

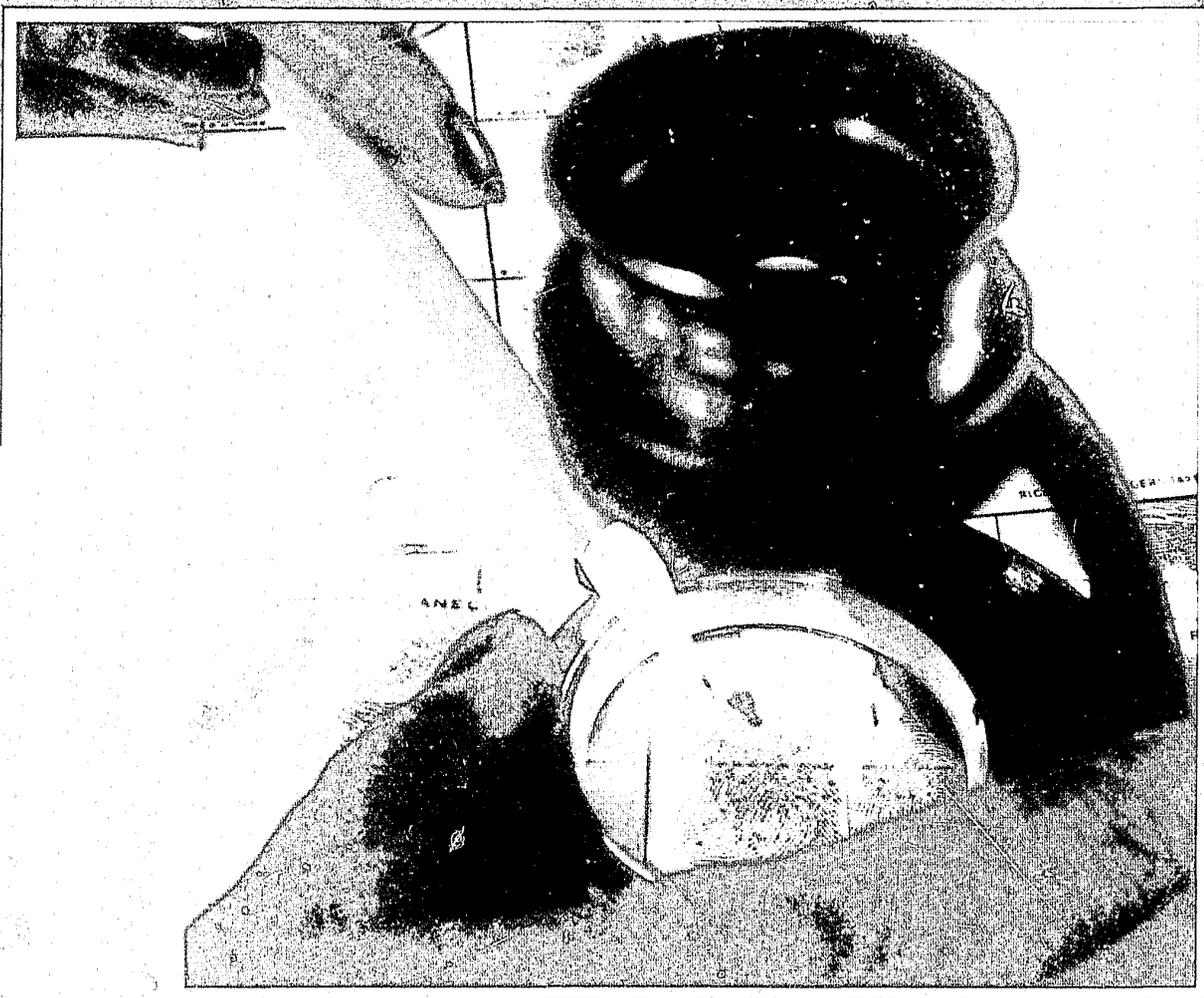


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Fingerprint Automation

Contents

March 1986, Volume 55, Number 3

- Identification **2** **Fingerprint Automation: Progress in the FBI's Identification Division** 0101538
By Charles D. Neudorfer
- Corrections **9** **Federal Probation: An Overview**
By Paul W. Brown
- Operations **12** **What Every Negotiator Would Like His Chief to Know**
By G. Dwayne Fuseller
- Crime Problems **16** **Automobile Insurance Fraud Pays ... and Pays Well** 0101539
By Mary Ellen Beekman
- Management **22** **Conducting Effective Meetings**
By Glen E. Plutschak and Carolyn Sue Brown
- Legal Digest **25** **Interrogation: Post *Miranda* Refinements (Conclusion)** 0101540
By Jeffrey Higginbotham
- 31** **Wanted by the FBI**

The Cover

The FBI's research and development in automating fingerprint processes revolutionized the science of fingerprint identification. See article p. 2.

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Fingerprint Automation

Progress in the FBI's Identification Division

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Time Magazine reported that 3 minutes after receiving its first assignment, Los Angeles' new automated fingerprint system identified a suspect in the "Night Stalker" killer case that had terrorized the city for months.¹ In a recent issue of the *FBI Law Enforcement Bulletin*, two police chiefs wrote:

"... the automation of fingerprints for classification and matching ... [is] the most significant technological innovation in law enforcement in decades...."²

The pioneering work done by the FBI in automating fingerprint identification provided the groundwork for most of the automated fingerprint systems used today by the Nation's police departments. The FBI's Identification Division has been the Nation's repository for fingerprint records since 1924. As early as 1934, the Division had experimented with automation; only the punch card system was then available, and it was not able to cope with the daily workload in the Identification Division. By 1939, the FBI's fingerprint files had grown to 10 million.

Today, the criminal fingerprint file contains over 83 million cards representing over 22 million persons. An average workday brings some 27,000 fingerprint cards to the Identification Division. This tremendous workload has required the employment and training of over 3,600 employees.

In 1975, the *Bulletin* reported on the FBI's progress toward automation by computer.³ This had begun in 1963 when assistance was requested of the National Bureau of Standards (NBS). The automation of the Identification Division's fingerprint work involved two kinds of information—criminal history records and fingerprints. Electronic data processing could be readily adapted to convert the criminal history file.

But computer hardware had to be designed to "read" fingerprints. The FBI and the NBS chose digital image processing as best suited to fingerprint automation. In effect, an entirely new method of matching fingerprints had to be developed.

A fingerprint reader had to be developed which would determine the position and orientation of the locations where ridges end or split (bifurcations). These are called the minutiae of the fingerprint.

The FBI contracted with Rockwell International and with Calspan Corporation to build engineering models of fingerprint readers. Concurrently, the NBS developed computer logic and algorithms (mathematical formulas) to search and match fingerprint data derived by these fingerprint readers.

While work on the computer fingerprint reader hardware and software was being done, the Identification Division began computerizing the criminal history records and automatically printing reports of identified file subjects, the first phase of the Automated Identification Division System. The entire project had to be accomplished in phases to take advantage of computer developments and to allow the daily work of the division to continue during implementation. By 1979, automated name searches in phase II of this system were being conducted to identify incoming fingerprint cards to records held in the Division.

In 1981, an ever-increasing backlog of over a half-million fingerprint cards and an average of 29 workdays to process new fingerprint cards caused the Identification Division to



Special Agent Neudorfer

suspend service to noncriminal justice users of the system for 1 year. This allowed reduction of the backlog and time to put into effect a user fee program for the processing of non-Federal employment and licensing fingerprint cards.

In 1983, the second phase of the automated system was connected with the National Crime Information Center's (NCIC) Interstate Identification Index.⁴ States that can access the Interstate Identification Index can now make on-line requests for records from the FBI's Identification Division and receive them back on-line.

The third and final phase of the Automated Identification Division System, when fully implemented in 1988, will provide better service by reducing processing time for fingerprint records for both the criminal justice system and employment/licensing agencies. Rockwell International Corporation prepared a 3,000-page document detailing functional specifications of the final phase of the system in January 1982.

In the final phase, there will be more on-line processing of fingerprint cards, simplified processing, automated document transport, reduction of errors by use of small printer work stations and optical character recognition equipment, better management tools, improved output processing, a savings of space, improved security, and spare work station capacity.

The culmination of the three-phase system will reduce the fingerprint work processing from the current 2 to 3 weeks to less than 18 hours for 95 percent of the requests for fingerprint record checks.

Latent Fingerprint Automation

Automation of the Division's work was initially concentrated on the processing of 10-print fingerprint cards, since this was the bulk of the Division's workload most seriously in need of automated support. However, as fingerprint identification began early in this century as a process to identify the criminal for court handling, the use of new technology to solve crimes was also developed. So, too, with the automation process.

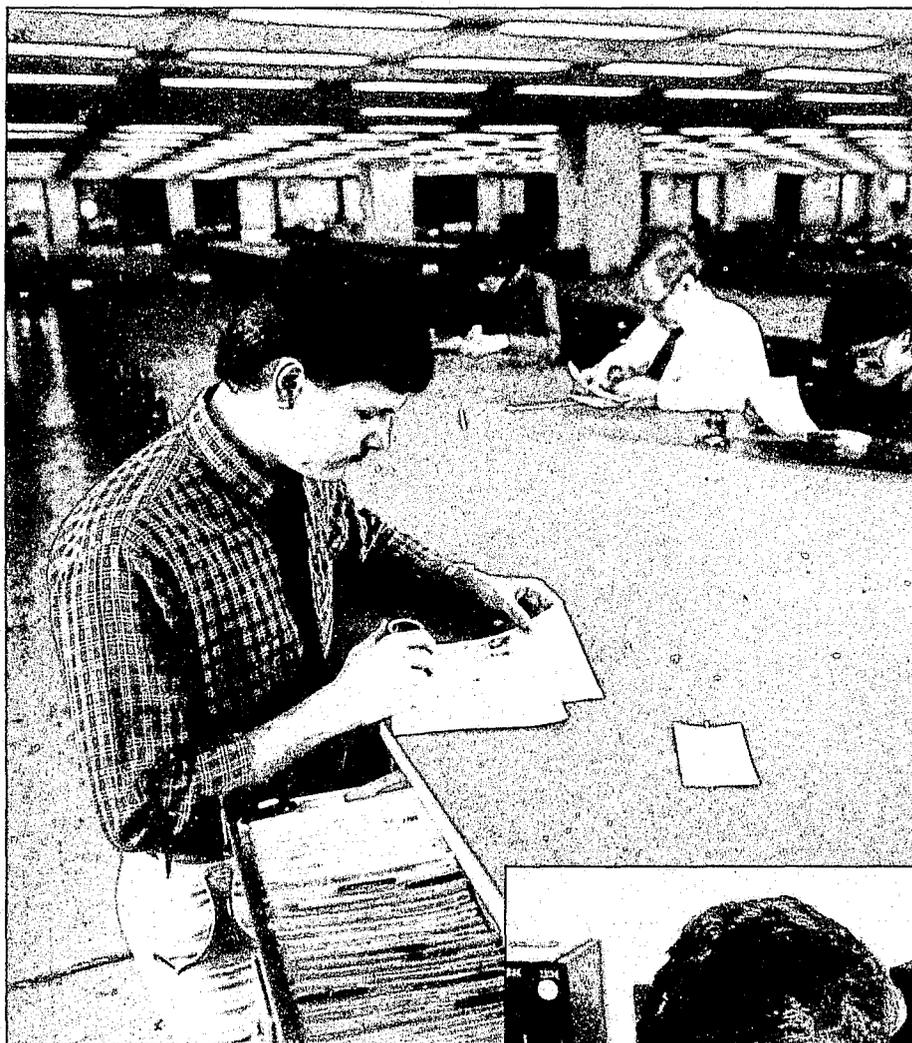
In recent years, work has been started to use computer technology as an aid in latent fingerprint work to solve criminal cases. With more and more of the Identification Division's data placed in computerized files, it is more feasible to let the computer perform tasks too labor intensive to be performed manually.

In the past, a latent fingerprint specialist would attempt every approach humanly possible to try to identify latent prints submitted as evidence in a case. But, after exhausting all possible suspects or leads without making an identification, the case would be returned to the contributing agency unsolved. Due to the millions of criminal fingerprints on file, attempts to develop additional suspects in a case were impractical.

But with the introduction of the computer and more than 16 million records now in the computerized files, it has become feasible to use new techniques to select logical suspects in cases involving crime-scene latent fingerprints. One program, the Latent Descriptor Index, is currently in operation.

Through the use of latent fingerprint pattern types, physical description information, and case information, a computer search of the Identification Division's automated files can be per-

"The ... three-phase system will reduce the fingerprint work processing from the current 2 to 3 weeks to less than 18 hours"



Above: Examiner manually classifying fingerprint card using card file.

Right: Automatic Voice Recognition—Examiner orally classifying fingerprint card using microphone.

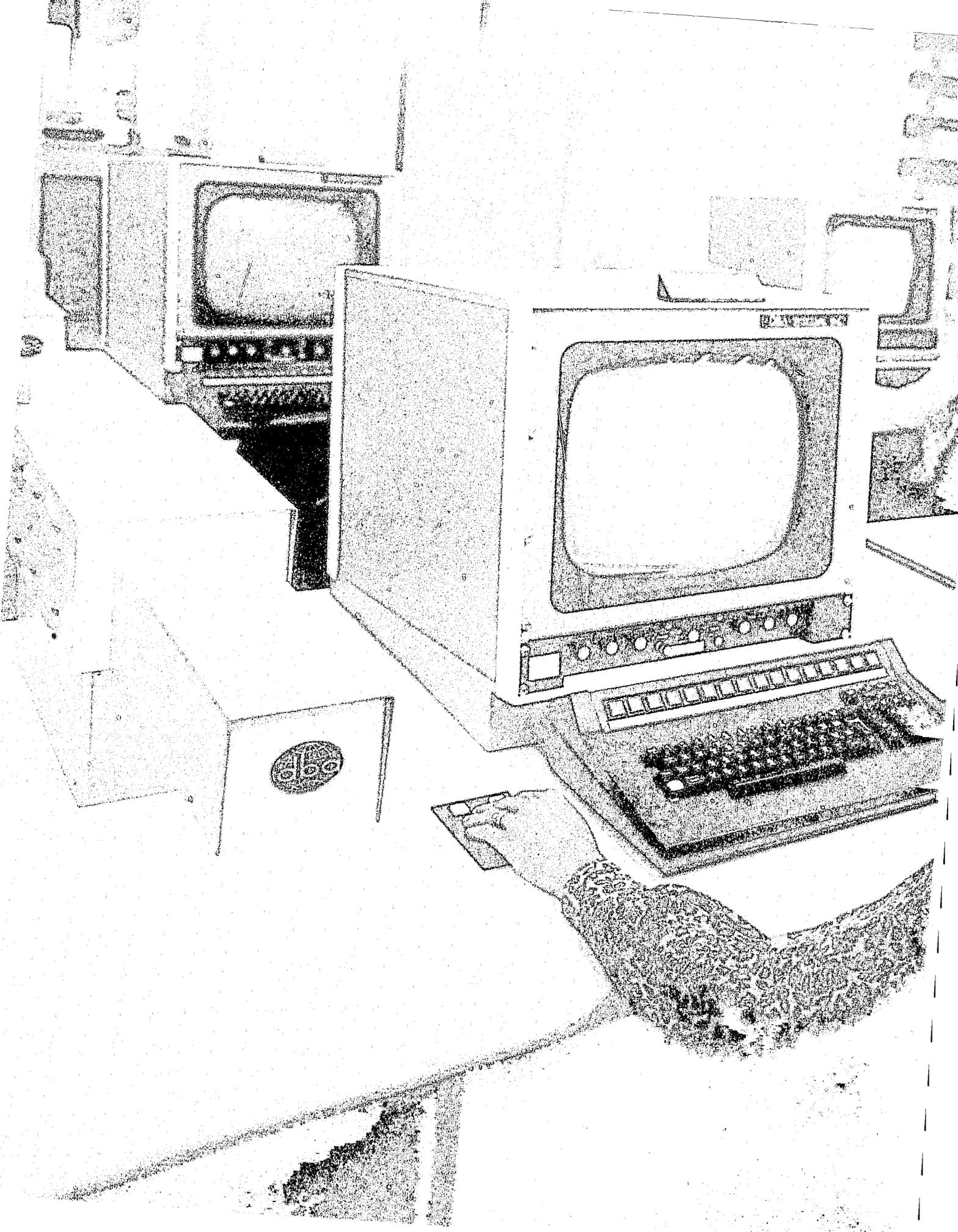


formed. In the 2½ years since being instituted, this program has solved cases that would not have been solved otherwise.

Work is continuing to enhance the capabilities of this system. With the introduction of the semiautomatic fingerprint readers—SAR terminals—fingerprint minutiae data can now be used in these searches to further limit potential suspects.

A new automated capability, called the Automated Latent System Model, is being developed. This system provides an on-line searching and matching capability against a data base of repeat offenders and criminals in specific crime-type categories. Currently, this data base contains 193,000 records, but expansion to several hundred thousand is planned.

This system works by entering as much of the personal descriptive information, crime information, and fingerprint data as is available into a semiautomatic fingerprint reader terminal. The Automated Latent System Model se-





lects candidates from the data base that match the personal and crime descriptive information submitted. Then all possible candidates are compared with the latent fingerprint via the matching algorithm.

Efforts to make this operational automated process more efficient are continuing. The data base is being expanded. Unsolved latent cases are being analyzed with this system in mind.

Future Automation

Today, the final step in the fingerprint identification process is the comparison of the incoming fingerprint card or latent print with a candidate fingerprint card selected by the automated search process. This is done by a qualified fingerprint examiner who decides whether the two prints are identical.

In order for these comparisons (a second examiner verifies the decision) to be made, the candidate fingerprint card must be retrieved from the manual fingerprint file, and after the comparisons are made, returned to the file.

Work began in 1983 on an Automated Image Retrieval System which will be able to display stored fingerprint images to the examiner, thus eliminating the manual fingerprint card retrieval process. This will also eliminate the problem of misfiled or out-of-file fingerprint cards which happen in a large manual filing system. But the important advantage of this system will be the response time savings. It will also permit the introduction of an on-line identification service through use of electronically transmitted fingerprint search requests from contributors.

*... will ...
... images to the examiner,
... manual fingerprint card
... retrieval process."*

Operator using Semiautomatic Fingerprint Reader to encode fingerprint manually.

"This approach is based on artificial intelligence concepts and will use rule-based systems to mimic the human decision process used in classifying a fingerprint."

This system is also a three-phase program. The first phase is the determination of the rigorous requirements for image quality, image capture, storage, and retrieval. The image-processing requirements for fingerprint images present an unusually complex problem in preserving the necessary detail of the fingerprint impression used by the fingerprint examiner. Again, the second phase will be the testing of a pilot Automated Image Retrieval System and finally the process of implementing production models into the overall automation system.

The requirements of the first generation automated fingerprint reader were to be able to read the minutiae characteristics (ridge endings and bifurcations) used by fingerprint examiners to identify an individual's fingerprints. After that reader was developed and tested, the potential for the reader to produce data which might be used to automatically classify a fingerprint was recognized. An attempt was made to add this capacity to the first readers, but it was learned that automatic classification was a much tougher job than minutiae reading.

Although there are some commercially available automated identification systems, which some local and State law enforcement agencies have, these systems have limited classification capabilities. The classifications produced by these systems are not compatible with the Henry-based NCIC classification system. More important to the Identification Division, these systems are incapable of handling the extremely large file of the FBI.

In 1983, the FBI initiated a new program to accomplish automatic classification by developing a second generation fingerprint reader. This new reader will be compatible with the

FBI's existing minutiae data base, but will be significantly enhanced in its ability to read poor quality fingerprints. The classification to be produced will be compatible with the Henry-based NCIC classification used by all the State and national data bases for criminal fingerprints.

Advanced image-processing techniques have to be developed for this program to obtain a computerized representation of the fingerprint ridge structure. This will, of course, improve the entire system operation. The new reader will also have the ability to decide if the fingerprint is too illegible to be handled by the automated system and will then direct the fingerprint card to a live examiner. This is important to avoid errors in classification.

The next phase of this project is to develop specific fingerprint classification rules the computer will use. Since the major requirement is to be compatible with the live fingerprint examiner, the rules will have to be the same as those used by the examiner. This approach is based on artificial intelligence concepts and will use rule-based systems to mimic the human decision process used in classifying a fingerprint.

After testing of these developments, it is expected that these second generation fingerprint readers will become operational in the early 1990's.

It is anticipated that these more diversified services will be provided over existing criminal justice communications networks, such as the FBI's NCIC and the National Law Enforcement Telecommunications System (NLETS). Efforts of the Identification Division to provide faster services will be in the direction of nationwide, on-line, automated fingerprint identification searches.

However, with almost 20,000 active users of Identification Division

services, needs and resources of the users vary considerably. Some users have neither a computer terminal nor fingerprint identification expertise. At the other extreme, a few have automated, minutiae-based fingerprint searching systems.

Thus, the Identification Division is adding its new capabilities rather than replacing existing services to provide a range of flexible services, consistent with the needs and resources of the various users. Any future capability for nationwide, on-line, automated fingerprint searches would be in addition to the existing range of capabilities.

Eventually, nationwide on-line fingerprint searches will be done in seconds with automated fingerprint classification, but if necessary, they can be done even before automated classification is operational. Electronic fingerprint image handling, such as that used in an Automated Image Retrieval System, would provide the speed and parallel processing capability that could make it feasible for complete classification and searching to be performed within a few minutes at most.

Future on-line fingerprint identification searches will be designed to be flexible enough to accommodate users without fingerprint identification expertise, as well as providing services that take advantage of the advanced capabilities of other users. In this way, the Identification Division will continue to meet the needs of all users.

FBI

Footnotes

¹Time, October 14, 1985, p. 96.

²Col. Carroll D. Buracker and William K. Stover, "Automated Fingerprint Identification: Regional Application of Technology," *FBI Law Enforcement Bulletin*, August 1984, p. 1.

³Conrad S. Banner and Robert M. Stock, "The FBI's Approach to Automatic Fingerprint Identification," *FBI Law Enforcement Bulletin*, January 1975, p. 2.

⁴George Lyford and Udy Wood, "National Crime Information Center," *FBI Law Enforcement Bulletin*, March 1983, p. 10.