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Computer-Printed Documents As Part of a Computer Crime Investigation

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ABSTRACT: Research related to the investigation and the prosecution of computer crime is continuing. Detailed, highly technical expertise may be required of the document examiner in the comparison, examination, and identification of computer-printed documents produced by high-speed printers. Such research in the area of the identification of computer printouts, as part of the evidence in a computer crime-related case, is continuing. It is important for the investigator, document examiner, and prosecutor to understand the basic workings of the computer, the entry of data by computer personnel, the processing of information via technological advances, and the output of data by high-speed impact or nonimpact printers and to relate such complex workings in everyday language so that the judge and jury may understand the evidence involved.

KEYWORDS: questioned documents, computers, printing equipment

Computer-printed documents may be a part of a computer crime investigation. The print style, the print quality, and the alignment of the computer-printed document may be examined by the document examiner. The purpose of this paper is to focus on information pertaining to the examination of computer-printed material and to provide an overview of the investigation of computer crime and the prosecution of a computer crime case. Prior publications have noted the various computer crime schemes and have attempted to catalogue these schemes. In addition, case studies have described federal legislation, state laws, and prosecution techniques [*1-11*].[2] Although considerable research has been conducted into white-collar crime, such as computer crime investigation and prosecution, little has been done about identifying computer-printed material as evidence in a computer crime investigation [*12-16*].

Basics of Computer Technology

Modern technological advances have streamlined the computer's ability and have enhanced the computer's functions from its early technological beginnings in the 1950s. At

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[2] A comprehensive listing of available references related to all areas of computer crime, computer abuse, programming, investigation, and prosecution may be obtained from National Criminal Justice Reference Service, Box 6000, Rockville, Md. 20850. This service is part of the U.S. Department of Justice, Law Enforcement Assistance Administration, National Institute of Law Enforcement and Criminal Justice.

that time there were approximately five system manufacturers. Today, many companies manufacture advanced computer configurations and remote terminal interfaces.

The computer system operates by using logic functions in a system of code identification. Information is input into the computer by coded cards, magnetic tapes or disks, or other computer entry techniques. This basic information is converted to bytes, which are part of the logic number system that enables the logic circuitry to record and process the information received. The preprogrammed logic system processes the bits and bytes of information sent through the computer. The information may be stored or output to hard-copy format.

Remote terminals can access information directly to the computer. Access can be on-line, immediate, or delayed.

Requests for information are sent via pulse-impulse signals that the computer processes before returning the required answer or information. Terminals can communicate with the processor or base computer via telephone lines or direct access lines. These telephone lines or dialing signal systems allow the pulses to be sent along the transmission lines. The earliest teletype codes are still in use. In addition, there are the standard dial-up codes and the three international standard data codes.

The sequence of pulses are conveyed via a "modem," a modulator-demodulator. Use of the modem has been described for such word processing systems as the IBM OS/6, which may communicate to other OS/6 stations at remote locations [*16,17*].

Information can be communicated via the remote terminal or processed through the computer either by batch or interactive mode. The batch mode permits a processing of all pertinent information to the hard-copy output. The interactive mode allows an information update or other communication between the question asked and the hard-copy output.

The complexities of the computer have created a mystique that many individuals find beyond their comprehension. The president of a company may not understand the computer workings of his organization; the prosecutor may not be able to describe a computer crime case to the jury if he relies only upon computer jargon. It is necessary in the investigation of a computer crime case to simplify the jargon to everyday language that the investigator, prosecutor, jury, and judge will be able to understand.

Investigation of a Computer Crime

Many computer crime cases are not uncovered until an individual exposes the computer crime caper or discrepancies are uncovered through an internal audit procedure. The three major types of computer crime investigations, as detailed in the book *The Investigation of Computer Crime* [*4*], involve the computer as the victim, the computer as the environment for the crime, and the computer as the accomplice for the crime.

With the computer as a victim by vandalism or by an extortionist, traditional law enforcement responses may be appropriate. For example, the information contained in a computer may be held hostage by a terrorist.

The computer used as the environment for the crime accounts for most of today's computer crimes because many fiscal transactions are accomplished by omission of data or by transferring rounded off percentages to a dummy account. The importance of internal auditing for computer programs cannot be overstated, given today's electronic transfer of funds and the many billions of transactions which occur daily.

The computer as the accomplice may be one of the crimes of the future where schemes such as the theft of computer time, information, or cash are manipulated by the user for the user's advantage [*11*, pp. 75–80].

The computer crime scene may appear to consist of millions of pieces of information, stored information on remote terminals, or hard-copy printouts. Thus, the total computer configuration as the crime scene may bewilder the investigator.

The operational guide to white-collar crime enforcement book, *The Investigation of Com-*

puter Crime [4], suggests several approaches to the investigation of computer crime. The investigator should have a concept of the types of computer crimes that have been perpetrated and should make a detailed work plan to aid in the computer crime investigation. This work plan may prove helpful during the court process by explaining to the jury which steps the investigator took to logically investigate the computer crime. The written plan should include the names of the areas searched, the persons interviewed, the documents searched, the files accessed, and other evidence that may be related to the computer crime.

Simple Functions of the Computer

Use of computer jargon is one of the easiest ways to confuse or threaten the successful investigation of a computer crime case. The following words aid in the understanding of the inputs and the outputs generated by a computer.

Input—Input may be made into the computer by various devices, including cassette tapes, programmed cards, and even hand-lettered numerals or letters.

Programming—Programming is a prearranged system that tells the computer what to do with the input data. Preprogrammed directions to the computer are binary functions that catalog and correlate sets of similar data.

Software—Software is the entire set of programs, procedures, and other documentation used within the computer system.

Data base—The data base is a list of files or text the computer has at its access on a preprogrammed mode. It includes whatever information is in the storage medium.

Output—The output may be observed by examining the hard-copy printout or an image appearing on a CRT (cathode-ray tube).

Communications—Computers may talk to each other from remote terminals connected by telephone, microwave, or other devices.

Types of Computer Crime

Generalized computer crime schemes involving the areas given above are these:

Input schemes involve the addition of fraudulent names or accounts. They can also involve the omitting of certain data; for example, a check may be debited to another's account.

Perhaps the most common of the programming schemes is the rounding off of cents at the end of a dollar and the addition of the fraction of cents to a special account.

Software may be mistreated or tampered with.

Operating system schemes are generally done by gaining access to the computer and using the computer without proper authorization.

Output schemes are accomplished by allowing the computer to print a number of duplicate items, such as checks, on the same account.

Perhaps one of the strongest threats to a data base is that it may be taken hostage and held for ransom.

It has been suggested that a systematic way to investigate a computer crime is to first develop a written investigation plan. This plan may come in handy at trial; it is important that this "road map" for investigating the computer crime be clear and logical so that the judge or jurors may understand how the investigation was begun and followed through.

Computer Crime Evidence

Much of the information contained in the computer is not visible unless it is on a printout. In addition, miles of computer tape or hard-copy printouts may be the source of evidence in-

volved in the computer crime. Additional problems may come into play; for example, search warrants could alert the computer criminal to the fact that a computer crime investigation is under way. Consent searches may only alert the criminal to destroy the evidence. Additionally, technical descriptions found on the search warrant may be extremely hard to define narrowly and specifically. Another problem may be the information that falls under the security and privacy laws.

During the initial part of an investigation, it may be suggested to the victim that all tapes and reels be duplicated. Preservation of the evidence is of high importance and rules of evidence should be followed. For example, each tape, reel, or high-speed printout should be identified by putting the investigator's initials on the item, and the chain of custody should be established.

Care and Handling of Computer Evidence

The computer and the hard-copy printed document may be termed the crime scene. Care in handling of the computer evidence is just as essential in a computer crime case as in other types of investigations. The hard-copy printed document should be preserved for possible latent prints. In addition, care should be taken with the reels of tape by marking the evidence properly and by storing it in a cool area.

The Document Examiner

Computer-printed documents may be submitted to the document examiner for examination or identification or both. It is important for the document examiner to know not only the types of high-speed printout devices but also those characteristics associated with each type of printer.

Classification of Printers

There are two primary classes of printers, the impact printer and the nonimpact printer.

Impact Printer

There are two basic classes of impact printers, the character printer and the line printer. The character printer is measured by the number of characters printed per second, whereas the line printer is measured by the number of lines printed per minute. The characters that place the alphanumeric or alphabet design on the page are primarily fixed pieces of type. The engraved characters may be similar to the engraved type found on the traditional typewriter. Of interest to the document examiner may be any defect or flaw formed during the process of the cooling and hardening of the molten metal in the shape of the letter or number.

The primary types of impact printers that contain engraved metal letters are the chain or train and the drum high-speed impact printers.

The chain or train high-speed impact printer is a configuration of letters on a chain that revolves horizontally. One way to identify a train- or chain-printed document is the horizontal alignment of the base of the letters resulting from the train or chain effect of the letters rotating around the printing mechanism. Train- or chain-printed documents may be aligned horizontally, but it is difficult for them to be aligned vertically. Letters appear within the desired space allocated. The timing mechanism causes the impulses to move the hammer, which strikes the character. Several characteristics may cause the width between the letters to be greater or less, such as the electronic impulses that move the chain and permit the hammer to strike the back of the letter, which presses it against the ribbon and then next to the paper. Dirt and other foreign objects force the widening of the distance between characters, which was originally established at the time of manufacture.

The print quality defects inherent in the chain or train impact printer may be described by the following conditions:

1. Either the right or the left side of a letter is not printing correctly, either because of the improper timing of the slug's hitting the paper or because of the ribbon's being worn.
2. Either the top or the bottom of the letters is not printing correctly because of an improper setting on the form's thickness lever found in the computer or the computer forms may be too thick.
3. Either a heavy or a light printing of the characters may be corrected by adjusting the print density control found in the computer, or a new ribbon may be selected.

Another important characteristic of the train or chain printer is that the letters or numbers used most frequently by a company may appear more times on the train or chain than other letters of the alphabet. For example, a company's logo could appear in many locations on the chain or train to increase efficiency by offering the least amount of time necessary to search for the particular character.

The significance of a letter appearing more frequently on a particular chain or train is the increased opportunity for letters with flaws to occur. A comparison of the type slug with the corresponding printed letter may be done by the document examiner. Defects may occur in the molten type slug head. In addition, the printed symbol or letter may be compared to the letters or symbols found on that particular chain design, and a combination of defective letters may be noted. This combination of significant defects in each letter found on both the type slug and the printed document may prove helpful in the investigation of computer crime case.

Also important for the document examiner and investigator to note is that train or chain print heads may be removed from the computer printer and replaced with another chain or train print head. Therefore, it is advisable to find out whether the company possesses more than one train or chain print head.

Lastly, it is important to compare line for line on the train or chain printout to note the corresponding placement of letters along the total line printed. In the cases where computer-assisted optical character recognition (OCR) is necessary for input on computers, the hard-copy computer printout may have fewer defects and print quality characteristics than that used for other types of applications. This will probably be required by a company that employs a full-time field engineer. The field engineer will constantly check for optimum print quality. When the hard-copy printout is not primarily intended for OCR, the print quality may be much less precise than that on printouts needed for high quality optical work.

Drum Printer

The drum printer also uses engraved type; however, it is wound around a drum. As the computer impulses select the letter needed, signals cause one of the available 132 hammers to strike between the ribbon and the paper and a character to give the desired letter or number. The hammer moves as the electronic impulses push it to the paper. The importance of the hammer striking the character is the resulting printed appearance of the letter on the page and whether the character hits higher or lower than manufacturers' tolerance permits. They way the letter strikes the page depends on the speed with which it is pushed toward the paper. This speed is an important factor in determining whether the letter will strike on the line or whether the hammer will cause the letter to hit the page incorrectly timed. Therefore, the letter may have only the upper or only the lower portion printed on the page.

Incorrect synchronization of the hammer and the character on the drum resulting in an incorrectly formed letter on the page can be adjusted by a field engineer. However, the field engineer may concentrate only on adjusting the most grossly affected letters and may not adjust the letters only marginally off because "time is money." It is hypothesized that in those

organizations where the print quality is of paramount value, the field engineer will devote time and patience to correct those letters not properly formed. When the appearance of the printout is of importance, the field engineer will ensure correct print quality.

Defective print quality may also be caused when extraneous ink surrounds the printed letter because the hammer hits too hard or the ribbon is of poor quality. In addition, the characters on the drum may be dirty; for example, a zero may have a filled-in space. Cleaning the drum printer is then necessary.

Wear patterns can develop in those characters most frequently used in a particular row. The metal hitting against metal with only the computer paper to buffer it may cause wear patterns, especially in those letters most frequently used and those located along the adjusted left-hand margin, or, for specialty hard copy, those designed for a particular spacial look.

When drum printouts are compared to determine whether they are from the same machine, columns must be compared. That is, column one must be compared with column one; column two compared with column two. Drum printers can be aligned vertically rather than horizontally. This can be pictured by imagining the column printing vertically down the page rather than across horizontally as found in the train.

The train printer provides for the alignment horizontally; that is, the letters move as a train moves on its track, horizontally on a rail. With the drum printer the vertical alignment becomes important and, because the hammer action is influenced by impulses, occasionally only a portion of the upper or lower portion of the letter hits the page.

Matrix

Another type of impact printer is the matrix printer. The matrix design employs the use of wire print heads to strike the page in the letter desired. The wires are mounted vertically. The impulses fired move the print heads from left to right to form the letter desired. The wires sweep back and forth almost like a paint brush to produce the letter needed. The printed character is the result of the wires hitting the ribbon. The letter resembles little dots. Therefore, the critical parts of a matrix-formed letter are the beginning and ending of the print line because the wires at the beginning of a new line are not moving at the same velocity as at the end of the line. What may be even more difficult to assess is the size of the wire and its influence on the width of the dot, which may be extremely complicated to measure.

Defects in letter formation can be caused by a lack of output from the voltage amplifiers, possibly causing a row of dots to be missing. Additionally, bent wires in the design head may cause improper characters to be formed. A defective decoder unit in the computer may cause an improperly formed letter to be printed. Improper paper feed may cause overlapping of letters and lines.

A confidence level test routine is performed by some printers to permit the operator to determine, by a preprogrammed maintenance test routine, whether the printer is performing correctly. This may be helpful in determining or isolating a data communications problem or a hardware problem. Such test routines indicate to the operator the nominal character size, the horizontal spacings between printed characters and the allowable tolerance, the vertical center line spacing, and the maximum-accumulated tolerance permitted for best performance by the print head.

Matrix letters and numerals can occur on both impact and nonimpact printers. The concept of the letter formation is similar on both, that is, the character is formed by use of the dot matrix.

Two other impact printers are the type head known as Selectric used as part of a computer system, such as Teletype, and a flywheel printer, such as the Daisy flywheel or the Diablo High Type II printer. Much has been written on the Selectric type head as found on the IBM Selectrics and other Teletype single-element type head printers.

The flywheel consists of a type slug or character attached to the end of a metal (or in some

cases plastic) arm attached in the center in the shape of a spoke. The important aspect of the plastic print wheel is its tendency to have one of the print heads broken off if the inked ribbon gets caught in the flywheel as it revolves. The metal flywheel is more durable and is not as easily broken as the plastic. It does, however, tend to wear with use.

Both the single-element type head, such as the Selectric ball, and the flywheel are character printers. A characteristic common to character printers, in general, is the loss of characters at the beginning of a new line, primarily because the carriage return and the line feed are combined in a single-impulse action. This disadvantage can be corrected by adding null characters to the end of a line, which gives the carriage return additional time before printing the next line of typing.

Nonimpact Printers

The advantage of the nonimpact printer is near-perfect registration for both horizontal and vertical alignment. Nonimpact printers may be described by the matrix design found in the ink jet printer such as the OS/6 and the laser printer such as the IBM 3800. There are other nonimpact printers such as the thermal printers, which use a heat-sensitive paper.

The ink jet printer has been previously described in great detail [*15–17*], and therefore only a brief overview will be given here. The OS/6 has the capability of data input through a keyboard. The input may be viewed on a CRT screen for correctness of detail. The information is output to magnetic cards. The cards are placed in the printer. The printer, on receipt of the information via the magnetic card, produces an ink jet letter formation capability, which begins at the right side of the page, travels across to the left, and goes down to begin the next line of writing. The principle behind the ink jet formation has been described as similar to water coming out of a garden hose. In this case ink is released through a power nozzle. A magnetic field prevents the ink from running all over the paper. In fact, the capability of the magnetic field allows only the ink droplets corresponding to the letter formed by the dot matrix print head to reach the paper. The quick-drying ink adheres to the page in the desired letter formation. The extraneous ink is returned to the ink reservoir and is reused for the next letter formation. The OS/6 has a tremendous capability for communication between remote terminals; for interchangeability of print styles; and for ease of correction. The generation of a new page of type, minus an omitted portion, is easily done by the OS/6 operator.

Equally phenomenal is the laser printer. This nonimpact printer may use magnetic cards to generate a photoconductive printed page similar to a photocopied page. The laser printer is extremely fast and is capable of formulating preprinted forms. Laser printers employ phototransfer to combine portions of letters to print one particular letter. This is achieved by an advanced matrix formation circuitry of an imaging subsystem that generates the pattern of modulated laser light that creates a latent image of the page and transfers the image to generate the printed page. Forms or even microfiche can be generated page by page and letters can be changed on a character-by-character basis. It can also call up any special logos, signatures, type fonts, bar charts, or graphs. The page rotation feature allows for horizontal and vertical type on the same page. Equally amazing is a prototype of a Xerox Corp. machine that combines the computer with a color copier. Thus a form and a computerized information format can be generated at the same time.

The nonimpact printer offers an advantage over the impact printer in that many different character styles and sizes and line spacings can be generated including proportional spacing. The print quality from this type of printer is very good. To date the print information is in the matrix or dot design.

Computer Printouts as Evidence

Some general information is provided on the use of computer printouts as evidence in court. Traditionally, the computer crime cases have been tried under the areas of forgery or

larceny or other related areas. To date, the prosecution of a computer crime case is a relatively new field. Federal legislation has opened the door for various states to adopt computer-related crime laws.

Some of the foundational requirements needed to produce computer-printed documents as evidence relate to the business records exception to the hearsay rule. Some cases that may be used for additional reference are described by the following selected criminal and civil cases.

The following legal citations pertain to the admissibility of computer printouts and address the foundational requirements needed to defeat a hearsay objection and to show that the computer printouts fit into the business records exception to the hearsay rule. The citations are described by selected criminal and civil cases [*3*].

Department of Mental Health v. Beill, 44 Ill. App. 3d 402, 2 Ill. Dec. 655, 357 N.E.2d 875 (1976).

State v. Watson, 192 Neb. 44, 218 N.W.2d 904 (1974), a criminal conviction for writing a check with insufficient funds.

United States v. Weatherspoon, 581 F.2d 595 (7th Cir. 1978), a conviction for racketeering, mail fraud, and false statements.

United States v. Scholle, 553 F.2d 1109 (8th Cir. 1977) *cert. den.* 434 U.S. 940, a narcotics conviction.

United States v. Fendley, 522 F.2d 181 (5th Cir. 1975).

United States v. Farris, 517 F.2d 226 (7th Cir. 1975) *cert. den.* 96 S. Ct. 189, a conviction of failure to file income tax returns.

Monarch Federal Savings & Loan Assn. v. Genser, 156 N.J. Super. 107, 383 A.2d 475 (1977). "The court held that personal knowledge testimony regarding the information received into the computer is not required, nor is it necessary to have the preparer testify. However, the testimony is required of a custodian or other qualified witness who can testify that the computer records were made in the ordinary course of business, that they were made contemporaneously, what the sources of the information were, and the method and circumstances of preparation."

"Many states have enacted the Uniform Business Records as Evidence Act. In construing it, most state courts have reached the conclusion that computer printouts can be business records. One example is *Missouri Valley Walnut Co. v. Snider*, 569 S.W.2d 324 (Mo. Ct. App. 1978), a breach of contract case in which the court held that the computer readouts were admissible under the business records exception to the hearsay rule. Testimony showed that the plaintiff's office manager received information daily from buyers and log inspectors and fed that information into the computer. The computer delivered a printout the following day that was checked for accuracy against the original records."

United States v. Smyth, 556 F.2d 1179 (5th Cir. 1977).

Summary

Research related to the investigation of computer crime and the prosecution of computer crime is continuing. Further detailed highly technical expertise may be called upon from the document examiner in the comparison, examination, and identification of computer-printed documents produced by high-speed printers. Such research in the area of the identification of computer printouts as part of the evidence in a computer crime-related case is continuing. It is important for the investigator, the document examiner, and the prosecutor to understand the basic workings of the computer, the entry of data by computer personnel, the processing of information via technological advances, and the output of data by high-speed impact or non-impact printers. It is extremely important for the investigator, the document examiner, and the prosecutor to understand the technological workings and to relate such complex workings to everday understandable language so that the judge and jury may

understand the findings, may understand the investigation, examination, and summary of the evidence involved in a computer crime case.

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