criminal offender, and that the offender had been arrested for a "serious" offense.

Table 13. Criteria used for Conversion of Manual Files to AFIS Ten Print Data Base: (n=79)

date of birth	44%
all classifiable, including criminal & applicant	22%
arrest within X years	18%
other	16%

Agencies were also asked if they had modified these criteria since the original conversion and about half said they had (see Table 14). The most frequently mentioned criteria, noted by 18% of agencies which gave a reason, was a modification of the date of birth criteria. About 10% of repondents also mentioned one or more of the following three areas: they were now including juveniles in their data base, including applicants to law

enforcement or other government positions, and offenders who were convicted of lesser offenses than had been originally defined were now being included.

Table 14. Criteria for Modifying Conversion of Manual Files to AFIS Ten Print Data Base: (n=72)

none	36%
date of birth	14%
applicants added	10%
other	40%

Database Size and Composition

We asked agencies the size of their ten print data bases and determined that as of 1990 approximately 31 million ten print cards were included in the data bases (see Table 15). The size of the individual data bases ranged from a low of 65,000 cards to a high of 6.6 million cards. More than 60% of ten print files (19.3 million) are in state data bases; another 11.3 million cards are in city/county data bases; and about 1.5 million are located in regional and private agency systems. The average size of state ten print files is about 806,000; city/county files have on average approximately 390,000 files; and the regional organizations have about 380,000 per data base.

Table 15. Size of Ten Print Data Bases

All Agencies: (n=57)	32,168,000
Average Size by Level of Government:	
regional and private (n=4)	380,250
state and commonwealth (n=24)	805,667
city, county and city/county (n=29)	390,035
Average Size by Vendor:	
MORPHO (n=5)	653,400
NEC (n=25)	849,160
Printrak (n=27)	284,148
Largest ten print data base	6,600,000
Smallest ten print data base	65,000

We inquired if agencies periodically purge their files and we found some do, with the most frequently mentioned criteria being when an individual exceeds a certain age or where a court has ordered that an offender's record be expunged. Other situations warranting a purge would be finding a duplicate record and where the individual has had no criminal activity over a

specified time period. Some agencies employed more than one of these criteria in combination, as where an individual has reached a certain age and has not been re-arrested within "x" years.

We asked about the composition of the data bases and found that, on average, 91% of data bases are composed of adult criminal records (see Table 16). About half of data bases have 1% or fewer noncriminal records in their files, and three-quarters have 5% or less noncriminal prints; the average for all respondents was about 6.6%. In a similar fashion, juveniles make up a very small percentage of files with more than a third having none, and about three-quarters having less than 5%; the average for all respondents was 2.7%. City and county agencies have the highest percentage of juveniles in their data bases (4.0%) and state and commonwealth agencies have the lowest percentage averaging about 1.2%.

Table 16. Data Base Composition: Mean Values

	% Criminal	% Non-Crim	%Juvenile	
all agencies	91.2	6.6	2.7	(n=46)
city & county	92.3	4.5	4.0	(n=24)
regional & private	96.0	2.5	1.5	(n=2)
state & commonwealth	89.3	9.6	1.2	(n=20)

Ten Print Searches

Agencies were asked how long, on average, it takes them to conduct a ten print search (see Table 17). Fifty-eight percent indicated three minutes or less and seventy-four percent, five minutes or less. Eighteen percent had average times in excess of ten minutes.

Table 17. Average Time for a Ten Print to Ten Print Data Base Search: (n=50)

0-3 minutes	58%
3+-5 minutes	16%
5+-10 minutes	8%
10+ or more minutes	18%

We inquired, too, about how many ten print searches are conducted in a typical 24 hour period (see Table 18). Responses ranged from a low of 7 searches to a high of 3150, with an average of slightly more than 300. State agencies make, on average, 519 inquiries daily, regional agencies about 269, and city/county agencies 144.

Table 18. Average Number of Ten Print to Ten Print Inquiries Per Day

By Level of Government:

city, county, city/county	144	(n=26)
regional and private	269	(n=4)
state and commonwealth	519	(n=21)

We also asked agencies for the total number of ten print searches they performed in 1989 and for the first six months of calender year 1990 (see Table 19). Twenty-eight agencies provided data for 1990 indicating a total of 1,032,352 ten print inquiries for the six month period. Broken down by vendor, we find that NEC systems accounted for about 83% of these inquiries.

Table 19. Ten Print to Ten Print Inquiries by Vendor

Calendar Year 1989:

NEC	1,374,321	(n=17)
Printrak	739,744	(n=17)

January-June 1990:

MORPHO	45,452	(n=3)
NEC	861,213	(n=12)
Printrak	125,687	(n=13)

The 1,032,352 inquiries reported resulted in a total of 211,138 "hits" or identifications for an aggregate hit rate of 20%. Table 20 breaks this information out by vendors, showing that NEC systems had the highest hit rate (23%), followed by Printrak (7%) and MORPHO (5%). (Many factors influence hit rates and they cannot be taken out of context as an indicator of vendor performance, see discussion of hit rates in Chapter 5.)

Table 20. Ten Print to Ten Print Hits by Vendor

Calendar Year 1989:

NEC	302,467	(n=17)
Printrak	37,081	(n=17)

January-June 1990:

MORPHO	2,123	(n=3)
NEC	200,039	(n=12)
Printrak	8,976	(n=13)

F. Automated Latent Print Systems

All the agencies which responded to the question (57) indicated they presently used their AFIS systems to search latent prints against their ten print data base. About 93% indicated they routinely search new additions to their ten print data base against their unsolved latent print file. While most AFIS systems have the capability, only about a third routinely search new latents against their unsolved latent file. About 60% of responding agencies indicated they had one or remote sites where incoming latent prints could be entered and their ten print file searched.

Slightly more than half (55%) the AFIS systems had dedicated matchers for latent print searching. This means that both the latent print and ten print inquiries could proceed simultaneously.

Latent Print Data Bases

We asked agencies if they maintained their latent (cognizant) data base separately from their ten print data base (see Table 21). Of the 56 agencies responding, 36% did. There was a fairly sharp distinction among vendors, with only 19% of Printrak users keeping a separate data base, 46% of NEC users, and 60% (3 of 5) of the MORPHO users.

Table 21. Separate Maintainance of Latent Cognizant (Ten Print) Data Base

Among all agencies (n=56).....36%

By vendor system:

MORPHO (n=5).....60%
NEC (n=24).....46%
Printrak (n=27).....19%

Table 22 gives sizes of unsolved latent print data bases in the various AFIS systems. A total of 53 agencies reported 272,467 latent prints in their unsolved data bases, with almost 60% of them in city and county locations. On average, city/county AFIS systems have 6,171 latents in their data bases, regional/private agencies have 5,930, and state/commonwealth have 4,014. By vendor, Printrak systems have the largest latent data bases with an average of 6,318 prints, NEC has 4,470, and MORPHO has 2,007.

Table 22. Size of Unsolved Latent Print Data Bases

All agencies combined (n=53).....272,467

By level of government

city, county, city/county (n=26).....160,445
average 6,171
regional and private (n=4).....23,721
average 5,930
state and commonwealth (n=23).....88,301
average 3,839

By vendor

MORPHO (n=5).....8,028
average 2,007
NEC (n=21).....93,860
average 4,470
Printrak (n=27).....170,579
average 6,318

Latent Print Inquiries

As shown in Table 23, state and commonwealth agencies make, by far, the greatest number of latent print to ten print data base inquiries per day (an average of 64), with regional agencies making an average of 21, and city/county agencies 17.

Table 23. Average Number of Latent Print to Ten Print (or Latent Cognizant) Data Base Inquiries Per Day

By level of government
city, county, and city/county (n=23).....17
regional and private (n=2).....21
state and commonwealth (n=18).....64

Table 24 shows the average time required to conduct latent print to ten print data base searches and ten print to latent print data base searches. Clearly the latent to ten print searches take longer; only 16% of the latent print to ten print searches are completed in 5 or fewer minutes, while 61% of the ten print to latent searches are completed in the same time frame. At the other end of the spectrum, about 70% of the latent to ten print searches take longer than 10 minutes while only 17% of the ten print to latent searches take that more than 10 minutes.

Table 24. Latent Print Search Times

Latent Print to Ten Print Data Base Search Time (n=50)

0-5 minutes	16%
5+-10 minutes	14%
10+-15 minutes	16%
15+-60 minutes	24%
one hour+ or more	30%

Ten Print Card to Latent Print Data Base Search Time (n=41)

0-2 minutes	29%
2+-5 minutes	32%
5+-10 minutes	22%
10+ minutes or more	17%

Latent Print to Latent Print Data Base Search Time (n=10)

0-1 minute	60%
1+-5 minutes	20%
5+-10 minutes	20%

For the productivity of searches, Table 25 provides data showing the number of inquiries made (by vendor) and Table 26 gives the number of identifications made (hits). As noted above and as discussed in detail in Chapter 5, hit rates are affected by a number of important variables and cannot be used as an isolated measure of system performance. We see, however, that for the first six months of 1990, reporting agencies conducted approximately 93,000 inquiries which resulted in 7,610 identifications. This gives an overall "hit" rate of approximately 8%. The reported rate by vendor varies substantially: MORPHO (3%), Printrak (5%), and NEC (13%).

Table 25. Latent Print to Ten Print (or Latent Cognizant) Inquiries by Vendor

Calendar Year 1989:		
NEC	81,338	(n=19)
Printrak	42,944	(n=16)
January-June 1990:		
MORPHO	21,176	(n=4)
NEC	44,025	(n=17)
Printrak	27,711	(n=14)

Table 26. Latent Print to Ten Print (or Latent Cognizant) Data Base Hits by Vendor

Calendar Year 1989:

NEC	9,119	(n=19)
Printrak	2,726	(n=16)

January-June 1990:

MORPHO	678	(n=4)
NEC	5,550	(n=17)
Printrak	1,382	(n=14)

For the same time period, we also asked agencies to report the number of ten print to latent data base inquiries and hits (see Tables 27, 28 and 29). The rate of success with these searches is much lower than for the inquiries described above. Overall, only about 0.3% of ten print to latent data base searches lead to an identification, with the rate extending from .04% (MORPHO) to .89% (Printrak).

Table 27. Average Number of Ten Print to Unsolved Latent Print Data Base Inquiries Per Day

By level of government (n=38)

regional and private	74	(n=2)
city, county, and city/county	109	(n=21)
state and commonwealth	175	(n=15)

Table 28. Ten Print to Unsolved Latent Data Base Inquiries by Vendor

Calendar Year 1989:

NEC	214,702	(n=12)
Printrak	188,362	(n=9)

January-June 1990:

MORPHO	23,032	(n=2)
NEC	214,626	(n=9)
Printrak	74,812	(n=8)

Table 29. Ten Print to Unsolved Latent Data Base Hits by Vendor

Calendar Year 1989:

NEC	971	(n=12)
Printrak	1,096	(n=9)

January-June 1990:

MORPHO	10	(n=2)
NEC	285	(n=9)
Printrak	662	(n=8)

We asked agencies for an estimate of the percentage of their latent to ten print data base inquiries which yielded the identification of juveniles. Only about 45% of agencies responded to this question, but of those who did, more than half reported that none of their hits was a juvenile, with an overall average of 6%.

We also asked agencies if they required that elimination prints be taken/submitted by police officers prior to conducting an AFIS inquiry (see Table 30). Twenty-one percent replied they required it, and an additional 28% stated it was recommended. We also inquired if agency hit rates included so-called elimination hits, i.e., where the AFIS search yielded the identification of one or more individuals who had rightful access to the location in question (a crime victim, police officer, etc). About 53% of the agencies reported that elimination hits were included in their figures.

Table 30. Requirement of Elimination Prints before Latent Inquiry (n=53)

Yes	21%
No	42%
For major cases only	9%
Recommended	28%

We asked about the latent to latent searching and found that although many agencies had this capability (49 of 55 reporting) only 17 made use of it. Search times for these inquiries are included in Table 24.

Agencies were asked to report how many latent identifications were made without the use of AFIS. These identifications are almost exclusively achieved where investigators submit the name of one or more suspects with the latent print and a subsequent comparison yields a match. For the first six months of 1990, 20 agencies reported they made a total of 4,740 hits, or an average of 237 hits per agency. This compares with an average of 217 hits per agency, made over the same period of time using AFIS.

G. User Satisfaction

The survey asked how satisfied AFIS users were with a range of issues concerning their systems. We began by asking if there were things they would do differently if their selection and implemention process were to be repeated. More than 90% of respondents said they would do things differently (see Table 31). The step that most agencies said they would like to change was

the process by which they converted their manual card files to the computer data base (amounting to 47% of the "like to change" responses). Two steps which tied for second place (each constituting 12% of responses) was the need for more benchmark testing of applicant systems and more or better trained personnel. Several agencies (8%) cited problems concerning the clarity of the Request for Proposals (RFP), resulting in differences in interpretation by the vendor and the issuing agency, and the subsequent contract. Other reasons accounted for 21% and included better site preparation and more hardware or software.

Table 31. Things that would be Done Differently if the Implementation Process were Repeated

Would you do anything differently? (n=47)
- Yes.....92%
- No.....8%

Things that would be done differently (n=76)
- conversion process (control, policy,etc.).....47%
- more benchmark testing or research.....12%
- more or better trained staff.....12%
- clarity of contract/RFP..... 8%
- other.....21%

We next asked if there were specific changes which agencies would like to see incorporated in future AFIS systems and if they had any specific expansion plans (see Tables 32 and 33). The primary recommendations for changes centered in the areas of: more user friendly systems, greater speed in handling inquiries, and a live scan interface for entering ten print files. Other reasons comprised 43% and included: automated pattern classification, better conversion process on the part of the vendor, networking capabilities, faster software, improved readers and printers, and statistical report generation.

Table 32. Specific Changes Desired in Future AFIS Systems (n=75)

- more user friendly.....29%
- greater speed with inquiries.....15%
- live scan interface.....13%
- other.....43%

Expansion plans (Table 33) commonly included steps to add (more) remote sites to their system, expansion of their current data bases and introduction of live scan (electronic fingerprinting) procedures. Other responses comprised 57% and included: hiring more personnel, upgrading system, new vendor,

and none due to budget constraints.

Table 33. Expansion Plans (n=76)

addition of remote sites	21%
larger databases	12%
live scan capability	11%
other	57%

We asked about agencies' general satisfaction with their existing systems as well as their satisfaction with specific features. This data is presented in Tables 34 through 47, as indexed below:

Tables 34,35: General User Satisfaction
Tables 36,37: Initial System Set-up
Tables 38,39: Card Conversion
Tables 40,41: Vendor Service
Tables 42,43: Software Upgrades
Tables 44,45: Vendor's Information about Other AFIS Systems
Tables 46,47: Vendor's Training Program

On a scale of 5 (very satisfied) to 1 (very dissatisfied), the mean general satisfaction rating for all respondents was 3.9. As Table 34 indicates, cities and/or counties were generally more satisfied (4.1) than state agencies (3.7). When the score is broken down by vendors we see than NEC users are substantially more satisfied with their systems (4.4) than either MORPHO (3.8) or Printrak (3.6). As Table 35 indicates, it was particularly on the high end of the satisfaction scale where the differences among vendors was greatest: half of NEC users reported they were very satisfied, in general, with their systems, while only a quarter of MORPHO users and 7% of Printrak users.

Table 34. General Satisfaction
(average score: 1=very dissatisfied; 5=very satisfied)

All agencies	3.9	(n=55)
By Level of Government		
city, county, city/county	4.1	(n=28)
regional & private	4.0	(n=5)
state & commonwealth	3.7	(n=22)
By Vendor		
MORPHO users	3.8	(n=4)
NEC users	4.4	(n=24)
Printrak users	3.6	(n=27)

Table 35. Levels of General User Satisfaction: Percentiles

	MORPHO (n=4)	NEC (N=24)	Printrak (N=27)
Level 1	0%	0%	0%
Level 2	25%	0%	0%
Level 3	0%	13%	41%
Level 4	50%	38%	48%
Level 5	25%	50%	7%

As we look throughout specific aspects of the systems, city and/or county agencies were more satisfied with these specifics than were state agencies. In general, agencies were most satisfied with the initial system set up and the way their vendor handled service and equipment problems. The least satisfaction was expressed with the card conversion process and, particularly, the information their vendor supplied about other AFIS systems.

With respect to specific vendors, we find that MORPHO users were most satisfied with the handling of service and equipment problems, software upgrades, and training of agency personnel. They were least satisfied with information supplied about other AFIS systems and the ten print card conversion process. NEC users liked the intial set up and the handling of service and equipment problems most of all, but were least satisfied with information provided about other systems, training and the card conversion process. Printrak users liked the initial set up and the training of agency personnel best, but were least satisfied with information on other systems and the card conversion process.

Table 36. Satisfaction with Vendor's Initial System Set-up
(average score: 1=very dissatisfied; 5=very satisfied)

All agencies.....4.1 (n=53)

By Level of Government

city, county, city/county.....4.5 (n=26)
regional & private.....3.6 (n=5)
state & commonwealth.....3.7 (n=22)

By Vendor

MORPHO users.....4.0 (n=4)
NEC users.....4.3 (n=24)
Printrak users.....4.0 (n=25)

Table 37. Levels of Satisfaction with Vendor's Initial System Set-up: Percentiles

	MORPHO (n=4)	NEC (N=24)	Printrak (N=25)
Level 1	0%	0%	0%
Level 2	25%	0%	16%
Level 3	0%	17%	8%
Level 4	50%	42%	40%
Level 5	25%	42%	36%

Table 38. Satisfaction with Vendor's Card Conversion Process (average score: 1=very dissatisfied; 5=very satisfied)

All agencies.....3.4 (n=51)

By Level of Government

city, county, city/county.....3.5 (n=26)
regional & private.....3.6 (n=5)
state & commonwealth.....3.3 (n=20)

By Vendor

MORPHO users.....3.7 (n=3)
NEC users.....3.5 (n=24)
Printrak users.....3.3 (n=24)

Table 39. Levels of Satisfaction with Vendor's Card Conversion Process: Percentiles

	MORPHO (n=3)	NEC (N=24)	Printrak (N=24)
Level 1	0%	8%	4%
Level 2	33%	13%	17%
Level 3	0%	25%	38%
Level 4	33%	29%	25%
Level 5	33%	25%	17%

Table 40. Satisfaction with Vendor Service (average score: 1=very dissatisfied; 5=very satisfied)

All agencies.....3.9 (n=53)

By Level of Government

city, county, city/county.....4.2 (n=28)
regional & private.....4.0 (n=4)
state & commonwealth.....3.6 (n=21)

Table 40. (continued)

By Vendor

MORPHO users	4.7	(n=3)
NEC users	4.2	(n=23)
Printrak users	3.6	(n=27)

Table 41. Levels of Satisfaction with Vendor Service: Percentiles

	MORPHO (n=3)	NEC (N=23)	Printrak (N=27)
Level 1	0%	0%	0%
Level 2	0%	0%	19%
Level 3	0%	17%	30%
Level 4	33%	44%	22%
Level 5	67%	39%	30%

Table 42. Satisfaction with Vendor's Software Upgrades (average score: 1=very dissatisfied; 5=very satisfied)

All agencies	3.7	(n=49)
By Level of Government		
city, county, city/county	3.8	(n=27)
regional & private	4.3	(n=3)
state & commonwealth	3.4	(n=19)
By Vendor		
MORPHO users	4.3	(n=3)
NEC users	3.8	(n=21)
Printrak users	3.5	(n=25)

Table 43. Levels of Vendor's Software Upgrade Satisfaction: Percentiles

	MORPHO (n=3)	NEC (N=21)	Printrak (N=25)
Level 1	0%	10%	4%
Level 2	0%	0%	12%
Level 3	0%	10%	24%
Level 4	67%	67%	48%
Level 5	33%	14%	12%

Table 44. Satisfaction with Vendor's Information about Other AFIS Systems
(average score: 1=very dissatisfied; 5=very satisfied)

All agencies.....2.8 (n=47)

By Level of Government

city, county, city/county.....2.8 (n=26)
regional & private.....4.0 (n=2)
state & commonwealth.....2.7 (n=19)

By Vendor

MORPHO users.....2.7 (n=3)
NEC users.....2.9 (n=21)
Printrak users.....2.7 (n=23)

Table 45. Levels of Satisfaction with Vendor's Information about Other AFIS Systems: Percentiles

	MORPHO (n=3)	NEC (N=21)	Printrak (N=23)
Level 1	33%	24%	13%
Level 2	0%	10%	26%
Level 3	33%	29%	44%
Level 4	33%	24%	9%
Level 5	0%	14%	9%

Table 46. Satisfaction with Vendor's Training Program
(average score: 1=very dissatisfied; 5=very satisfied)

All agencies.....3.8 (n=51)

By Level of Government

city, county, city/county.....3.8 (n=26)
regional & private.....4.0 (n=4)
state & commonwealth.....3.4 (n=21)

By Vendor

MORPHO users.....4.3 (n=3)
NEC users.....3.5 (n=22)
Printrak users.....3.7 (n=26)

Table 47. Levels of Training Program Satisfaction: Percentiles

	MORPHO (n=3)	NEC (N=22)	Printrak (N=26)
Level 1	0%	5%	4%
Level 2	0%	23%	12%
Level 3	0%	23%	27%
Level 4	67%	18%	27%
Level 5	33%	32%	31%

H. Effects on Agency

We asked agencies what they considered to be the overall organizational effects (impact) and their AFIS system with respect to personnel, space and workload issues (see Table 48). By and large, agencies were most positive with respect to the impact of AFIS on the capabilities and morale of personnel. They noted little effect with respect to how it had influenced the level/number of personnel and space in their unit. There was unanimity that AFIS had dramatically increased their workloads (which, of course, was being handled at a faster rate). Many of the respondents commented that their agencies had not provided them with adequate resources (namely personnel) to respond to the increased flow of cases demanding processing. As a consequence, managers commented that they felt there systems were underutilized for lack of personnel to enter and process data. The effect on space, overall, seemed not to be a problem area.

Table 48. Agencies Indicating Positive, Negative or No Effect of AFIS Implementation on Organizational Factors

Effect on:	Pos.	Neg.	None	(n)
Number of Personnel	44%	21%	35%	(51)
Capabilities of Personnel	86%	8%	6%	(49)
Space	42%	30%	28%	(49)
Morale	88%	10%	2%	(50)
Workload	86%	8%	8%	(47)

In terms of the principal impact of AFIS on agencies since its implementation (see Table 49), the most frequently mentioned impact by far was AFIS's role in solving otherwise unsolvable crimes through latent prints (constituting 37% of references). There was another group of outcomes, each of which made up between 10-12% of responses: the overall increased speed and accuracy of the system, the expediting of the ten print search and identification process, and an overall greater awareness of the value of technology to law enforcement.

Table 49. Principal AFIS Impact Since Implementation (n=82)

solving otherwise unsolvable crimes.....37%
increased speed & accuracy of process.....11%
greater awareness of value of technology.....12%
expedited ten print search process.....10%
other.....30%

We asked specifically if the AFIS manager believed this technology had had an impact on the investigation and processing of criminal cases (see Table 50). The greatest consensus fell in the criminal investigation area where 73% of respondents believed AFIS did have an appreciable impact. With respect to prosecutions, 52% believed AFIS had registered an impact, but almost as many stated they simply didn't know. Concerning its impact on sentencing and the crime rate, more than three-quarters replied they didn't know and less than 20% believed that it had.

Table 50. Agencies Reporting an Impact of AFIS on the Investigation and Processing of Criminal Cases

criminal investigations	73%	4%	23%	(52)
prosecutions	52%	6%	42%	(52)
sentencing	17%	6%	77%	(52)
crime rate	19%	6%	75%	(52)

With regard to public relations, the majority (70%, n=46) responded they believed AFIS had a positive impact. The most commonly mentioned public relations impact had been media coverage of AFIS through television and print media (see Table 51). Others mentioned the impact of latent print identifications and their coverage in the press. The press issue is an interesting one in that about a quarter of responses (27%) mentioned that media coverage had been very "low key". In several jurisdictions this was by design. Some AFIS managers clearly believe that widespread publicity concerning the merits of AFIS can actually hurt the law enforcement mission by alerting criminals and influencing them to wear gloves and taking extra precautions to insure they don't leave their prints at crime scenes. These managers were content in letting AFIS do its job but purposefully avoiding the release of information to the press that might lead offenders to be more careful.

Table 51. Type of Public Relations Impact of AFIS Implementation (n=34)

media coverage (t.v., newspapers)	38%
"very low key"	27%
through latent identifications	12%
other	21%

We also asked if the agency had taken any steps to recognize AFIS personnel who had either fingerprinted arrestees who were subsequently identified or had developed latent prints which AFIS subsequently matched (see Table 52). About half of respondents replied affirmatively and another ten percent indicated such procedures were planned. The three most common means of recognition were a departmental letter to the individual commending him/her on their work, a pin or certificate to the officer, and the posting of the achievement in the work environment.

Table 52. Programs in Place for Recognition of Personnel for AFIS-related Achievements (n=50)

yes	50%
no	38%
planned	12%

I. Quality Assurance

We asked agencies several questions regarding steps they take to monitor the accuracy with which their AFIS performs its searching and identification process. First we asked if scores of latent prints leading to an initial hit were compared with scores for the same latent print submitted at a later time. In other words, is the AFIS recognizing and registering the same information from latent and ten prints in a reproducible fashion. Fifty-six percent (n=50) reported they did perform such procedures and another 20% indicated they planned to take such steps in the future. About 44% (n=50) indicated they currently evaluate the proficiency of latent print examiners in their preparation of latent prints for AFIS inquiry. Another 16% indicated such steps were planned. Inked prints taken by booking officers were evaluated by 29% of the agencies (n=49) and another 16% indicated they planned to.

We also inquired if agencies checked to determine if their AFIS systems continued to meet design specifications in terms of capacity, speed and accuracy. In excess of 80% of all agencies indicated they did all three: 87% said they verified capacity, 84% indicated they verified speed, and 83% said they checked

their system's accuracy. For those who checked on design capacity, 87% of respondents said their system met or exceeded its design capacity; 84% reported it met or exceeded its speed specifications; and 83% indicated it met or exceeded accuracy specifications (see Table 53).

Table 53. Systems Reported to Continue to Meet Design Specifications of Capacity, Speed and Accuracy

Capacity	Yes	No	Don't Know	(n)
All Agencies	87%	4%	9%	(52)
MORPHO	100%	0%	0%	(3)
NEC	91%	0%	9%	(22)
Printrak	82%	7%	11%	(27)

Speed	Yes	No	Don't Know	(n)
All Agencies	84%	8%	8%	(51)
MORPHO	100%	0%	0%	(3)
NEC	90%	0%	10%	(21)
Printrak	78%	15%	7%	(27)

Accuracy	Yes	No	Don't Know	(n)
All Agencies	83%	4%	13%	(52)
MORPHO	100%	0%	0%	(3)
NEC	91%	0%	9%	(22)
Printrak	74%	7%	19%	(27)

J. Networking

The last group of questions asked users about their networking with other data bases and remote sites outside their jurisdiction (see Table 54). When asked about outside networking, 45% of respondents indicated they did. Of those that did, 65% said they did it routinely and 35% reported they did it in special cases only. Almost 90% of the networking agencies indicated they did it with both latent and ten prints. Practically all the networking is done among agencies using the same vendor.

Table 54. Networking Outside AFIS Jurisdiction

Performed at All? (n=58)
- yes.....45%
- no.....53%
- planned.....2%

How Often? (n=26)
- routinely.....65%
- special cases only..35%

Network with: (n=27)
- latents prints.....7%
- ten prints.....4%
- both.....89%

CHAPTER 5. DISCUSSION

Much of the survey information speaks for itself. Although less systematic, our site visits and telephone interviews uncovered additional issues which probably represent the principal concerns of AFIS users. In this chapter we will present these issues and highlight key aspects of the survey data.

A. Survey Response

Ultimately we found almost all AFIS database agencies to be enthusiastic and cooperative participants in our survey. Initially we met with some resistance for a variety of reasons. It was apparent that our study was one of a large number of survey-type inquiries received at AFIS system sites and that personnel were in many cases reluctant to spend time filling out "yet another survey." Our experimental design, however, specifically addressed these difficulties:

- we asked for a minimum of information in our initial contact letter
- we established a personal contact in each agency who had the responsibility to respond to survey requests
- our contact utilized a staff member who had actually done fingerprint work for a police agency
- we acknowledged and expressed appreciation for the effort required to respond to the survey
- we provided, through advance mailing and follow-up telephone data collection, the opportunity to collect the needed information and to convey it with a minimum of effort

Our project goals also differed from most of the surveys in that our intent was to provide a research product to help guide management and policy issues, rather than to justify a specific purchase, promote a commercial product or advocate a specific practice.

Eventually 53 of 62 agencies (86%) provided complete information, and another 5 gave partial responses. Only four agencies did not respond. Two of these were in the implementation phase and could not reasonably respond to most of the survey questions. The other two agencies steadfastly refused to participate. On the whole we are very pleased with the response rate and agency participation.

B. Currency of information

User conferences are a major source of current information regarding AFIS systems, now well-established for each of the major vendors. During consideration of alternative systems, active participation in these user group conferences may be the

best way to keep current and to establish partnerships with agencies with the systems under consideration.

C. Budgetary Support

An expected, critical issue in the procurement and management of AFIS systems is their cost. Funding mechanisms for procurement vary substantially, from the early federally-funded systems, to specific bond issues and specific legislation. The politics and opportunities of each setting dictate this initial budgeting, but what appears to be a substantial problem is the availability of funds for upgrades, maintenance and operations. Along with many examples of reasonably funded systems. We encountered a number of extremely unfortunate circumstances where insufficient funding, following initial budgeting for an AFIS system, has crippled the operation. Continued financial and political support is needed to promote and insure maximum utilization of AFIS systems.

Cost-sharing between local police agencies, using the AFIS, and a state, county or regional AFIS database agency, is common, but does not ensure cooperation among agencies or sufficiency of funds to meet future needs.

Cooperation appears to be of the utmost importance in achieving the efficient use of these systems. One state agency that has been operational for well over a year and has yet to see major participation from its local agencies. Operators state that they "have to beg" for latent submissions and that many local agencies claim to have been unaware of the system when told about it, yet rarely utilize it once they are aware.

Older, less capable systems may create low expectations among both the operating and using agencies. Since there is already an AFIS, there is little political leverage for additional funding. The importance of realistic and reasonably assured continued funding of the system is critical.

Another county agency experienced initial refusal of local police agency participation, even though these agencies paid user fees. During the card conversion process many local agencies refused to submit their ten print cards, not wanting to lose "control" to the central agency. Now, even if such in-fighting is resolved, the additional costs of conversion and the necessary system upgrade will significantly encumber development of a functionally healthy AFIS system.

D. Planning

Failing to plan adequately or to readjust to unexpected costs can also have a severe effect on the AFIS system. One

agency, failing to anticipate the costs associated with air conditioning of the system, elected to omit an originally-funded image retrieval from their system. Without this, any hit candidate cards must be manually pulled from files and a verification effected. There is little prospect for the funding needed to upgrade the system in the wake of the initial procurement and the agency is faced with an ongoing, increasing, manual burden.

E. Card Conversion

Difficulties with the initial card conversion process was the most frequently cited problem among all AFIS users. We also encountered numerous specific complaints during our telephone interviews and site visits.

Agencies usually have an option of having the vendor convert the card files or doing it themselves. The costs and security of the card files are issues that have caused a handful of agencies to elect to convert the cards themselves, on-site. These conversions have, for the most part, been either financially or functionally unsuccessful. The difficulty is that it is an intensely time consuming, one time operation that requires familiarity with fingerprints, responsibility and skill. Hiring tens of extra staff with these qualities is not really feasible and using existing staff continues the process considerably and has caused extensive delays and backlogs in routine operations. One agency attempted on-site conversion by hiring about a hundred untrained staff and working three shifts. Major problems with the card conversion personnel resulted and ultimately the task was referred back to the vendor.

Another major difficulty with conversion has occurred as the older models of AFIS take on image-retrieval upgrades. Reconversion (or re-scanning) of the original data is then needed since the digital records do not have the optical information in them. One agency, after converting their inked cards, destroyed them, maintaining a backup system on microfiche. This appeared to be sufficient for all foreseeable needs. A new system upgrade was then purchased. Electronic files of the old system were not compatible with the upgrade, so reconversion of the original data was necessary. It was then found that the microfiche backup records were not suitable for this re-conversion, resulting in a disastrous effective loss in data.

F. The Ambiguity of Hit Rates as a Summary Statistic

Perhaps the greatest area of misunderstanding in AFIS system evaluation is the use of "hit rates" as a summary statistic. Hit rates, loosely defined, are the number of identifications made

divided by the number of searches. A critical examination of hit rates is necessary in order to appreciate their value and limitations.

Hit rates may be defined by the system vendor, but usually they are defined by the user agency. Recall that a search produces a candidate list in the order of matching score. The agency has a specified limit on how far down this list the (manual or computer-assisted) comparison will proceed. If the print is identified within the agency-specified limit (e.g. in the top ten candidates) then a "hit" is recorded. If the number eleven candidate is identified to the search print, then, by some interpretations, the search will not have "contractually" resulted in an AFIS "hit." Other vendors and agencies may simply say "a hit's a hit"; that if a search print is identified to a candidate then AFIS did its job.

The inclusion of "elimination hits" is another variation in this statistic. If a crime scene print is found through AFIS to be that of the investigating officer, or of the emergency response team to a violent crime, then this would be, by many agencies, included as a hit.

In the sense above "hits" are used as an evaluation of the AFIS system. Sometimes this has contractual implications, in which case the term must necessarily be rigidly defined. We should recognize, however, a series of related statistics, most of which are not routinely kept by AFIS agencies. Three additional statistics are accuracy rates, clearance rates, and suspect identifications.

Hit rates can be left as the percent of searches where the search print is correctly matched to standard prints in the database, including elimination hits. Accuracy rates measure the percent of searches where the correct record is matched in the number 1 position. Clearance rates are based on the number of crime reports that are resolved through the identifications, whereas suspect identifications are the number of searches which result in matching a crime scene print with a new suspect.

It should be apparent that care is necessary in defining these measures. For example, consider a case containing five unidentified latents. One latent is searched and subsequently identified to an AFIS candidate. As a result of this AFIS "hit", the other four non-searched latents are identified to the same individual (or to a known accomplice). The results of the AFIS search may either be recorded as one AFIS hit or five AFIS hits (in the sense that one AFIS hit resulted in identifying all five). The flexibility in defining these statistics should be appreciated and controlled for in any serious attempt to compare agencies or to study changes in one agency over time.

In addition to these definition-related aspects, system

factors also greatly affect hit rates. The larger and more comprehensive the database, the more likely it is, perhaps, to contain a record of the person who actually made the print. Higher quality data will facilitate matches, as will higher quality latents. Operator skill and experience, and the search covariables will also influence the frequency of hits. Superimposed on all of these variables is the accuracy of the matching algorithm itself.

Each of the variables mentioned above must be carefully considered before hit rates can be used as a meaningful comparative measure between systems. If the variables are otherwise constant, a consistently defined hit rate can none-the-less be of use to monitor variations in the performance of a single system.

G. Quality of Input Material

The major limiting factor on AFIS performance was the quality of input material: 10-print cards and latents. Training and quality control will improve this to some extent, and some agencies put considerable emphasis in this area. Awards systems are in place, for example, for officers who develop latent fingerprints which result in the identification of a suspect or elimination of an individual; and where rolled inked prints, when registered to the AFIS data base leads to a verified identification in the unidentified latent file. or where AFIS evaluates at least six of eight rolled prints to be of top quality.

Another approach is the "integrated system" where crime scene investigators are involved all the way through the process: they collect prints, prepare them for searching, perform the searching, make the identifications, and testify to them in court. This approach has been highly successful, but obviously cannot be applied where a number of agencies are submitting material to a central facility. One agency had used an integrated approach upon the initial introduction of their AFIS system. This resulted in high quality control and a very high hit rate not seen at any other police agency. However, because of the increase in workload brought about by AFIS, and AFIS expansion, specialization was introduced and tasks were divided among several different technicians and examiners. This brought about a reduction in quality of latents, inked ten prints and AFIS inquiries and directly affected the hit rate.

It is clear that the latent print collection phase is critical and that AFIS systems operate most effectively where officers are motivated to collect high quality latents.

The taking of elimination prints and making preliminary elimination searches is an important part of the process. Where

personnel are involved in the entire case process it will be worth the effort to conduct these comparisons so that time will not be wasted further on in the case.

H. Quality Control

Quality control programs were found to be in the implementation stages in many agencies. One agency had a particularly ambitious program, designed to test both the computer and the personnel who operate it. There were five components:

- inked print cards previously searched would be searched again and their scores compared, looking for any degradation in the system.
- technicians would be checked for consistent evaluation and orientation of latent prints selected for testing these operations
- the system would be checked by resubmitting latents that had hits and rechecking scores and candidate lists
- examiners would be given 1:1 photos of latent prints, some of which may have been "hits" with different scores on candidate lists. Examiners would then prepare and enter each latent. The work would be reviewed by a senior technician.
- every person using the system would have a unique identifier, making it possible to compute such statistics as search time per latent, number of latent searches and "hits"

I. Mature System Operation

The long range effect of AFIS on latent comparison operations is beginning to emerge in some jurisdictions. Before AFIS cold hits were quite rare in all jurisdictions. Identifications were usually made when suspects were developed in a particular case and their fingerprints were directly compared to the latents in that case. As these systems mature more and more identifications are seen to be made on the AFIS database. This occurs as a local agency develops their database to the point where most of the offenders in an area are represented and where proficiency in AFIS procedures is developed.

Some of the most successful systems are those where local databases can be developed and local control remains over searching operations. This is most directly achieved in smaller, self-contained agencies, but some of the larger networked systems maintain the same local control through their policies and remote sites.

The great majority of hits made in latent print searches are from the local data bases as opposed to state or regional searches.

I. Future Recommendations

A well-controlled, specific study of AFIS impact is indicated. The ultimate effect of AFIS on arrests, prosecutions and sentencing is of interest, along with studies of the efficiency of operations. The greatest impacts will remain the efficiency of 10 print searching and the ability to conduct cold searches. To evaluate the impact of AFIS essentially involves the evaluation of these two principal effects.

The present study is preliminary in scope and it was dependent primarily subjective agency self-evaluations, supplemented with information developed at some specific sites. There is a need for a external, controlled study that would allow variables in policy and procedure to be evaluated with respect to overall efficiency and effectiveness.

In conducting such a study a number of areas of difficulty will be encountered. One is that the effect of AFIS systems will be difficult to separate from the effect of fingerprint identifications themselves. It is the same scientific evidence regardless of whether an AFIS selects a candidate record or whether the record comes through developing a suspect via traditional investigation. It will also be difficult to separate the effect of AFIS from additional evidential variables in a case. Where a cold search is responsible for developing a suspect, however, we can reasonably expect that that case would have remained unsolved, at least for some time, and where rapid 10 print identifications on minor arrests result in discovery of outstanding warrants, we can reasonably expect that the arrestee would have otherwise been released.

Tracking of cases, for a variety of reasons, was encountered in a number of agencies, but these were self-guided. In order to compare the performance of different systems in different agencies, and to benefit from the elicited information, consistent methods need to be applied for each system.

Study of the satisfaction of police agencies who are users of others AFIS systems is also of importance. This study did not address this important issue.

APPENDIX A: SURVEY DOCUMENTS

UIC The University of Illinois at Chicago

Department of Pharmacodynamics (M/C 865)
College of Pharmacy
Box 6998, Chicago, Illinois 60680
(312) 996-0888 Fax: (312) 996-0098

May 19, 1990

Dear AFIS Administrator:

We are engaged in a national study of Automated Fingerprint Identification Systems, with the support of a grant from the National Institute of Justice. Our basic goal is to identify and describe the operations of all AFIS systems throughout the United States. To the best of our knowledge there is no single resource which contains this type of information and we feel it would be useful to practitioners, policy makers and researchers alike. Included in such a document would be information describing the size and composition of data bases, basic information on system performance (latent and ten print identifications), and the direction these systems seem to be headed in the future. We are also interested in any "impact" studies you may have completed which have documented the role of AFIS in solving crimes, and prosecuting and sentencing offenders. We are most interested in producing a product which examines the full range of effects these systems are having on the justice system and how that impact can be improved.

Collectively we have experience in fingerprint classification, identification, evidence evaluation and statistical methods. We have monitored the progress of AFIS systems over the past ten years and are excited by the prospects of creating a document of the type we have described.

At this stage in the project, we are contacting all agencies in the country which have AFIS data bases and requesting summary information along with the name of the appropriate person in each agency with whom we can make further contact. We also ask that you provide the names and addresses of remote sites which make inquiries to your data base. Could you also supply us with any information you may have already prepared which describes the origins, characteristics and performance of your AFIS system? We have learned that different agencies also have different policies with respect to maintenance of information about their systems. For that reason, we also ask that you include a summary of recent (1989 if possible) statistical data that describes the size of your data base(s), number of inquiries made to the system, identifications made (ten print and latents), and any other important characteristics.

Enclosed is a very brief information sheet which we ask that you complete and return in the postage paid envelope. We have placed extra postage on return envelopes so you can include any additional information and statistics on your AFIS system. We would be most appreciative if you would return this information as soon as possible.

We greatly appreciate your assistance and we look forward to working with you on this project. If you have any questions, please feel free to call us collect at (312) 996-2764.

Sincerely,

David J. Klug, Graduate Research Assistant, Forensic Sciences
Joseph Peterson, Associate Professor & Head, Department of Criminal Justice
David A. Stoney, Assistant Professor & Director of Forensic Sciences

UNIVERSITY OF ILLINOIS AT CHICAGO
Criminal Justice Department
Center for Research in Law and Justice

AFIS - Operating Agencies Questionnaire

1. Agency: _____

2. Address: _____

_____

_____

3. Telephone No.: _____

4. Contact Person: _____

5. Make/Model AFIS: _____

6. Month/Year AFIS went Operational: _____

7. Number of Remote Sites: _____

Please attach list of remote sites/users names and addresses

UIC The University of Illinois at Chicago

Department of Pharmacodynamics (M/C 865)
College of Pharmacy
Box 6998, Chicago, Illinois 60680
(312) 996-0888 Fax: (312) 996-0098

July 27, 1990

Dear AFIS Administrator:

Enclosed is a copy of the AFIS Operating Agency survey which we have prepared to gather basic information about AFIS around the country. We received a high (95%+) response rate to our initial mailing and have received many valuable comments and suggestions. We are most grateful for your assistance thus far. We have attempted to formulate questions the answers to which will be of interest to most AFIS managers.

Before you read through the survey, we would like to make several important points and assurances:

1. Your responses will be treated confidentially; replies will not be linked to particular agencies but will be summarized in aggregate form. All agencies participating in the survey will receive a copy of the results.

2. We will be administering the survey over the telephone. Overall, we think this will save time on both our parts and will allow us to clarify any ambiguities or questions you might have over the telephone.

3. Some of the questions ask you to provide statistical information on your system. We have tried to limit these questions and only to ask those where most agencies keep such records. Nevertheless, we recognize there may be some where you don't have the data. If you don't keep this information, please skip that question and answer those you can. Your input on the remaining questions is important to us.

4. We plan to begin making calls to agencies beginning on August 6. If you could read through the survey now and begin gathering the statistical information, we can hopefully complete the form in a single call. If that isn't possible, we will follow it up with another call.

Thank you, again, for your assistance and we look forward to talking to you in a couple of weeks.

Sincerely,

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AFIS Operating Agencies Survey

Date_____

AGENCY INFORMATION

1. Name of agency_____

   _____

2. Survey respondent_____

3. Nature of jurisdiction(s) primarily served:

   a. Level of government_____

   b. Population_____

4. Location of automated ten print system:

   a. organizationally_____

   b. physically_____

5. Location of automated latent print system:

   a. organizationally_____

   b. physically_____

BASIC SYSTEM INFORMATION

6. Vendor name/model_____

7. Number of remote sites_____

8. Approximately how many hours per day is ten print system available_____; in use_____.

9. Approximately how many hours per day is latent print system available_____; in use_____.

SYSTEM SELECTION

10. What were the initial problems/conditions that led your agency to acquire an AFIS? List up to three reasons.

_____

_____

_____

_____

11. On what basis did you select your present vendor/model over the competition? List up to three reasons.

_____

_____

_____

_____

12a. Aside from the present one, has your agency ever had a different AFIS? Y/N

b. If yes, please explain._____

_____

NOTE: All subsequent questions refer to your present system.

13. When was AFIS installed at your agency?_____

14. When did AFIS become operational at your agency?_____

15. When was AFIS legally accepted by your agency (or appropriate regulating body)?_____

COSTS

16. What were the initial start-up costs for establishing your AFIS in regard to:

    a. Hardware/software $_____

    b. Conversion $_____

    c. Site preparation $_____

    d. Total $_____

17. Please briefly describe the funding formula used to finance your system._____

_____

_____

18. What was the annual operating cost (including personnel, equipment, maintenance) of AFIS for fiscal 1990?

_____

TEN PRINT TO TEN PRINT SEARCHING

NOTE: Questions 19-30 refer to ten print to ten print searching only.

19. Which of the following ten print search capabilities does your AFIS have?

a. Automatic classification of pattern types Y/N

b. Image sub-system (optical storage) Y/N

c. Live scan/electronic fingerprinting Y/N

d. Ten print registration from remote sites Y/N

e. Ten print searching from remote sites Y/N

f. Dedicated matchers for ten print searching Y/N

g. Reinquiries to search other data bases Y/N

h. Other_____

_____

20a. What criteria were used for conversion of your manual file to AFIS data base?_____

_____

b. Have these criteria been subsequently modified?_____

_____

21a. What is the design size (capacity) for your ten print data base?_____

b. Currently, what is the size of your ten print data base?_____

22. What criteria do you use to purge your data base?_____

_____

23. On average, how long does it take to conduct a ten print search?_____

24. On average, how many ten print searches are conducted in a 24 hour period?_____

25. How many fingers per ten print card are registered into the data base?_____

26. Which fingers are used in conducting ten print searches?_____

27. Approximately what percent of the following ten prints compose your data base?

	Adult	Juvenile
Criminal	_____%	_____%
Non-Criminal	_____%	

28. How many ten print searches were performed in:

a. Calendar year 1989_____

b. January - June 1990*_____

*On this and subsequent questions, only if data for this most recent six month period are readily available.

29. How does your agency define a "ten print hit"?_____

_____

30. How many ten print searches resulted in hits in:

a. Calendar year 1989_____

b. January - June 1990_____

LATENT SEARCHING

NOTE: Questions 31-41 refer to latent searching only.

31. Does your AFIS have the following latent print search capabilities? Do you use it?

		Capability	Used
a.	Latent to ten print	Y/N	Y/N
b.	Ten print to latent	Y/N	Y/N
c.	Latent to latent	Y/N	Y/N
d.	Latent print registration from remote sites	Y/N	Y/N
e.	Latent print searching from remote sites	Y/N	Y/N
f.	Dedicated matchers for latent searching	Y/N	Y/N
g.	Other_____		

_____

32. Is the latent (cognizant) data base maintained separately from the ten print data base? Y/N
(If no, please skip to Question 35.)

33a. What is the design size (capacity) for this latent data base?_____

b. Currently, what is the size of your latent data base?_____

c. What criteria do you use to purge your latent data base?

_____

34. What is the approximate breakdown of the ten prints in this latent data base?

	Adult	Juvenile
Criminal	_____%	_____%
Non-Criminal	_____%	

35a. What is the specified design size (capacity) for your unsolved latent data base?_____

b. Currently, what is the size of your unsolved latent data base?_____

c. What criteria do you use to purge your unsolved latent data base?_____

_____

36. On average, how long does it take to conduct the following searches:

    a. Latent to ten print _____

    b. Ten print to latent _____

    c. Latent to latent _____

37. On average, how many latent inquiries are conducted in a 24 hour period in the following search catagories:

    a. Latent to ten print _____

    b. Ten print to latent _____

    c. Latent to latent _____

38. How many latent to ten print searches were performed during:

    a. Calendar year 1989_____

    b. January - June 1990*_____

    *On this and subsequent questions, only if data for this most recent six month period are readily available.

39. How does your agency define a "latent hit"?_____

    _____

40. How many latent to ten print searches resulted in hits in:

    a. Calendar year 1989_____

    b. January - June 1990_____

    c. What percent of these hits were juveniles?_____

    d. Are "elimination hits" included in these figures? Y/N

41. How many ten print to latent searches were performed in:

a. Calendar year 1989_____

b. January - June 1990_____

42. How many of these searches resulted in hits in:

a. Calendar year 1989_____

b. January - June 1990_____

43. How many latent to latent searches were performed in:

a. Calendar year 1989_____

b. January - June 1990_____

44. How many of these searches resulted in matches in:

a. Calendar year 1989_____

b. January - June 1990_____

45. How many latent identifications were made <u>without</u> the use AFIS in:

a. Calendar year 1989_____

b. January - June 1990_____

46. Must elimination prints be obtained and compared to the questioned latents prior to an AFIS inquiry? Y/N
Please explain._____

_____

_____

USER SATISFACTION

47. In general, how satisfied are you with your AFIS operations?

Please circle

Very Satisfied				Very Dissatisfied
5	4	3	2	1

48. More specifically, how satisfied have you been with your vendor with regard to:

	Please Circle				
	Very Satisfied				Very Dissatisfied
a. Initial set up. 5	4	3	2	1
b. File conversion(s).....5	4	3	2	1
c. Service/equipment problems. 5	4	3	2	1
d. Software upgrades. 5	4	3	2	1
e. Information/documentation about other AFIS.....5	4	3	2	1
f. Training of agency personnel.....5	4	3	2	1

49. If you were able to repeat the entire implementation process, would there be things you would do differently based on your present knowledge and experience with AFIS? Please specify._____

_____

_____

_____

50. Are there specific changes you would like to see incorporated in future AFIS? Please specify._____

_____

_____

51. Do you have any plans for expansion? Please specify._____

_____

_____

EFFECTS

52. What have been the overall organizational effects (impact) on the Identification Bureau/Crime Laboratory/Crime Scene Unit in regard to:

	Positive (+)	No Effect	Negative (-)
a. Number of personnel	_____	_____	_____
b. Capabilities of personnel	_____	_____	_____
c. Space	_____	_____	_____
d. Morale	_____	_____	_____
e. Workload	_____	_____	_____

NOTE: If you feel these effects have been very different for the units involved, you may duplicate this table and answer the question for each relevant unit, or we can discuss these differences over the phone.

53. What has been the principal AFIS impact on you agency as a whole?_____

_____

_____

54. Has AFIS had an appreciable impact on the following activities? Please circle.

a. Criminal investigations Yes/No/Don't know

b. Prosecutions Yes/No/Don't know

c. Sentencing Yes/No/Don't know

d. Crime rate Yes/No/Don't know

e. Explanation (if necessary)_____

_____

_____

55a. Are personnel recognized for having either developed an AFIS suitable latent or taken inked fingerprints which result in identifications? Y/N/Planned

b. If yes, with what type of recognition?_____

_____

56. Do you believe AFIS has had a public relations impact on your community? If so, in what way?_____

_____

_____

QUALITY ASSURANCE

57. Does your agency continue to monitor the accuracy with which your AFIS performs the following functions:

a. Resubmitting a selected number of latent prints where hits were made and comparing the first hit scores with hit scores achieved in a follow-up inquiry.
Y/N/Planned

b. Proficiency testing of Latent Print Examiners in terms of their preparation of latent prints for AFIS inquiry?
Y/N/Planned

c. Proficiency testing of personnel in terms of fingerprinting individuals?
Y/N/Planned

58. Has the system continued to meet the design specifications established for the following criteria? Please circle.

a. Capacity	Yes/No/Don't know
b. Speed	Yes/No/Don't know
c. Accuracy	Yes/No/Don't know

NETWORKING

59a. In addition to serving as data base, is your agency networking with data bases or remote sites outside your jurisdiction? Y/N

b. If so, is this networking done routinely or only in special circumstances (e.g. serial crimes)?_____

c. Is networking done with latents, ten prints, or both?_____

d. Is networking with AFIS done using the same vendor? Y/N

e. Is networking with AFIS done using different vendors? Y/N

60a. Are any of your remote sites networking with data bases outside their jurisdiction? Y/N

b. If so, can your remote sites network directly these data bases or is that networked through their data base (you)?

APPENDIX B: LIST OF AGENCIES SURVEYED

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(These agencies maintain an AFIS database)

Alameda County Sheriff's Department, Hayward, CA
Alaska Department of Public Safety, Anchorage, AK
Albuquerque Police Department, Albuquerque, NM
Austin Police Department, Austin, TX
Baltimore Police Department, Baltimore, MD
California State Department of Justice, Sacramento, CA
Chicago Police Department, Chicago, IL
Cleveland Police Department, Cleveland, OH
Colorado Bureau of Investigation, Denver, CO
Contra Costa County Sheriff-Coroner, Martinez, CA
Dallas Police Department, Dallas, TX
Delaware State Police, Dover, DE
Florida Department of Law Enforcement, Talahassee, FL
Georgia Bureau of Investigation, Decatur, GA
Hawaii Criminal Justice Data Center, Honolulu, HI
Houston Police Department, Houston, TX
Illinois State Police, Springfield, IL
Indiana State Police, Indianapolis, IN
Indianapolis Police / Marion County AFIS, Indianapolis, IN
Iowa Division of Criminal Investigation, Des Moines, IA
Jacksonville Sheriff's Office, Jacksonville, FL
Kansas Bureau of Investigation, Topeka, KS
Kentucky State Police, Frankfort, KY
King County Police Department, Seattle, WA
Los Angeles County Sheriff's Department, Los Angeles, CA
Los Angeles Police Department, Los Angeles, CA
Louisiana State Police, Baton Rouge, LA
Massachusetts Department of Public Safety, Boston, MA
Metro Dade Police Department, Miami, FL
Metropolitan Police Department, Washington, DC
Miami Police Department, Miami, FL
Michigan Department of State Police, Lansing, MI
Milwaukee Police Department, Milwaukee, WI
Minneapolis Police Department, Minneapolis, MN
Minnesota Bureau of Criminal Apprehension, St. Paul, MN
Missouri State Highway Patrol, Jefferson City, MO
Nassau County Police Department, Mineola, NY
New Jersey State Police, West Trenton, NJ
New Orleans Police Department, New Orleans, LA
New York State Division of Criminal Justice Services, Albany, NY
North Carolina Bureau of Investigation, Raleigh, NC
Northern Illinois Police Crime Laboratory, Highland Park, IL
Northern Virginia Regional Information System, Fairfax, VA
Oklahoma City Police Department, Oklahoma City, OK
Orange County Sheriff's Department, Santa Ana, CA
Riverside County Sheriff's Department, Riverside, CA
San Diego Sheriff's Department, San Diego, CA
San Francisco Police Department, San Francisco, CA
San Jose Police Department, San Jose, CA
Shelby County Sheriff's Department, Memphis, TN
South Carolina Law Enforcement Division, Columbia, SC
St. Paul Police Department, St. Paul, MN
Suffolk County Police Department, Yaphank, NY

Pierce County Sheriff's Department, Tacoma, WA
Puerto Rico Police, San Juan, PR
Pennsylvania State Police, Harrisburg, PA
Regional Justice Information Service, St. Louis, MO
Tennessee Bureau of Investigation, Nashville, TN
Virginia Department of Criminal Justice Services, Richmond, VA
Washington State Patrol, Olympia, WA
Western Identification Network, Inc., Sacramento, CA