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The Fax Systems: A Bright Outlook for Business Communications

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by Mary S. Moore

I. *Introduction*

This unit will focus on the fax machine to show its affect on business communications in the workplace. Students in the business management class will receive an introduction to the fax machine concepts, theory and practice. They will learn that fax systems are one of the most modern technology in the field of business communications. They will also learn that it is one of the leading device of the electronic-imaging revolution that has had a major impact on business in the way it disseminates information all over the world in seconds, for very low costs. Today, the fax machine is the most dynamic device to hit the office-product industry since the personal computer. This unit will be geared toward high school students from grades ten through twelve. A recommended of three class periods would allow student to complete the operation of using the fax machine.

Upon completion of this unit, student will be able:

1. to know what fax is
2. to identify the basic machine parts for operating a fax machine
    (a) start-up procedures
    (b) routine operation of machine
    (c) special features
    (d) functions and programming
3. to know fax terminologies
4. to understand the basic construction of facsimile apparatus drum scanning to flat-bed scanning
    (a) photo-electric conversion reading technique
    (b) recording and writing
    (c) incompatibility

II. *What is Fax?*

Fax is a method of sending an exact facsimile of your document almost anywhere in the world in seconds. Fax machines are easy to use and increasingly versatile. The basic function of a fax machine is having transceiver plugs connected to a standard telephone socket, which scans the document fed into it, and then transmits the result electronically to a similar machine at the other end of the line where a facsimile document is printed out.

The two units may be separated by only a few feet of wire or they may be thousands of miles apart. The fax machine can also be looked upon as a cross between a telex machine and a copier, as it can transmit anything that the telex can and many things that it cannot—such as graphs, charts, photographs and signatures.

The procedure for sending a document is really quite simple, and although it may vary slightly from machine to machine, the basic process is the same. The operator places the original in the feed slot and then dials the telephone number of the facsimile machine to which he or she wishes to transmit. When the receiving unit "answers," a high-pitched tone is heard in the sender's telephone receiver. The facsimile machines of today automatically select the transmission speed (measured in bits-per-second, or bps), and the document is sent. The entire transmission usually takes less than 30 seconds per page.

The standard telephone toll charge is the only expense you'll have in a fax transmission. The fax machine lets your get the most out of each phone connection, reducing the time and expense of placing additional calls. After transmission is completed on some of the more advanced machines, the fax automatically requests the receiving terminal to transmit any documents it may have waiting.

Voice request lets you carry on a conversation with someone at the other end before, during or after a document transfer. There's no need to pay for a separate call. Fax machines lets you take advantage of the bargain off-peak rates of many common carriers. Savings of 60%, 70% and even more can be realized, depending on your carrier and whatever special rates may be in effect.

The more advanced fax machines comes with a built-in autodialer, send later capability, recorded voice announcement, monitor speaker, 64-shade halftone control, full 8 1/2 in. scanning and recording width, transaction confirmation report, error report, page header with batch numbering and delayed sequential polling.

The biggest factor in fax's success, is the emergence of machines for small business and departmental use that cost under $2,000. Facsimile is expected to reach a million placements a year in 1990.

AT&T's Bell laboratories developed the modern facsimile machine in 1925, and U. S. companies were the first-generation leaders. But in recent years, they allowed the technology to languish, and no significant U. S. makers exist today. All other faxes sold in the U. S. are either marketed directly by Japanese makers such as NEC Corp, and Matsushita Communications, or made in Japan and sold under a U. S. Label.

III. *What fax can do for you?*

Fax has its advantages and disadvantages versus other methods of communication. While the telephone is direct, fax is worth more because it can produce pictures, facts, figures, letters, graphs and forms which can be transmitted around the world in a matter of seconds. Telex, unlike fax, only handles alphanumeric text, where someone must retype the entire communication. Retyping takes time, and can introduce errors. Telex also cannot handle any form of graphic information.

Fax is not a cost-effective alternative to regular mail if time is not a factor, unless the connecting telephone call is local. Dialing a telephone number on autodial is often easier than addressing envelope. Fax can save considerable over express mail. A three-page overnight letter from New York to Los Angeles costs about $1.00, compared with $8.75 to $11.00 for express delivery. From New York to Paris, it's about $4.12 compared with $21.00, according to a publicist of AT&T.

Today's fax machines can distribute a document to multiple destinations around the country probably faster than an interoffice mail can distribute a memo. Many businesses are now creating their own fax networks because the equipment has become smaller, less expensive and easier to operate, says Gregory L. Voros, President of Fujitsu, a leading fax manufacturer.

IV. *Background on the Fax Industry*

The facsimile was invented in 1843 by Alexander Bain, earlier than the telephone invented by Bell in 1876. The facsimile came into practical use much more slowly than did the telephone. Using early achievements in electronic engineering such as the vacuum tube and photo cell, practical models were developed in the 1920's in the United States, Germany, France, and Japan. After their introductions, facsimile apparatuses were used in specialized areas, such as for transmission of news pictures and weather maps, and pickup and delivery of telegrams.

Facsimiles are classified into either *photographic* facsimile, in which the original copy is reproduced faithfully with graded tonal densities, or *document* facsimile, in which the original copy is reproduced primarily with black and white.

For many years before the growth of the fax machines, Alexander Bain modified a system of synchronized electric clocks to make the first fax machine. He devised a way of skimming raised metallic letters with a stylus attached to a pendulum. With this method, a stream of electric pulses were sent by a wire to the receiving device where a second synchronized pendulum swept across chemically-treated paper, leaving a dark mark wherever a pulse occurred. The rate at which the apparatus was capable of working was discovered accidentally by a broken spring. The fax principle was established and Bain received 7,000 for his telegraphic patent. The money he received was wasted in litigation and he died a poor man.

After the death of Bain, a handful of European inventors began to build upon his non-success and refine the fax principle. Giovanni Caselli, Frederick Bakewell, Ludovic d'Arlincourt and Edouard Belin each contributed innovations, but it was not until 1902 that Arthur Korn, a German, demonstrated the first photo-electric scanning fax system. The previous methods had depended upon Bain's contact-scanning technique. In 1902,

Dr. Arthur Korn developed a photoelectric scanning system for the transmission and reproduction of photography, and in 1907, he established a commercial picture transmission system. This system eventually linked Berlin, London and Paris and became the world's first facsimile network. Facsimile then made slow but steady progress through the '20s and '30s, and in 1934 the Associated Press introduced a wire photo service. Korn's breakthrough of giving the fax machine "sight" prompted serious commercial experimentation by three American telecommunications giants: AT&T, RCA and Western Union. Korn's success and achievement in using the fax brought new development and direction for broadcast publishing to the United States.

V. The Basic Construction of Facsimile Apparatus Drum Scanning to Flat-Bed Scanning

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The basic block construction of a facsimile apparatus is shown in Fig. 1(a). The classical and modern means used to achieve the functions of each block are shown in the schematic diagrams (b) and (c) of Fig. 1.
(figure available in print form)
In the photo-electric conversion block at the transmitter and the recording block at the receiver, the older drum scanning system, in which the original or recording paper was wrapped around a drum and scanned, has advanced to the flat-bed scanning system, in which scanning is performed while the original remains flat. This improvement has made operation much simpler. Also, in place of mechanical scanning, electronic scanning by using a solid-state image sensor or recording head was introduced. As a result this, much higher speed and reliability were achieved.

For the processing and transmission of signals, recent developments have been proceeding from analog to digital technologies. In previous analog transmission systems, amplitude modulation (AM) or frequency modulation (FM) was widely used. Also, vestigial sideband (VSB) transmission was partially used as the band compression technology. When such analog transmission systems are used over the normal telephone line, they require about three to six minutes to send a single A4-size document. The quality of the receiving document suffered greatly because of the telephone line transmission characteristics. Today's high-speed transmission method uses modern digital-processing technology to perform redundancy reduction, encoding, and conversion to binary signals. These signals were then transmitted by using a data transmission modem, resulting in a transmission time for an A4 page of one minute or less.

As scanning systems supported by advancements in semiconductor technology move to solid-state electronics, and as hardware and software continue to progress, these new developments contribute to the improved cost performance of facsimile apparatus.

For facsimile transmission, the public-switched telephone network is most popular in many countries, but in Japan a special public facsimile communications network has also been made practical, thus allowing low transmission costs. As public data networks and future ISDN's become practical, high-speed digital transmission lines will likely be used for even faster and higher-resolution transmissions.

Photo-electric Reading and Writing Technique are the two processes involved in facsimile transmission. When the fax machine cord is plug into an AC power line, and the switch is *on* , the document is ready to be placed in the transmitter for duplication. The synchronous motor that keep the drums rotating at a constant speed, allows the scanner and recorder to move line by line picking up the image of the original document in the form of light impulses. These synchronized impulses pass through a precision optical system and hit the photo-

electric cell where they are converted to an analog or digital signals which are coded and transmitted over ordinary telephone lines. The synchronized impulses sends information which cause the rotation of the scanner and recorder to go at the same speed, allowing both pictures to start at the edge of paper. This is call synchronization of timing. At the receiving end, the process is reversed and the electronic signals are coverted back into printed matter to produce a facsimile, or exact copy, of the original.

Many kinds of recording methods are used, such as spark recording, electrolytic recording, ink-jet recording, electrostatic recording, electrophotographic recording, and thermal recording. These recording methods all have their own merits and demerits in the areas of recording speed, resolution, reproduction of halftones, sensitivity to environmental conditions, and economy. The methods in widest use at present are thermal recording and electrostatic recording. One reason these systems have come into such broad use is their good adaptability to solid-state scanning technology and digital signal-processing technology.

The thermal recording method is shown in Fig. 3. The recording paper construction is shown in Fig. 3(a), a layer of color-developing emulsion being coated on a base paper. The color-developing layer includes a dispersion of two components, A and B, which chemically react with each other in the presence of heat, thus developing the color. These components remain separated under normal temperatures so that no color is produced.

(figure available in print form)
The recording head uses a row of heating resistors spaced at minute intervals on an insulating board. Various means, including thin-film, thick-film, and semiconductor technology, are used to fabricate the thermal head, but thin-film technology is used most widely.

Thermal recording is a type of direct recording, which does not require the additional steps of developing and fixing. Therefore, its recording construction is simpler, and maintenance is easier than in electrostatic recording. On the other hand, electrostatic recording has higher speed and higher resolution than thermal recording, and its hard copies have superior preservative qualities. Thermal reading is the most widely used for document facsimile in offices, but there is also a strong demand for electrostatic recording, especially for the transmission of legal documents.

One of the greatest obstacles to the expansion of the facsimile market has been the problem of incompatibility. Incompatibility between facsimile machines causes distortion, compression or expansion of copy, and sometimes complete inability to communicate. There are numerous factors involved with this problem of incompatibility; some of the more common ones are the use of both FM and AM modes and variations in transmission speed and resolution.

Part of the responsibility for this lack of compatibility was with the manufacturers who had exhibited little desire to conform to an industry standard. In addition, for many years the technology of facsimile was still developing so that many within the industry feared that standardization would come at the expense of further advancement and improvement in the field. Each company had been hoping that by introducing a more advanced line of machines, it could dominate the market. thereby creating a de facto standard. In recent years, however, the situation has improved quite markedly, with manufacturers offering a variety of speeds on a single machine and with the introduction of international (standards) guidelines provided by the CCITT.

The CCITT (Consultative Committee for International Telephone and Telegraph) is a committee of representatives from member countries of the United Nations that has been set up to study telecommunications equipment and to recommend standards in design and operation. Although

subcommittees meet continuously, a plenary session is held once every four years, at which time subcommittee recommendations are considered for ratification.

All machines that were manufactured over 30 years during this time were divided by the CCITT into four groups: Group I and II machines employing slower transmission speeds. Group I includes analog machines which can transmit and 8 1/2" x 11" page in four or six minutes, and Group II includes analog machines which can transmit an 8 1/2" x 11" page in two or three minutes. Group III includes digital machines using data compression to transmit an 8 1/2" x 11" page in one minute or less. Group IV machines have transmission speeds that are six times faster than those of Group III; however, the telecommunications bandwidth required by Group IV facsimile machines has only recently become available and still is so costly that few users take advantage of its high speed.

Now that most of the facsimile units can communicate with one another, technological advancements in the field have increased and manufacturers are producing what the users want: less costly, high-speed models that can fall back and communicate with slower machines. These models are also able to communicate with word processors and serve as printers for remote computers and data processing terminals.

VII. *Recent Developments*

Portable Facsimile Machines : Currently available are small, lightweight fax units which are designed primarily for the traveling business executive and salesperson. With acoustic coupler that attaches to any public, private or cellular telephone, these units can be easily carried and used anywhere—in hotels, airports and even an automobile. They can weigh as little as 10 pounds and are small enough to fit inside an attache case. Portable models should not be confused with transportable units, though, which are essentially small office facsimile models that are light enough to be transported from office to office, but not light enough to be transported from building to building.

Compact facsimile machines: Japanese manufacturers were the first to introduce desktop portable facsimile machines which incorporate a telephone into the unit. Known as "faxphones," these models are professional-looking, one-piece systems that can be placed on the executive's desk, thus reducing the necessary office space for a telephone and a facsimile machine. Compact units offer many of the same features as the larger ones, including approximately 20-second transmission speeds and Group III and II compatibility.

Links to personal computers: Although fax machines encode documents as images (whereas personal computers encode alphanumerics individually), companies like Gammalink (Palo Alto, California) and Xerox (Lewisville, Texas) market add-on PC boards that enable PCs to display faxed documents as graphic images. This makes it possible for PC users located remotely from centralized fax devices to view fax information at their desks instead of having to go to central sites to pick up hard copy.

Future Developments : Much of the future of facsimile can already be seen. The Group III machines which are now at the forefront of market activity will become smaller, more portable and less costly. Increasingly, they will be given plain paper printing capabilities. Also, as wideband telecommunications services (such as AT&T's Switched 56 offering) become more widely available, it will become easier to put high-powered Group IV machines to work. Nonetheless, the current Group III devices promise to remain the primary type of fax terminal into the 1990s.

VIII. *Conclusion*

At present, facsimilees are used as business communications devices in offices via the public switched telephone network. The public telephone network is the most widely avail able throughout the world, and about one million telephone network facsimiles are being used, largely in Japan, the United States, and Europe. The public data network is limited in terms of service area, there are relatively few new subscribers to it, and time will be required for the expansion of the ISDN. For the present, it is likely that the G3 facsimile will continue to occupy the main current of expansion and development.

In order for the use of home facsimiles to expand, it will be necessary to bring the various home information systems into conformity with facsimiles, not for message transmission, but for such applications as videotex, television program recording, TV multiple, and facsimile broadcast reception. In these applications, it will probably be desirable to produce low-cost small-size apparatus capable of reproducing halftones and color.

IX *Teaching Strategies*

Sample Lesson

Fax Machine

Objective The students will be able to identify a fax machine by showing a copy of one displaying a telephone.

Material and equipment Needed: Overhead projector and handouts on fax

Procedures Give an introductory on the fax machine history. Use transparencies to identify basic machine parts for operating a fax machine. Explain to students how fax machines are used. Make sure that the students understand the operation panel characteristics and its function. Allow students to ask questions. Review lesson for clarity and introduce new lesson for next day.

Related Activities Give a matching quiz on fax terminologies and definitions.

Sample Lesson

Initial Start-Up Procedures

Objective The students will be able to program the following items to enable full operation of a fax machine by using the operator's manual.

Materials needed Handout copies of the initial start-up procedures

Procedures Introduce and explain the features of starting up a fax machine. Display a fax machine for hands-on experience. Discuss and explain the functions of each features. Make sure that students follow the item and mode in the proper sequence for full operation. Allow students to ask questions. Review for clarity and introduce lesson for next day.

Related activities
Have students to write out the procedures for starting a fax machine.

Routine Operation, Special Features and Functions and Programming

Objective The student will be able to prepare machine for basic transmission after a demonstration by a resource speaker at Southern New England Telephone Company, Telecommunications Department.

Equipment to be used Two fax machines

Procedures The speaker will provide a copy of each procedure to students. He will explain and demonstrate the procedures by using the fax machine. Students will be allowed to asks questions during each demonstration. The speaker will use two tax machines to show students how transmitting and receiving is done by businesses. He will also give students a handout in explaining the two processes involved in facsimile transmission.

Related Activities Students will be allowed hands-on-experience in programming basic transmission of document. They will also write a report on their visit to share with other class members.

Fujitsu Imaging Systems

Fujitsu of America, Inc.

3 Corporate Drive, Commerce Park

Danbury, CT 06810

Sales Information 1-800-243-7046

Corporate Headquarters 1-203-796-5400

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Milford, CT 06460

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Public FAX

2811 East Katella Avenue Suite 200

Orange, CA 92667

1-714-532-5330

Harris 3/M Document Products, Inc.

P. O. Box 785

Dayton, OH 45401

1-800-44FAXIT

X. Glossary of Fax Terms

(figure available in print form)
Fax Guide
(figure available in print form)

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This report gives an introduction of the facsimile machine. It explains the processes involved in facsimile transmission, its two categories of speed, problems of copy quality, incompatibility, future of facsimile, selecting a facsimile system, servicing, purchasing and renting a facsimile.

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