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A Look into Facsimile Transmission

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ABSTRACT: Facsimile copies are becoming an increasingly popular means of communicating information, particularly when distance and speed are important factors. Consideration will be focused on the production and recognition of facsimile copies and special features incorporated in various makes and models of machines.

KEYWORDS: questioned documents, facsimile, machine generation, thermal transfer, lasers

Today's facsimile machine is a device capable of scanning a document and converting the image to digital data which can be sent over national and international telephone systems. The receiving fax demodulates the signal and restores the image to its original form on paper [*1*]. Fax machines are actually transceivers in that they can both send and receive an encoded audio signal.

The transmitted signal is derived by scanning a document with a tightly focused light beam extending across the width of the slot. A series of mirrors compacts the image reflected from the document into the acceptance angle of a lens which, in turn, focuses the image on the faces of a charge coupled device (CCD) [*2*]. Electronic scanning of the CCD provides a bilevel signal for the electronic system.

Initially, the images were formed by a heat or an electric burning stylus that tracked over the paper. The heat stylus actually burns the image into thermal paper, whereas an electric current passing from the stylus through electrostatic paper changes the color of electrostatic paper at the burn [*3*]. Current methods are a direct transfer to thermal paper, direct transfer using a thermal ribbon to plain paper, and the laser image which incorporates toner and developer.

Background

The principle of facsimile transmission is not a new idea and is purported to have been developed in the 1840s in Scotland. It is reported that Arthur Korn of Germany developed the first commercial fax system in 1907 to transmit pictures between distant European cities, and in 1922, created the first "wirephoto" by sending a picture from Rome to the United States by radio [*4*]. In the late 1920s, companies such as RCA, AT&T, and Western Union used facsimile technology to transmit news pictures and weather maps by radio or over special communication circuits. It was not until the late 1960s that a court ruling paved the way for the modern revolution in facsimile technology. The ruling opened access to public telephone lines for nontelephone communications, including facsimile.

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Xerox Corp., in the late 1960s, began introducing a line of telecopier machines that could transmit a page in about 6 min. In the 1970s, a Geneva-based United Nations organization established standards for the industry. Although U.S. companies were the leaders in first-generation facsimile machines, in recent years, they have allowed the technology to languish and no significant U.S. makers exist today [5]. Xerox Corp., once a fax leader, now has all of its machines made by its Japanese partner, Fuji Xerox Company of Tokyo. Ricoh makes facsimiles for AT&T. Statistics indicate that Japanese makers account for 98% of world sales of fax machines.

Generations of Machines

Three generations of facsimile machines are in use today having standards set by the International Telegraph and Telephone Consultive Committee (CCITT), the organization which sets the standards for all international communications. First-generation machines, under these standards, were introduced in the early 1970s and are referred to as Group 1 machines. These facsimiles required 6 min to send a letter-sized sheet of paper [5]. The document was mounted on a spinning drum that was tracked by a electromechanical assembly and images were literally burned onto paper [3].

The second-generation machines, Group 2, are in the time period of the middle to late 1970s and required approximately 3 to 4 min to transmit a message. Group 2 machines represent a period between the electromechanical and the digital eras. They operate by using electronically derived AM modulation [3]. The document is scanned on a flatbed, as opposed to the drum, and the printing paper is fed from a roll.

The standards for Group 3 machines, the present generation, were set in 1980. These are the digital faxes and they transmit in under 1 min. It is likely that CCITT Group 3 will become the basic communication standard, while Groups 1 and 2 become obsolete [6]. Group 3 machines offer many important advantages over earlier models, including high speed of transmission, automatic operation, and lower cost.

Imaging Methods

Various makes and models of Group 3 machines offer several different methods of placing the image on paper. The most common method, presently, is direct transfer onto thermal paper. All facsimile manufacturers have models with this form of imaging.

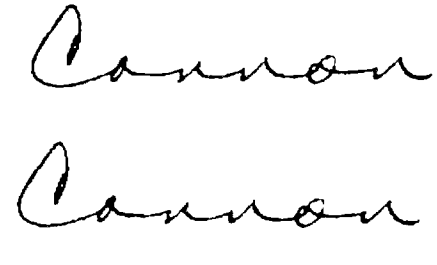
Within approximately the last few years, a direct thermal transfer system using a thermal ribbon has been introduced. The paper used with this system is a plain, smooth, specially coated, thermal sensitive roll paper. The heated printhead wires allow the ribbon to release a plastic-type coating onto the paper. Cannon, Ricoh, and Toshiba offer this system in addition to the thermal paper method.

Xerox, within the last year, has introduced a fax that uses the thermal transfer ribbon system but prints onto plain bond sheet paper. At present, it is the only manufacturer using the thermal transfer ribbon with plain sheet paper.

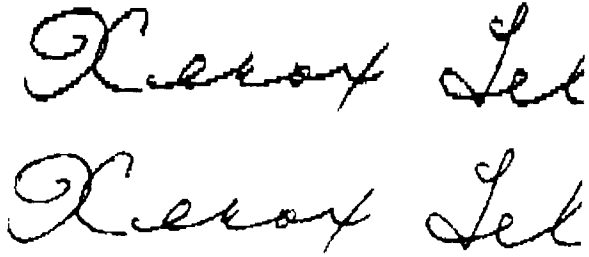
Cannon, and very recently Sharp, market a laser fax which uses toner and developer and prints onto plain sheet paper. These machines are expensive and currently more suited to the high volume user.

Recognition of Fax Imaging Methods

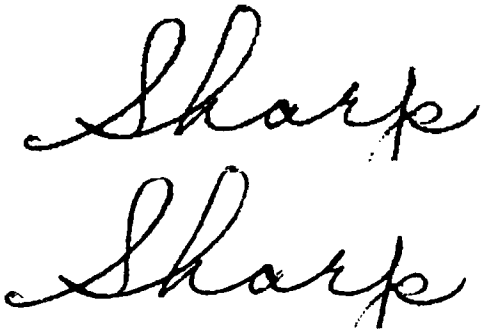
Facsimile printing is recognized by its notched or stepped effect (Fig. 1). The printhead images one line at a time as the paper moves through the machine. Direct thermal transfer to thermal paper is recognized by the special paper and the even appearance of the image in the paper coating. This image can be entirely scraped off the paper. Thermal ribbon



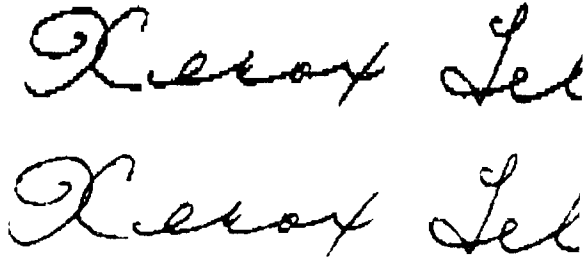
Plain Paper(roll) Thermal Ribbon
Fine and Superfine



Thermal Paper - Standard and Fine



Plain Paper(sheet) Laser Printer
Fine and Ultrafine



Plain Paper(sheet) Thermal Ribbon
Standard and Fine

FIG. 1—*Recognition of fax imaging methods.*

transfer leaves a plastic-type substance on the paper fibers, and its appearance is affected by the type of paper used, whether the specially coated thermal sensitive roll paper or plain bond sheet paper. Particles of the ribbon transfer image can be scraped off but much of the substance remains adhered to the paper fibers. Even though a faxed document is photocopied, the notched or stepped appearance of the characters will indicate facsimile transmission and possibly the method of printing.

Laser fax printing is recognized by the fine, shiny, grainy particles of toner forming the images. The notched or stepped effect, though more latent than with the thermal paper or thermal ribbon transfer methods, is still present and can be perceived under magnification.

Group 3 machines have various resolution modes that affect the appearance of the image on the paper. Resolution modes are generally standard (98 lpi × 203 lpi), fine (196 lpi × 203 lpi), and superfine (392 lpi × 203 lpi), with the laser printer having an additional mode of ultrafine (392 lpi × 406 lpi). The resolution mode determines the speed at which the document is scanned. The slower the scan, the finer will be the definition of the printed images. High resolution, plain paper, and thermal ribbon each contribute to the minimization of the notched or stepped effect of the faxed image.

Features of Facsimile Machines

All fax machines operate on the same principle. The difference between various models is in the number and type of features provided. A faxed document can offer clues as to the make and model machine from which it was generated. Features of interest are:

Contrast—dark and light settings in addition to the automatic setting. Halftone with grey scales from 16 to 64 shades.

Document Feeder—unattended feeding of multiple pages, usually from 10 to 50 pages.

Automatic Reduction—roll paper measures 8½ in. (21.5 cm) in width and up to 328 in. (833 cm) in length. On some models, pages up to 11 in. (28 cm) wide can be fed but are automatically reduced to 8½ in. (21.5 cm) during transmission.

Compatability—most machines are and should be compatible with Group 2 and Group 3.

Automatic Paper Cutter—automatically trims paper to the length of the original document. Only the smallest models do not have an automatic paper cutter.

Memory—holds document information for later transmission to take advantage of reduced telephone rates in offpeak hours.

Confidential Transmission—allows the capability of sending documents directly to the memory of a compatible machine where they can be printed only after entering the correct code.

Voice Request—allows the sender to speak to the receiver before, during, or after transmission for the cost of one call.

Modulation Transfer/Smoothing—ensures that small letters and fine or curved lines are accurately reproduced.

Copier—provides a replica of how document will look at the receiving terminal so adjustment can be made before transmission if desirable.

Storage—telephone numbers are stored and can be dialed with a one- or two-digit code.

Automatic Redial—if connection is not made immediately, the number can be redialed at programmable intervals.

Polling—instructs other compatible terminals to send any documents in their automatic document feeder. This may be done on a transmission call to minimize phone charges. A "secure" feature is generally incorporated to ensure that only authorized terminals pick up documents.

Error Report—report identifying lost pages and reason for the problem.

LCD (Remote Terminal Identification)—displays the number dialed. On some machines, this display of messages or prompts can be switched to French or Spanish.

Modem Speeds—9600/7200/4800/2400 bps. Most machines have an automatic fallback so that if the transmitting machine senses that the receiving machine cannot accept the document at the programmed speed, it will automatically fall back to an acceptable speed.

Error Correct—resends specific sections of documents if distorted in any way by phone line.

Transmit Terminal Identifier—automatically prints the date, time, location, and page number on the top of every page received. Optional information such as name and phone number may be included up to a set number of characters.

Transmission Report—confirmation that a document is sent and is okay.

Activity Report—a record of all incoming and outgoing traffic printed automatically after a certain number of transmissions or on demand.

Specific Manufacturer Features

Xerox—Plain paper faxes have reduction modes of 80, 75, and 65%. The machine has a transmission report in which the reduced copy of the document, or first page, is shown above the information and software available to connect the fax to a personal computer (PC).

Sharp—The laser fax has an enlargement of 114% and a reduction of 81%.

Cannon—The machine has an uncurl device for paper on some models, has a feature to trim excess edges of a document to pick up all information possible, and stamps each document as it is faxed to avoid confusion later.

The Future of Facsimile

There will be a consistent move in the direction of plain paper faxes. Thermal paper is reminescent of the obsolete copying machines, fades easily, and has no permanency [7]. Plain paper will be desirable for archival storage and the ability to write on a copy.

The next steps in fax development will be integration of functions currently available only on different machines and PC fax machine integration. Advances coming to market soon include enhanced memory, portable fax units, and public access fax machines. An ideal future system would combine normal PC functions, fax emulation, optical character readers, and image editing [6].

A new generation of facsimile machines, Group 4, is now under development and will operate over high-speed data networks, thereby increasing transmission speed more than ten times. Group 4 machines will not, however, render Group 3 obsolete, because public data networks are rare, installation costs are high, and slow growth is expected for their use [8]. Group 4 technology is expected to set standards for data communication and for the integration of all office systems; but until data networks are readily and inexpensively available, Group 3 units will continue to be the primary faxes.

References

[1] Green, J. H., "Facsimile: On the Verge of Maturity," *The Office*, May 1987.
[2] Helber, C. A., "Facsimile: 1940–1988," *Radio Electronics*, Nov. 1988.
[3] Friedman, H., "The Facts on Fax," *Radio Electronics*, Nov. 1988.
[4] American Facsimile Association, Philadelphia, PA.
[5] Joseph, J., "Fax Technology Gains Could Fire Up Market," *Electronics*, 9 Dec. 1985.

[6] Voros, G. L., "The Future Fax: a System–Solution Approach Needed," *The Office*, May 1987.
[7] Beiswinger, G. L., "Fax Manufacturers Seek to Offer a Better Mousetrap," *The Office*, Sept. 1988.
[8] Franz, R. M., "Group Four Fax Technology: Its Effect Will Be Felt," *The Office*, Aug. 1985.

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