Electronic Imaging

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Abstract

The technology of document imaging is one of the newest tools available to assist in the handling of massive amounts of paperwork. How, or if, this technology could benefit law enforcement was the focus of this research. To ascertain whether document imaging would be feasible, a number of factors had to be investigated. The first item considered was the equipment, personnel and the cost to implement an imaging system. Next, the microfilm / paper process was compared to electronic imaging. The results revealed the new technology to be more effective and efficient. Lastly, the archival and legal requirements were reviewed and it was found that this is an emerging technology and legal precedents are still evolving.

Introduction

Data storage by means of an electronic media process is only 30 years old. The microfilming of data is only 60 years old. Prior to both of these processes is the method of putting data on paper. All of these methods are still in existence today and no one method replaces the older methods but just supplements the entire process. The computerized process of electronic imaging is a fairly new technology. The law enforcement community could easily benefit from the speed of access to records and the ability of many people to view the same material. Imaging raises questions that must be answered when it is applied to a law enforcement agency.

First, one must define the term electronic imaging. How does the image, as it appears as a page of text, or a picture, become an electronic entity? What is the process that takes place to make this transformation? How is this transformed entity stored and accessed by the computer system of the user and the final user himself?

The process of transforming a piece of paper into an image takes specific equipment, specialized training, and the money to make all this come together. The equipment needed is specific to the imaging process. Some of the pieces of equipment have familiar sounding names but perform a totally different function. One such term would be the jukebox, but it does not have any audio capability. Some of the other pieces of equipment needed are a scanner and a high-resolution monitor. These pieces of equipment require the operators to be trained over and above the normal level of training for entry-level office personnel. Increased training and more expensive equipment means a greater monetary impact. The initial expenditure is easily traced. The greater challenge is to assess a cost to the actual conversion of older files if this is undertaken.

The reason to expend money and manpower on an imaging system can only be justified by increased efficiency and effectiveness. One of the primary advantages is that an electronic image can be viewed by more than one person at a time. This shared viewing can take place as the report or image is being processed or later on in its life. Later in its life, would be when any number of people need to view the same document simultaneously. As the amount of information to be shared increases, the amount of storage space required decreases greatly when compared to the space required by microfilm. Electronic images, stored on an optical disk, can replace 30 to 40 rolls of microfilm. The optical disk does not have to be loaded and refiled as does microfilm. In the same vein of time saving, the use of electronic imaging reduces time spent in looking for lost paper reports, filing, and copying of these reports. These time saving

and space saving features carry over to the area of archiving.
There are no files to prep for microfilming and no paper to shred upon the approval of the microfilmed reproduction of the paper product with electronic imaging.

When all the advantages of electronic imaging and optical disk storage are listed the system looks great, but there are problems that could be encountered. The method used to implement an imaging system can cause major problems. Another consideration is whether to go back in time or begin scanning on the day of implementation. Without a proper examination of all the facets of an organization, record keeping needs could cause the system to fail. The other major force that could cause a system like this to fail is to not allow the proper people access to the information.

As great as electronic imaging might be, if it does not meet the archival and legal requirements then the system is of no value to a law enforcement agency. The imaging system must meet and exceed the state requirements for archiving records. These archival requirements are strict and must be adhered to if an imaging system is to be used. Before the archival worries can be considered the legal requirements of reducing paper documents to images must be dealt with. Along with the evidentiary needs is the need to safeguard the images and the integrity of the system. This technology is young and it must be determined if it is truly a viable solution by considering all of the above facets in concert.

Methods

This research project was accomplished using two research methods. The first and primary method is the literature review. The second method utilized is that of interviews. A case study would not lend itself to a full explanation or exploration of this new application.

The literature review consisted of looking at the topic from both the academic side and the commercial side of the issue. The academic side consisted of professional organizations that have a mission of the advancement of imaging as well as educating prospective users. Organizations in this category are The Association of Information and Image Management, American Records Management Association, and the National Consortium for Justice Information and Statistics.

The second part of this research methodology is that of interviews. Various professionals from the imaging industry were interviewed. These individuals were selected because they work for national firms. These people had solicited Clearwater Police Department when an imaging component was sought for the Records Section. These professionals have “hands-on” knowledge and have implemented many imaging systems. The other side of the coin, independent contractors or consultants, people not specifically involved in imaging but intimately knowledgeable about computers were interviewed. It is the second type of professional who provide the information about problems with implementation and applications. Police professionals currently using imaging were also interviewed for their knowledge and expertise pertaining to law enforcement. Specifically the Ventura County Sheriff Department of Ventura, California was contacted. This office has a fully integrated imaging system.

Results

Definition

"Electronic imaging is defined as an automated system to store, retrieve, transmit, process and manage documents" (Avedon, 1994b, p.28). This entire process starts with the conversion of a document into a form that can be interpreted by a computer system. Avedon (1994a) states that there are only three forms that a document can be converted into:

1. Analog
2. ASCII / EBCDIC
3. Bit-mapped.

Analog is that form of information that is readable by a human. Examples of this form are blue prints, handwritten/typed reports or charts. This form can be converted into a computer language and then into an electronic image (Avedon, 1994a).

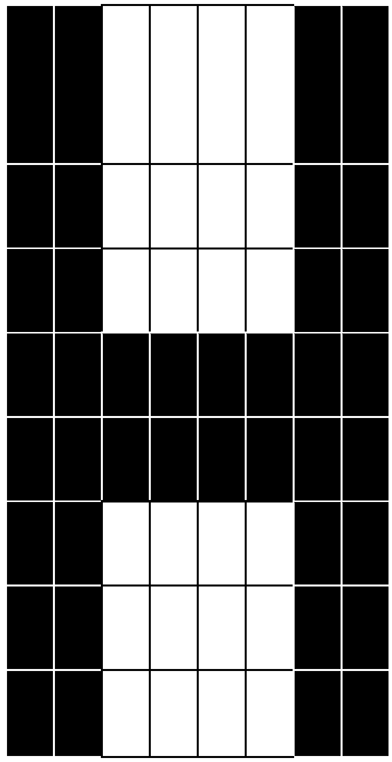
ASCII / EBCDIC is a binary digital code that represents a number and letter which is a standard for computer coding. This conversion allows the computer to read and understand the converted form. Listed below is an example of the conversion (Avedon, 1994a).

	ASCII	EBCDIC
A	1100 0001	1010 0001
B	1100 0010	1010 0010
C	1100 0011	1010 0011 (Avedon, 1994a).

The third and final form of document conversion is bit-mapping which is a representation of a document by use of a binary code representing light and dark points in the document. A bit is a single digit in a computer binary number (1,0). Groups of bits make up a storage unit called a character or byte (there are 8 bits to a byte). The character is not recognized but the light and dark contrasts are. Each point of light and dark are called pixels where 0=white and 1=black. An example of this form of conversion can be seen below (Avedon, 1994a).

When comparing the ASCII character based digitization to bit-mapping there is a world of difference. The character based system is referred to as the intelligent system. If one were to scan a page of text and then import that scanned image into a word processing program, one could direct the computer to search for a specific word such as in a search and replace routine. The bit-mapped system is referred to as the dumb system. When the computer looks at a scanned image done by bit-mapping, it only sees light and dark pixels, words are unintelligible. This difference plays an important part when it comes to the actual process of indexing the information that is converted to an image. Another major difference between the two systems is the storage space required for each system.

> A document with 400 words stored in ASCII code takes about 24,000 bits, or 3,000 bytes (3kb). (There are 8 bits per byte.) An 8 ½-by-11 inch document bit-mapped at 200 dpi (dots per inch, 200 pixels horizontally and 200 pixels vertically) takes 3.74 million bits or 467,500 bytes (467kb) (Avedon, 1995, p. 30).



This difference represents a 150 percent larger storage requirement for bit mapped images than character based digitized images.

A way to compensate for bit-mapping storage requirement is to compress the data. Compression can be anywhere from 7:1 to 30:1 (Avedon, 1994a). Compression is the data conversion of a digital image by use of a mathematical algorithm (mathematical formula) to lower the number of bits for storage. The amount of compression effects the speed of the system and space require by the image. Compression is necessary when large numbers and or large images must be stored. If compression is not employed the number of disks required for intermediate storage, file server disk space, and final storage, would be enormous. The compression rate is normally dictated by the imaging software being used (Newcombe, 1995).

Equipment

Imaging is a technical process and as such requires specific equipment to convert a paper document into an image. The first piece of equipment that is needed to start the imaging process is the scanner. From a system's point of view, the digitizing scanner is the counterpart to a microfilm camera, the scanner records the information (Avedon, 1994a). This recording process is actually the reading of the document and converting it to a bit map image so the information can be stored by the computer. The type of scanner, and the way the scanner processes the data dictates the quality of the image. The quality of the image is dependent upon the number of dots per inch, or pixels per inch. The range of quality runs from 100 pixels per inch which is considered marginal to 400 or more which is excellent quality to video grade images (Avedon, 1994a).

The next piece of equipment that is needed in the process is a high resolution monitor.

This monitor allows the operator to inspect the image for quality and accuracy. The monitor is usually 23 inches which is larger than the normal computer monitor. This increased size allows an entire 81/2" X 11" page to be displayed. Some software allows two pages to be displayed simultaneously (Avedon, 1994a).

Once the image is of acceptable quality the operator must index the image. According to Avedon (1994a) indexing is the process of connecting descriptive information about the image to the image itself. The index is the tool that is used to find the document in the future. For example, take the imaging of a document that must be connected to a specific police report. If a single index, such as the report number, is the only index used accuracy is imperative. If a number in the report is transposed the document will probably never be found again. If multiple indexes, such as report number, officer's name and victims name etc., are used, then an error in one index does not spell disaster because the other indices can be used to locate the image. All of the indexing and the checking for accuracy of the images is normally done on a stand alone computer and not a network (Avedon, 1994a p. 22).

The next piece of equipment that comes into play is the intermediate storage unit. This unit is usually a magnetic storage device such as a file server. A file server is normally a large microcomputer that has a large hard drive, and fast processor which is connected to the network. This device allows the scanned image to be accessed prior to it being written to a WORM (Write-Once-Read-Many) disk. “WORM disks are a relatively inexpensive, ready-to-use recording medium that the user can plug into a drive (much like a floppy disk) and use to record data” (Newcombe, 1995, p.61). The WORM is very specialized, and is driven by specific and highly technical software. There is no function for the disk writer software other than write images to a disk.

Once the WORM disks are written they are placed into a device called a jukebox if they are to be accessed and be part of a network configuration. According to Newcombe (1995), the purpose of this equipment is to hold any number of disks and read the appropriate disk when directed to do so by the software at the request of an end user. This allows the system to have enormous amounts of data "on-line" without having to manually change disks.

When all of the equipment is put together it becomes an integrated system. Figure 1 is a graphical representation of an imaging system. (Roberts & Peters, 1992, p.3)

Figure 1: Sample imaging configuration (Roberts & Peters, 1992, p.3).

All of the equipment discussed is controlled and coordinated by specific imaging software.

The software functions are to:

A. Provide interfaces between the operator, peripheral components and the control computer processor, and;

B. Regulate the flow of information, including;

- translate commands from the operator into specific hardware instructions;
- allocate hardware resources;
- form indexes and cross references;
- produce work flow scripts for routing;
- provide administrative statistics and reports.

According to Avedon (1995, p. 35) There are also three and sometimes four categories of software needed.

A. Operating system software.

Layer I - Turnkey software packages, providing housekeeping instructions to the computer.

Layer II - Device drivers and hardware-component interface software.

B. Application software.

Layer I - General - purpose programs, such as file/data management, word processing, spreadsheets.

Layer II - Application programs for a particular industry.

Layer III - Proprietary software customized to the needs of a specific organization.

C. Utility software.

Layer I - Programmer work benches or toolkits that allow the user organization to modify the software.

Layer II - Disk File Systems.

D. Specialized software.

The last element needed to bring this entire system together is that of a computer network. This piece of the technology must be examined closely. “One of the most common mistakes company officials make when adopting client/server imaging system is incorrectly assuming that their current network can handle the bandwidth requirements” (Cole, 1995, p.40).

Training

Once special equipment and new processes are introduced to the work place, the affected personnel must be trained. The training required for the scanning/indexing process is distinct from that required by the computer system administrator. The scanning/index person needs 8-16 hours of training in the actual scanning process. Along with this training there would be hands on use of the system. The actual training would consist of the use of the scanner and the input and indexing part of the application software. The larger part of training would deal with imaging system administration/security and the end product. The end product is the production of disks for the overall computer network (S. Andrikut, personal communication, November, 1995).

Once the topics of equipment and training are broached the next logical concern is that of the cost involved. The bottom line for all equipment, and training is the cost factor. An imaging system can be small such as a scanning station with two or three viewing work stations. An imaging system can be larger, such as multiple scanning stations and everyone on the network having access to the images. Just as the size can vary so can the money required to acquire an imaging system. The starter system can be purchased for $50,000 and go up from there (J. Albright, personal communication, December 1995).

Another cost that must be considered when implementing an imaging system is that of back file conversion. Back file conversion is the imaging of documents that existed prior to the initiation of the imaging project. Whether to convert the back files or not is a managerial decision. “There are at least three ways to handle the back file issue:

1. Don't convert the back files at all
2. Convert the back files
3. Scan on demand." (Avedon, 1994a, p.11).

Back file conversion is labor intensive so the cost benefit ratio must be considerable for the conversion of all files to be considered. "The retention schedule, reference rate, urgency of reference, quantity of material and operating system should all be considered when determining whether, or how much of the back file should be included in the new system"(Avedon, 1994a, p.38).

Benefits

Imaging is currently being used by law enforcement agencies to digitize mug shots, enhance fingerprints, crime scene investigations, property cases and to handle large amount of paperwork (Zimmermann, 1992).

The digitizing of mug shots is one of the most popular uses of the imaging process by law enforcement. The imaging of mug shots saves money in the area of film, developing of the pictures, and labor involved in storage and retrieval. Another reason this is a popular application is that portions of different photos can be manipulated to help victims form a composite of the suspects. When a specific suspect is known, the digitized photos can be searched for similarities by using the indexes and coming up with good photo packs (Zimmermann, 1992).

Imaging is very helpful in the area of fingerprint examination. This new technology allows fingerprints to be enhanced thereby aiding in identification. Software lets fingerprint technicians separate the fingerprints from the background. At times fingerprints are found on backgrounds which are not conducive to fingerprint identification. At other times edges of fingerprints are found and again this makes identification difficult. A digitized fingerprint can be enhanced with light or enlargement. This enhancement could mean utilizing the 256 shades of gray available compared to the 60 shades the naked eye can see. This enhancement could also enable the actual print to be distinguished from the surface the print was found on. The same is true with partial prints. The partial print can be enlarged so the identifying elements can be compared to known prints (Zimmermann, 1992).

Fingerprints come from crime scenes and are a small part of the overall scene. Imaging technology now allows the entire scene to be video taped and digitized. This gives an investigator the ability to view the evidence without going to a crime lab or evidence vault. Wise (1995) states that these tapes are then idexed with key words or phases. The primary reason for this indexing is so that the video can be found and viewed in the future. The secondary advantage of indexing is that of the search capability that the index provides. This index can be search for key words or phases and might reveal other cases with similarities. These similarities could be modus operandi, weapons used or other crime scene characteristics (Zimmermann, 1992, p. 58).

The next logical step for investigators is to use the technology for property cases. A grand theft report can be supplemented with scanned images of the property stolen. According to Alan Harman (1995), Scotland Yard has implemented this system and found it has replaced the time consuming and laborious operation of checking recovered property cases against stolen property cards. The imaging process also eliminates the need to circulate photos of art work or antiques to all police services that might need to be aware of such thefts.

Just as imaging assists with small but important aspects of police work like fingerprint identification , it can also aid in large complex cases which generate thousand of pages of paperwork. Organizing the paperwork in a complex investigation is an enormous task. An example of this particular use of imaging is in the Gainesville, Fl. case where five University of Florida students were murdered, and 100,000 pieces of paper made up the case file. It will take years for the case to get through the court system and the case file will have to be maintained. The danger of not being able to find, or even worse, losing a critical piece of information is high and imaging lessens that danger (Zimmermann, 1992).

All of these applications help police departments in the effort to expedite information access. This increased exchange of information can only assist in the apprehension of criminals.

Archival and Legal requirements

Just as paper files and microfilming of documents have archival and legal requirements, imaging must also comply to certain standards. The state of Florida dictates archival methods and standards. The courts and legal system determine the evidentiary rules for the acceptance of imaged documents and the overall use of imaging in law enforcement.

The rules governing electronic record keeping can be found in the rules of the Department of State; Division of Library and Information Services, Chapter 1B-26, Records Management Standards and Requirements (See Appendix B). The rules are for records that are to be retained for more than ten years and have not been microfilmed or kept in the original paper form.

Chapter 1b-26, F.S., lists and explains the administrative requirements for the electronic record keeping system. These rules cover such things as policies for use, access, security and production of copies. The selection of electronic records storage media and the maintenance of electronic records is also covered in the chapter. There are a few major storage media requirements. First, the optical disks must be guaranteed for ten years for readability. Second, the software system used to place data on the disk must support specific compression techniques. These techniques are standards which are accepted by the entire industry. These standards must be adhered to if the media is to be used for archival purposes (Chapter 1B-26, F.S., 1992). Third, multiple vendors must offer this type of optical system. Fourth, the information must not be lost due to changing technology. This can only be done by converting stored media to an agency's current hardware and software. The last logical standard is that the electronic records must be copied and kept off site.

In the area of records maintenance there are also a number of major standards. First, a sampling of records must be read annually. Second, the actual disks must be labeled with specific information so the data can be identified and the indexes listed. Finally, there is a rule that once the retention period is met, disks containing sensitive information are not to be reused.

The entire purpose of electronic record keeping is to be able to reproduce the data. In the area of law enforcement many of these records are entered into court records, and therefore must be accepted by the legal system.

The state of Florida addresses the legal requirements of record keeping by listing standards for legal authenticity. The agency must be able to document that records are stored and recreated using the same process each time. Thorough written procedures should be in place before starting to use this technology. It will be these written policies and the adherence to them that will guarantee the integrity of the technology. Written procedures, training and security are of the utmost importance. Security procedures must be in place and documented to assure those interested in authenticity that the documents were not modified. The agencies must also identify the media on which the records are stored throughout the records life cycle (Harris & Barton, 1994).

The legal profession takes a different look at imaging technology. The admissibility of scanned images and photographs are questioned as to authenticity and integrity. In the past two rules were used to govern this type of evidence. One of these rules is that evidence must be sufficient to support a finding. The other tenet is that of the silent witness theory. "The photographic evidence is a 'silent witness' which speaks for itself, and is substantive evidence of what it portrays independent of a sponsoring witness" (Guilshan, 1995, p.7). These tenets are being questioned now because electronic photographs can be manipulated with the use of a computer. Once the original photograph is manipulated the new version becomes the original (Guilshan, 1995). This is the heart of the problem when challenging authenticity and veracity.

The concern is not only voiced by people in the legal profession. The advent of images being captured by use of digitized photography also worries the journalism industry as indicated here.

> Along with a flurry of creative experimentation and playfulness the capability(to create synthetic images) has triggered concern that images are becoming as unreliable as words, no longer defendable as records of criminal behavior, political sin and other historical reality. . . . Analysis has compared the process of image manipulation to genetic re-engineering or surgery at the molecular level (Sawyer,1994, p.38).

These concerns will prompt the courts to reevaluate the standards. One way to insure authenticity is to depend on the photographer himself. A move in this direction would require the photograph to testify that he in fact did take the picture and that it was not modified. This would do away with the silent witness theory.

The standard of admissibility the courts presently use for photographs is no longer viable in light of the emergence of electronic photography. Computer imaging, SVCs and image synthesis are just three of the important ways in which technology is changing the veracity of the photographic image. With such manipulative capabilities at hand, it no longer is possible to implicitly trust the reliability of a photograph (Guilshan, 1995).

Discussion

Today, most police departments fall into one of three categories when it comes to computerization. The first category is the paper work stage which means the department's records are processed by hand. The second category is the PC stage. In this segment there are a few personal computers around the department. These computers are used in a stand alone mode and there is no real plan or scheme for their use. The third category is the automated stage. In this stage there is a comprehensive electronic records management system that is integrated with other sophisticated systems at the local and state level. (Pilant, 1995)

Imaging is currently being used by law enforcement to digitize mug shots, enhance fingerprints, crime scene investigations, property cases and the handling of paperwork. These applications are just the beginning of the application of imaging to benefit law enforcement.

Availability

The most visible of the benefits to law enforcement is that of increased availability. Imaging allows all personnel with the proper security to view the reports and the imaged appendices. A good example of this attribute is that of a team of investigators all working on the same case. In a strictly paper driven process, the report must be copied numerous times or only one investigator can view the paperwork and the evidence in succession. Imaging allows all to see every aspect of the case at the same time. When an addition is made to the case, all can view the addition simultaneously or at their leisure.

This attribute of availability translates into a cost saving in materials and time. The material being saved is that of the photographs and film that must be processed and stored. Another material that would be involved in a paper process is that of the copying cost of the actual paper and photographs, drawing and the attendant paperwork. All of this material costs money, but the larger cost factor is that of the labor to provide the paperwork. When the time of the identification technicians and clerical staff of the records unit is calculated the cost is very high. This logically translates to large savings when using an imaging system. The Ventura County Sheriff's Office is employing the imaging process to reduce costs within the Records Section. All reports are scanned as they are received in the Records Unit and then all requests for the report are produced from the scanned image. This saves all of the clerical time required to retrieve reports, photocopy, and then re-file the original report. The process is viewed as a success and the back-filing of reports is now in progress (L. Reynolds, personal communication, 1996).

The attribute of availability contributes to cost savings in time and material but it also alleviates lost reports. Paper reports are easily lost or mis-filed never to be found except by accident. It is estimated that a billion documents are generated each day in the United States alone; Approximately three percent are mis-filed. Finding mis-filed documents costs an average of $140 to $200 per document (Newcombe, 1995).

One of the newest and most dramatic benefits of imaging is that of the ability to search for key words or phases. This feature allows all the images to be searched for similarities. Imagine a major case being worked where there is a specific modus operandi. An example of this would be a specific phrase a rapist used during the commission of the crime. When the attendant paperwork is scanned and attached to the report, the peculiarity of the case and the specific phrase is recorded and indexed. Then all of the other imaged and indexed cases can be searched for matches. Ten years ago to find such a similarity, the information had to be passed down from detective to detective or the same detective had to be working the new case. This feature allows detectives access to information they might not have known existed. This also aids crime analysts by narrowing their search if all other aspects of the case are not notable or extraordinary.

Prior to this point, imaging has been examined from the viewpoint of the process such as property cases or fingerprints. Imaging must also be examined and related to the entire agency.

Security

The accessibility of reports is a great feature, but with this feature comes the responsibility of security. Security can be achieved by the agency's computer system in most cases (P. Wormerly, personal communication, August, 1995). If the agency is using a Novell or similar network system, different levels of security exist to protect sensitive data. In the basic system a user name and password could grant access. On a more sophisticated system, user names and passwords are used, but only certain sections or groups of people can have access. This system is set up and maintained by the system administrator.

Sections of data can exist on the department's network without the knowledge of many users. These users have no need to know or view this data. It is the administrator's duty to assure the data is kept secure. Audit software must be employed to monitor the databases. When an unauthorized person gains access it is recorded and corrective action taken. This audit trail can also be used as part of the system's documentation to prove the data's veracity. If required the audit records could be produced in court (J. Albright, personal communication, December, 1995).

Another security issue must be considered and that is the transmission of data between remote locations. These remote locations can be a substation, mini-police stations or the State Attorney's office or the Courts. Since modems and open data lines are used for this transmission a way to secure the data is needed. Normally the data is encrypted to prevent interception. There are specific software programs available to accomplish this task (P. Wormerly, personal communication, August, 1995).

<u>The Archival process</u>

The archival process is affected by an imaging system, but this is not particularly visible to the agency personnel. If all the attendant paperwork is attached to reports, then all the reports could be placed on a WORM and the archival requirement met. This process is strictly a computer process and there are no labor costs involved except that of the computer operator's time (J. Albright, personal communication, September, 1995). This is a dramatic difference from the archival process of microfilming. The microfilming process is extremely labor intensive. The process first requires the records section personnel to assure that the reports taken are in the file and accounted for. Next each report must be unstapled , and all pages put in the order that they are to be microfilmed. Once this is accomplished, each page is placed into a microfilm camera, and photographed one at a time with approximately 3700 frames per reel. The film is then developed and returned. On its return the film is checked for clarity and accuracy. If everything is acceptable, all the paper is then shredded. This entire microfilming process could take three to six months since this is not the primary job of any one person in the records section. To write the platter (WORM) for an entire year's reports might take less than 8 hours using a dedicated file server writing to the WORM (J. Albright, personal communication, September, 1995).

<u>Archival costs</u>

The difference between microfilming to archive and using an optical disk does not stop with the creation of the media. This difference continues on to the manner in which the data is accessed in the future. As was the case with the creation of the media, speed and cost are major factors. These are not the only two factors, but the other factors are of lesser importance.

The factors of speed and cost continue to come into play when using the archived data. By using an example, it is easy to show the benefit of using a WORM to archive data over microfilm. When an investigator needs to review a case that is on microfilm he usually calls the Records Unit to make a copy of the report. This entails a clerk locating the appropriate roll of film. Then the clerk must then locate the report on the film, using a reader printer, and make a copy of each page. The time for this task is totally dependent on the size of the report and the availability of the clerk to devote their total effort to this task. If the cases or reports started and finished in a single year, then the report appears on one roll of film. If the case was a major unsolved or involved case that was worked over a number of years, the total report would be on more than one roll. The number of rolls could be the same as the number of years since the initiation of the report. If the clerk is unaware of the fact that supplemental reports exist on separate rolls, these pages would never be connected to the original report.

With an optical disk as the archival media, the task of reviewing an older report is much simpler. The detective would access his computer and go to the archived report's menu. He would enter the report number he wished to view and it would appear. All the pages would appear in sequence even if the report spanned a number of years. Looking at this example, optical disks do away with the need to utilize a records section clerk to reduce the archived report to paper. This saves the time of the clerk to produce the report. This also saves the time of the investigator waiting for the report and possibly waiting for the supplemental pages to be found on additional microfilm rolls. When archiving reports to a WORM, 15% of the disk space is saved so supplemental reports can be added when they are archived. This is the feature that allows the user to view the entire report at one time from one location. An optical disk system also saves the cost of owning and operting a microfilm reader printer.

This is only one example, and some consideration must be given to what this technology would mean if the savings were multiplied department wide. A good way to do this is to see what occurred on a citywide conversion. Durham is a city that has networked imaging and the results were dramatic. The Durham City officials looked at all the positions that dealt with strictly paperwork and then calculated the time spent on these tasks. The results of this study were very surprising to the city officials. One hundred and seven positions were studied and it was found that 30 percent of their time was spent on tasks that imaging could eliminate. With an entire city on a networked imaging system the City of Durham estimated it saved $578,000 to $770,000 annually (Government Technology, 1995).

Durham was able to get a good estimate of the dollar values that the city could save with this new imaging system. Other estimates of savings are 40 to 50 % gain in productivity for typical clerical type work (The Imaging Business Report, 1991).

<u>Space savings</u>

Reports are not the only things that can be put on optical disks/ CD-ROMS to assist law enforcement. Today many of the reference materials that are used by the communications center and the investigative division can be found on this new media thus utilizing the latest technology. All law enforcement agencies use the Hill-Donnelly cross reference directories, or a similar reference from another vendor. There are normally 8t o 10 large, 11" x 14" books 3 inches thick, that list street names and numbers and the respective telephone number for specific cities or counties. These books contain vast amounts of data which now are reduced to a single WORM Disk. These books are now available on CD-ROM disks that can be used by all divisions using the department's computer network. This does away with the need to buy two or three sets of these books, thus saving money and space. This same benefit is realized with the Florida Statutes.

With the saving of time documented above, a saving of space is also accomplished. When reports are taken on laptop computer there is no need to reduce these reports to paper unless they must be distributed outside the agency. Additionally when the report's attendant paperwork is scanned at the time it is received, there is no paper to store. No paper to store means that there is no need for banks and banks of file cabinets. This frees up needed and valuable space in the records section. This space saving also translates to the keeping of reels upon reels of microfilm, which are kept in cabinets. There is no comparison to a 12 platter or smaller CD-ROM that would be in a jukebox.

As recently as a year ago, the idea of imaging as a widely accepted technology was on the "cutting (if not the bleeding) edge" of technology. At the time of the debut of Microsoft Windows '95 imaging was still a technology for the few. In August of 1995 the idea of imaging became much closer reality. With the mass marketing of Windows '95 imaging will be on every computer that employs windows '95. Wang, an industry leader in imaging, announced that an imaging component will be in the next release of Windows '95. This will bring the ability to view images to the desktop.

Conclusion

After examining the theoretical aspects of imaging, this new technology would benefit law enforcement. The cost of implementing an imaging system in terms of equipment and training of personnel is minimal when compared to the increased efficiency and effectiveness. Although the technology is not widely used by law enforcement agencies at this point, it is an emerging technology that will continue to grow in popularity as its benefits are realized.

Imaging will be tested by the legal system but so far it has withstood the test when proper procedures are in place. Imaging is a tool that will be a major contributor to the overall effort of law enforcement in the area of investigations and records management.

Captain Donn Githens is currently assigned as the Support Services Division Commander for the Clearwater, Florida Police Department. During his 17 years with the department he has worked as a member of the Patrol Division and in the Criminal Investigations Division as a crimes against persons detective. Promoted to Sergeant in the Patrol Division, he was reassigned to the records unit where he supervised all records functions as well as the police service technician unit. Donn's professional interests are in the computerization of police records and reporting processes.

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APPENDIX A

GLOSSARY

algorithm - Mathematical formula or procedure.

analog - Continuously variable measurement of physical phenomenon. Representations which bear some physical relationship to the original quality; usually electrical voltage, frequency, resistance or mechanical translation or rotation.

aperture card - Card with one or more apertures specifically designed for the mounting or insertion of microfilm before or after imaging (ISO).

aperture card scanner - Device for scanning micro images in aperture cards. NOTE: Some scanners can also read information on the card. See also aperture card, reader-scanner and scanning.

bandwidth - (1) Number of hertz expressing the difference between the lower and upper limiting frequencies of a frequency band. (2) Width of a band of frequencies. (3) Maximum number of information units (bits, characters) capable of traversing a communications path per second. See also channel.

bar code - Array of vertical rectangular marks and spaces in a predetermined pattern.

baud - Unit of transmission speed equal to the number of signal events per second. NOTE: In asynchronous transmission, the unit of signaling speed corresponding to 1 unit interval per second; that is, if the duration of the unit interval is 20 milliseconds, the signaling speed is 50 baud. Technically baud is the same as "bits per second" when, and only when, each signal event represents exactly 1 bit(which is rarely true), but in casual, non-technical usage, baud is often mis-used to mean bits per second.

binary - Pertaining to a system of numbers with a base of two.

binary digit(bit) - Represents the binary code (0 or 1) with which the computer works. NOTE: The bit can take the form of a magnetized spot, an electronic impulse, a positively charged magnetic core, etc. A number of bits together are used to represent a character in the computer.

bit- See binary digit.

bit-mapped image - Representation of image data where each pixel has a corresponding memory element. See also digital image, image, memory and pixel.

black and white scanner - Scanner that interprets scanned data as black and white, but with additional software, can perform electronic screening, dotting or dithering to produce simulated gray scale pixel configurations. See also dithering, and pixel.

byte - (1) Group of bits, processed or operating together. (2) Term used to describe one character of information. NOTE: The most common byte is eight bits long. A byte allows 256 different possible combinations of eight binary digits.

cartridge - Case containing an optical disk.

CAV - See constant angular velocity.

CCITT - See International Telecommunication Union - Telecommunication Standardization Sector.

CD-ROM - See compact disc-read only memory.

channel - Path or circuit along which information flows.

CLV - See constant linear velocity.

COLD - See computer output laser disk.

compact disk-read only memory(CD-ROM) - Optical disk that is created by a mastering process and used for reading.

compression - See data compression.

compression ratio - Relationship of the total bits used to represent the original to the total number of encoded bits. See also data compression and data decompression.

computer output laser disk (COLD) - Technique used to transfer computer-generated output to optical disk.

constant angular velocity (CAV) - Technique enabling data recorded with a variable linear density to be read, whereby the speed or rotation of the disk remains constant.

constant linear velocity(CLV) - Technique enabling data recorded with a constant linear density to be read, whereby the rotation speed of the disk varies in inverse ratio to the radial position of the reading beam.

Consultative Committee for International Telegraph and Telephone (CCITT) - International organization that develops international communication standards.

controller - Central control processor in a computer system, such as a document filing system, a CAD/CAM system or a word processing system.

data compression - Conversion of a digital image to a lower number of bits for storage. For example, a series of 0s or 1s could be counted and replaced with a code that represents the number of 0s or 1s in that position. See also, data decompression.

data decompression - The regeneration of a bit-map from a compressed representation. See also data compression.

decompression - See data compression.

demodulation - Extracts the information (digital or analog) from the carrier signal, so that the transmitted information may be used.

digital - Use of binary code to record information. "Information" can be text in a binary code, e.g. ASCII, or images in bit-mapped form, or sound in a sampled digital form, or video. NOTE: Recording information digitally has many advantages over its analog counterpart, mainly ease in manipulation and accuracy in transmission.

digital image - I mage composed of discrete pixels of digitallyquantized brightness. See also pixel.

digitization - Use of a scanner to convert documents (on paperor microforms) to digitally coded electronic images suitable for magnetic or optical storage.

digitize - Use of a scanner to convert documents to digitally coded electronic images. See also, electronic imaging and scanner.

digitizer - Device for the digitization of a document. NOTE: This term is often used, by extension, to refer to a device that allows both the scanning and the actual digitization of the document.

digitizing - Conversion of an image or signal into binary code. See also analog and digital.

disk - Round, flat recording medium which consists of a substrate(s) with one or more layers deposited on the surface(s) onto which information can be recorded and played back when the disk is loaded in a disk drive.

disk drive - See drive.

dithering -Method of simulating shades of gray using different patterns of black and white pixels within a cell. See also pixel.

dots per inch (dpi) - Measure of output device resolution and quality, e.g. number of pixels per inch on display device. Measures the number of dots horizontally and vertically.

drive - Machine for reading and, when possible, writing a data storage medium (disk, tape, card, or otherwise); can be optical, magnetic, etc.

EBCDIC - See extended binary coded decimal interchange code.

EIM - See electronic image management.

electronic image gray scaling - Production of a digital image comprising several shades of gray.

electronic image management (EIM) - Coordinated use of all the electronic imaging techniques for capturing, recording, processing, storing, transferring and using images. See also digital image, electronic imaging and image.

electronic imaging - Electronic techniques for capturing recording, processing, storing, transferring and using images. See also digital image, electronic image management and image.

enhancement - Technique for processing an image so that the result is visually clearer than the original image.

extended binary coded decimal interchange code (EDCDIC) - 8-bit computer code that is used to represent upper and lower case characters and special symbols. NOTE: This system is not a standard, but it is used extensively in IBM and IBM compatible large mainframe computers.

facsimile transmission - Process by which a document is scanned, converted into electrical signals, transmitted, and recorded or displayed as a copy of the original.

flat-bed scanner - Device for scanning that has a flat surface for input material. NOTE: Generally used for scanning bound material. See also scanner.

image - Digital representation of a document.

intelligent character recognition (ICR) - Advanced form of OCR technology that may include capabilities such as learning fonts during processing or using context to strengthen probabilities of correct recognition. See optical character recognition.

intelligent scanner - Scanner with additional capabilities such as optical character recognition (OCR), bar code reading, etc. See also bar code, optical character recognition and scanner.

International Telecommunication Union-Telecommunication Standardization Sector(ITU-

TSS) - International organization that develops international communication standards.

International Telegraph and Telephone Consultative Committee (deprecated) - See International Telecommunication Union-Telecommunication Standardization Sector.

ITU-TSS - See International Telecommunication Union-Telecommunication Standardization Sector.

jukebox - Automated device for housing multiple optical disks and one or more read/write drives.

LAN - See local area network.

laser - Source that produces light that is nearly monochromatic (of only one wavelength) and highly coherent (with waves in phase both temporally and spatially). Acronym for light amplification by stimulated emission of radiation.

linearity-Measure of actual distance versus computed distance in both the X and Y axis.

lines per inch(or mm) - Number of scanning or recording lines per unit length measured perpendicular to the direction of scanning.

local area network(LAN) - Data communication network of connected devices within a small area, such as a building or group of buildings.

lpi - See lines per inch.

magneto optic recording - Recording data using optical means to change the polarity of a magnetic field in the recording medium. NOTE: Data is erasable and/or re-writable. See also rewritable optical disk.

memory - Area of a computer system that accepts, holds, and provides access to information and data.

microfiche - Microform in the shape of a rectangular sheet having one or more micro images usually arranged in a grid pattern with a heading area across the top.

microfiche scanner - Device for scanning microfiche. See also microfiche and scanning.

OCR - See optical character recognition.

optical character recognition (OCR) - Technique by which characters can be machine-identified then converted into computer processable codes (e.g., ASCII, EBCDIC, etc.)

optical disk - Medium that will accept and retain information in the form of marks in a recording layer, that can be read with an optical beam. See also compact disk-read only memory, rewritable optical disk and write-once read-many optical disk.

optical memory - Memory in which data are recorded and/or read by optical means. See also memory.

pel (deprecated) - Abbreviation for pixel. See pixel.

peripheral equipment - Supplementary equipment external to a computer that puts data into or accepts data from the computer, such as disk drives and printers.

phase change recording - Ability of a media to transform between amorphous (structureless) and microcrystalline (structured) states. Such media can be transformed a finite number of times.

pit - Broadly used to refer to data carrying marks in optical media, but originally coined to describe the rimless troughs written in photo-resist on videodisc masters and transferred by molding to videodiscs.

raster - Description of a rectangular or square array formed by a number of horizontal scan lines comprising a number of picture elements. The number of scan lines establishes the vertical dimension of the array and the number of picture elements forms vertical rows which establish the horizontal dimension of the array.

raster data - Set of data defining the values of pixels in a raster image.

raster graphics - Method of representing a two-dimensional image by dividing it into a rectangular two-dimensional array of picture elements. See also electronic image and pixel.

raster image - Image formed by modulating the intensity of the individual picture elements within a raster array. See also image, pixel and raster.

raster scan - Method of generating or recording the elements of an image via a line-by-line sweep.

raster to vector conversion - Conversion of a raster image into a vector data image. See also raster, raster data, raster graphics, and vector data.

reader-scanner - Device that scan an image on a microfilm and produces a bit stream (digital) output which can subsequently be displayed or printed locally or at a remote location.

resolution - (1) The ability of a scanning or image generation device to reproduce the details of an image. (2) Measure of capability to delineate picture detail. (3) In micro-graphics, the ability of a photographic system to record fine detail. See also resolution test chart, resolving power and spurious resolution.

rewritable optical disk - Optical disk on which data is recorded. The data in specified areas can subsequently be deleted and other data can be recorded.

roll film scanner - Device for scanning microfilm in roll form. See also scanner.

scaling - Technique using an algorithm to convert a bit-map of one density into a bit map of another proportional density. NOTE: Scaling usually involves enlarging or contracting an image.

scanner - Device that electro-optically converts a document into binary (digital) code by detecting and measuring the intensity of light reflected or transmitted. See also binary code.

scanner threshold - Setting that determines whether a pixel is white or black. See also pixel.

scanning - (1) Operation which precedes digitization whereby the surface of a document is analyzed for characters and graphics, and analog signals are produced corresponding to the optical density of the sampled points. See also analog, digitization and document. (2) OCR scanning is the conversion of printed or other symbolic information from paper or microform into ASCII code. See also handprint character recognition, intelligent character recognition and optical character recognition. (3) The systematic examination of data (ISO).

scan size - Dimensions (length and width) of the part of a document that can be digitized.

scan time - Total time to convert text or graphical information to electronic raster form.

SCSI - See small computer system interface.

small computer system interface (SCSI) - (pronounced "scuzzy") Industry standard for connecting peripheral devices and their controllers to a microprocessor. NOTE:T he SCSI defines both hardware and software standards for communication between a host computer and a peripheral.

system - Organized collection of hardware, software, supplies, people, maintenance, training and policies to accomplish a set of specific functions.

threshold - See scanner threshold.

thresholding - Process by which, in a photo detector, i.e., photo diode, CCD, etc., the analog gradation of dark to light is recognized by the scanner's detection mechanism to produce digital signals.

tiling - Method of breaking a digital image into identically-sized, perfectly interlocking regions.

track - Path followed by the write or the read beam.

vector data - Digital description of an image stored as a series of points and mathematical functions to describe the geometric figure, i.e., line, circle, arc, etc.

vector to raster conversion - Conversion of vector data image into a raster image. See also raster, raster data, raster graphics, and vector data.

WORM - See write-once, read many.

write-once, read-many (WORM) - Digital optical disk on which data is recorded once and can be read many times.