An overview of the computer output microfilm field

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INTRODUCTION

From the earliest times, man has made his mark. At first his marks were made with his own fingers on walls of caves. He used a chisel or brush to create pictures of animals. He developed symbols, alphabet and languages. Man used marks to pass information from person to person and from generation to generation. Through the ages, man recorded information to be used again and again. He recorded history, mathematics and law. These things brought order to his life. The history of civilization is the history of man’s ability to communicate, record and make marks.

In making marks, there is most always a moving object. Man used his own fingers. Today most marks are made by a type slug, a print hammer, a moving drum, or some mechanical device. And now man has electronic digital computers. These machines manipulate and generate information at unprecedented speed. Man’s need to make marks has multiplied many times in the past few decades. Much of the drudgery of handling information has been relegated to the computer. The speed of computers is so great that mechanical mark-making devices can no longer keep pace. Devices using a stylus or print hammer will not move fast enough and require too much maintenance.

This is the beginning of our story—a new method for making marks—COM.

What does COM mean?

2. Computer Output Microfilmer: a recorder which converts data from a computer into human readable language and records it on microfilm.

This paper will describe COM technology and the various types of COM recorders. Some of the uses and applications will be explored. A description of the various recorders and a comparison of the units will be made. Microfilm origination, dissemination and retrieval systems will be reviewed. Some COM market forecasts will be looked at and a survey of the field by the National Microfilm Association will be presented.

General

Over the past several years, American industry as well as the scientific community have turned increasingly to the use of computers and microfilm as a means of controlling what is referred to as the “paperwork explosion.” Computers and microfilm have been generally used independently to cope with the same problem. Both have been successful, but neither alone has completely solved the problem. The effect of combining microfilm and the computer in a system for information handling may turn out to be more dramatic than the effect of either alone.

Computer systems of all generations, first, second and...
third, have been plagued by an imbalance of speeds. The functions of computer systems—input, processing, and output—though intertwined as functions, have been sadly imbalanced in their speed relationships one to the other. The computer itself, or the mainframe, has seen an ascension of speed and power of phenomenal proportions from the mid-1950's to the present. The older vacuum tube equipment could process at thousands of seconds or milliseconds. The transistor and solid state technology brought forth microseconds or a millionth of a second speeds. Finally, the third generation in this evolution, the micrologic of integrated circuits, has caused nanosecond speeds, a billionth of a second, to be realized. However, the input/output twins have seen no similar evolution. On the input side the basic medium of data input is still the EAI card which is over 30 years old. On the output side mechanical printing and its hardcopy paper medium has been the major avenue of getting the information to the user.

Although there have been several major efforts to improve the input/output situation, and especially to eliminate the output bottleneck, none has succeeded until now. The Computer Output Microfilmer, or COM recorder provides the solution to the computer output problem. A COM recorder has the output equivalent of as many as 30 impact printers operating simultaneously. Some COM units have a transfer rate as high as 100,000 characters per second (transfer rate: the speed at which information can be transferred from magnetic tape to microfilm).

The COM is a device which records computer data on microfilm in human readable form. It is a recorder which may be connected directly to the computer for "on line" operation or to a magnetic tape unit for "off-line" operation. The magnetic tape unit "reads" information into the COM from a magnetic tape which previously has been recorded directly from the computer.

There are three types of COM devices:

Business— alphanumeric printer

Scientific—alphanumeric printer and plotter

Graphic Arts—special quality alphanumeric printer and plotter

Recording the output of a digital computer directly on microfilm is not new. As early as 1955 at least one COM recorder was in use for this purpose. The early units as well as some of the new units were designed for scientific work. These recorders are printer-plotters; that is, they are capable of reducing the digital output of computers to convenient, usable plots and curves that are annotated with alphanumeric information. Figures 1 and 2 are typical scientific plots. This was the role of the COM until recent years when some of the scientific users began using the printing capability for non-scientific alphanumeric listings.

Figure 1—Typical scientific plot

Figure 2—Typical scientific plot
These non-scientific (business) applications prompted the development of special COM devices which are designed for high-speed recording of alphanumeric computer output. These units record the same type of information as impact printers only they are much faster and the information is placed on microfilm instead of paper. Figure 3 shows an example of this type of information. Thousands of computers in use today do not yield full capacity. The computer systems are slowed down by their output devices, the impact printers, which produce too much paper. The mountains of printout they produce are smothering the very efficiencies for which computers were designed. These thousands of computers do not put vital information into the hands of the right people in the right places in time for the right decisions. These new business
Figure 4—Typical business report graphics

COM recorders can solve this problem. The problem is solved by the following advantages the COM system has over the impact printing system:

1. Printing at computer tape speeds.
2. Forms printed with data simultaneously.
3. Retrieval coding placed on records as it is created.
4. Smaller records storage.
5. Reduced cost of supplies and material.
6. Weight of information significantly reduced.
7. Microfilm doesn't have to be decollated, burst or bound.

The third type of COM is the graphic arts printer. This is an electronic composition system. This type
of recorder can produce alphanumerics and graphics with graphic arts quality at data processing speeds.

The evolution of the COM is quite interesting; it began with the scientific device being used for plotting technical data in graphic form. Now it is being used extensively by business for alphanumerics as a replacement for impact printers. I predict that business management will quickly realize that they too would have great advantages from the scientific type of system and have their business information plotted and presented in graphic form instead of as alphanumerics or having a draftsman manually prepare charts from alphanumeric data. Figure 4 shows a business report produced by a scientific COM recorder.

**Technology**

**Speed**

The most obvious technological advantage of a COM is the speed at which computer information is translated into human readable form on microfilm. It is difficult to visualize or appreciate this speed. I, therefore, present these comparisons:

\[
\begin{align*}
5,000 \text{ electric typewriters} & = 30 \text{ impact printers} & = 1 \text{ COM recorder} \\
\end{align*}
\]

Looking at it another way:

<table>
<thead>
<tr>
<th>Characters per sec.</th>
<th>Lines per min.</th>
<th>Lines per hr.</th>
<th>Pages per hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typewriter</td>
<td>15</td>
<td>7</td>
<td>400</td>
</tr>
<tr>
<td>Impact Printer</td>
<td>2420</td>
<td>1100</td>
<td>66,000</td>
</tr>
<tr>
<td>COM recorder</td>
<td>70,000</td>
<td>32,000</td>
<td>1,900,000</td>
</tr>
</tbody>
</table>

**Cathode ray tube (CRT) systems**

The Computer Output Microfilmer, as the name implies, produces computer generated microfilm records with no intervening paper copy. This is achieved by converting the computer digital signals to voltages which are applied to a cathode ray tube. Another method, electron beam recording, will be described later. This conversion process results in the information being displayed on the cathode ray tube screen in human understandable form. The microfilm record is produced by photographing the information displayed on the cathode ray tube. The basic nature of this process is illustrated in Figure 5.

**Electron beam recording (EBR) systems**

The second method of recording directly on microfilm uses an electron beam, see Figure 6. Using the stroke method, much like that of a pencil writing on paper, the electron beam writes a latent image directly on dry-silver microfilm. The electron beam originates at the cathode of the electron gun, located on the top of a sealed housing. Electrostatic plates and electromagnetic yokes, or magnetic lenses, deflect the beam to form characters and position them on the microfilm frame. The housing is similar in principle to a
Figure 6—Electron beam recording on microfilm

cathode ray tube except in place of a phosphor screen it has a small aperture through which the beam passes to write directly on the microfilm. Vacuum pumps reduce the air pressure within the housing to a level low enough to facilitate generation and precise control of the beam. Because the beam has practically no inertia, it can be deflected, or modulated, rapidly enough to keep pace with the data transfer rates of the tape drive.

Character generation

There are several methods of creating characters for COM recording. Stromberg-Datagraphix has developed a special cathode ray tube called a Charactron® Shaped Beam Tube. The Charactron tube creates an image by directing an electronic beam through individual characters cut in a matrix—a thin precise disc with alphanumeric and symbolic characters etched through it. This matrix is located within the neck of the tube. This method extrudes the beam into the shape of the character being printed. This has the effect of stenciling each character onto the tube face.

Another method of creating characters is by the use of a “stroke” generator. In this type of system a spot is deflected to trace the shape of the character desired. The voltages necessary to deflect the spot are generated by sweep generators, one for X deflection and one for Y deflection. Instructions for the characters are stored in memory. About 16 strokes are used on an average per character.

Characters can also be created by point plotting. This method is generally used for special symbols or type faces.

Line generation

Line generation in scientific COM recorders is done by the use of a “line” or “vector” generator. This is known as a vector stroke generator and is capable of drawing vectors. Line width, vector direction and intensity levels are all generally programmable.

Forms overlay

Forms overlay features are provided on most units. The forms overlay feature provides the capability of superimposing predetermined, fixed forms with the generated image. Forms are interchangeable by an operator or on some units may be called in by program. These forms may contain maps, company logos, charts and graphs such as the one in Figure 7.

Retrieval coding

COM recorders can generate retrieval codes and patterns for each or selected frames of information. The following coding systems are usually standard features: Codeline, Image Blip (Image Count) and Miracode. These indexing identifiers are recorded on film simultaneously with the data. This feature is the key to push button easy retrieval of information on microfilm.

Films

There are two recording films in use today in the COM field. Almost all CRT systems use Kodak (Kodak) Dacomatic® film, types 5461 and 7461. The EBR systems use 3M Computer Film, type 761 (dry-silver). The Dacomatic film is available in the following sizes:

a. 105mm nonperforated
b. 35mm with perforations
c. 16mm with perforations
d. 16mm nonperforated

The 3M dry-silver film is available in 16mm non-perforated form.

The 105mm film is used in the business type COM and the film is cut and used as microfiche. The 35mm

* Charactron is a trademark of Stromberg-Datagraphix, Inc.

* Dacomatic is a trademark of Eastman Kodak.
film is generally used for scientific work (graphics). The 16mm nonperforated film is used for almost all business applications. The perforated 16mm film is only used for special high-precision applications.

**Users and applications**

**Scientific**

A few of the scientific applications are: circuits, printed wiring board masters, thin film masks, animated movies, graphs and charts. See Figures 1, 2 and 3. The following are some of the organizations using scientific COM recorders:

- North American Aviation
- NASA
- Collins Radio
- Bell Telephone Laboratories
- Lawrence Radiation Laboratories
- MIT Lincoln Laboratories

**Business**

Business applications include all types of listing; account reports, management reports and anything that might have been produced by a computer and impact printer. The following are some of the organizations using COM’s in business applications:

- Sears Roebuck & Company
- J. C. Penney Company
- Social Security Administration
- Equitable Life Assurance Society
- Bureau of the Census
- International Harvester Company

**Systems service centers**

At the present time there are over 40 systems service companies operating COM service centers in the following cities in the United States:

**California**
- Canago Park
- Culver City
- El Segundo
- Glendale
- Los Angeles
- San Francisco
- Stockton

**Colorado**
- Bolder
At the writing of this paper the following companies were marketing COM units:

a. AMETEK/Straza (Scientific)
b. Beta Instrument (Scientific)
c. California Computer Products (Scientific)
d. Canon (Business)
e. Computer Micro-Data Systems (Scientific)
f. Computer Industries (Scientific & Business)
g. Control Data (Scientific)
h. Eastman Kodak (Business)
i. Information International (Scientific)
j. 3M (Business)
k. RCA (Graphic Arts)
l. Scan Graphics (Scientific)
m. Singer-Link (Scientific)
n. Stromberg-Datagraphix (Scientific & Business)

Total COM systems

As can be seen in Figure 8 there is very little difference between photographing a CRT or a paper document. In selecting the film for recording from a CRT it should be matched to the phosphor of the tube in sensitivity. The polarity of the image on a CRT is negative (light lines on a dark background) and on paper it is usually positive. Therefore, with normal film processing the image of the CRT will be reversed and appear on film as a positive and a microfilm of a positive paper document will appear as a negative. Since most users of microfilm prefer to use negative images in readers and for making hardcopy it is necessary to obtain a negative image of the COM film, this is done one of two ways. At the time of processing the recording film is flashed and developed in a special movie processor which provides a negative image on film from the negative CRT image. The second method of obtaining negative film images is to make a second generation duplicate on Kalvar or silver film which will reverse the polarity again and therefore from a negative CRT image we get, with normal processing, a positive first generation recording film and then a negative second generation duplicate.

Figure 9 depicts the various systems used for COM operations. In scientific applications the film is most often put in aperture cards or used as short strips or on reels. In most business applications the film is used in roll from in cartridges. There are a few systems where
the film is cut and pasted up to make a master microfiche. A recent development, the 105mm film head for a COM provides microfiche directly and therefore eliminates much of the manual labor in producing microfiche. In most business applications film duplicates are required to disseminate the information to many users. In all systems, readers, reader-printers, retrieval devices and enlarger-printers are needed by the end users of microfilm. Additional information on these items can be obtained from the National Microfilm Association's "Guide to Microreproduction Equipment" now in its fourth edition.

There are six generally used methods of making copies of computer generated reports. Figure 10 provides a cost comparison of a 100 page report. As can be seen on the graph, distribution of microfilm duplicates is the lowest cost method at any quantity of copies.

**The COM market & NMA survey**

At the end of 1968 there were about 300 COM recorders in use. Of this number about 60 units were being operated by systems service companies.

There have been many forecasts made of the COM field with as many conclusions as studies. Figure 11 shows the range of these forecasts, which is that by 1975 there will be between six and 12,000 recorders in operation. The cost of a COM is $60,000 to $300,000 with the average being about $100,000. This average rental is in the order of $40,000 per year.

In the Spring of this year the National Microfilm Association made a survey of all its over 3,000 members with regard to the use of Computer Output Microfilm. The following are some of the statistics obtained and my comments:

1. Questionnaires were returned by 24 percent of those queried.

Comment: 24 percent is considered an excellent return on a direct mail survey. NMA
HAVE NOT BEEN INCLUDED IN ANY OF THE FOLLOWING STATISTICS.

2. Questionnaires were returned by 74 organizations indicating they now have a COM recorder(s), 29 were scientific and 45 business units.

Comment: 33 percent of COM's are scientific type today 67 percent of COM's are business type today

3. 105 organizations indicated they would obtain their first COM in the next two years. 28 organizations indicated they would obtain an additional COM in the next two years and 55 organizations indicated the use a COM was under study.

Comment: By the end of 1970 there will probably be more than 1,000 COM's in use.

4. Positive versus negative original recording film: 56 using positive (normal processing) 29 using negative (flash reversal processing) A few organizations use both positive and negative

Comment: Even though it requires special processing equipment to obtain a negative image on the original film it is being done, there must be a need.

5. The following film processors are being used in COM systems:

Fulton 10 users
Kodak 18 users
Remington Unipro 3 users
Stromberg 6 users
Other 35 users

6. The following is the quantity of original recording film being used per month by 48 respondents who gave figures:

<table>
<thead>
<tr>
<th>Type of Film</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>16mm perforated</td>
<td>80,000 feet</td>
</tr>
<tr>
<td>16mm nonperforated</td>
<td>852,000 feet</td>
</tr>
<tr>
<td>35mm perforated</td>
<td>62,000 feet</td>
</tr>
<tr>
<td>35mm nonperforated</td>
<td>31,000 feet</td>
</tr>
<tr>
<td>105mm nonperforated</td>
<td>6,000 feet</td>
</tr>
</tbody>
</table>

Comment: The following is an estimate of the quantity of recording film all COM's are currently using per month.

<table>
<thead>
<tr>
<th>Type of Film</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>16mm perforated</td>
<td>400,000 feet</td>
</tr>
</tbody>
</table>
7. 57 of the 74 users duplicate their film.
   - 23 Diazo
   - 29 Kalvar
   - 22 Silver
   
   Some used more than one process.

   **Comment:** Convenience and turnaround time are most important.

8. Duplicating film being used per month by 40 COM systems reporting:

   - 16mm—3,800,000 feet
   - 35mm—35,000 feet
   - 105 x 148mm—34,000 fiche
   - 3-1/4" x 7-3/8"—270,000 fiche
   - 6" x 8"—34,000 fiche
   - Aperture cards—367,000 cards

   **Comment:** The following is an estimate of the quantity of duplicating film being used per month by all COM systems:

   - 16mm—22,800,000 feet
   - 35mm—200,000 feet
   - Aperture cards—2,200,000 cards
   - Microfiche (various sizes)—2,000,000 fiche

9. Microforms being used in COM systems reporting:

   - Roll Film (including cartridges)—56 users
   - Microfiche—21 users
   - Jackets—13 users
   - Aperture cards—13 users

   **Comment:** The following are the percentages of COM systems using each microform:

   - Roll film (including cartridges)—55 percent
   - Microfiche—21 percent
   - Jackets—12 percent
   - Aperture cards—12 percent

10. For those using roll film and cartridges the following indexing systems are in use:

   - Miracode*—10 users
   - Image Blip (Image Count)—24 users
   - Code Line—7 users
   - Flash—9 users
   - Other—12 users

   **Comment:** Most COM systems are now using the Image Blip (Image Count) system of retrieval.

11. Regarding a question on the use of hardcopy the following responses were received:

   - Never used—5 users
   - Seldom used—20 users
   - Frequently used—34 users
   - Always used—6 users

   **Comment:** Hardcopy is required, but on a selected basis.

12. For 35 respondents, 844,000 pages of hardcopy are produced each month.

   **Comment:** The average COM system produces 24,000 pages of hardcopy per month.

**Standards**

In February of 1968 the National Microfilm Association (NMA) established a committee to investigate and recommend standards for microfilm produced by COM recorders. This committee has members from most of the COM manufacturers, several COM systems service companies and many users in government and industry. There are three sub-committees each with a mission as follows:

- Format, Quality and Glossary.

   The National Microfilm Association is attempting to coordinate the activities of this new microfilm application by considering standards, reporting of many specific applications in its Journal and having COM exhibits at its annual convention.

   For additional information on the COM field, write to the National Microfilm Association, P.O. Box 386, 250 Prince George Street, Annapolis, Maryland 21404.

* Miracode is a trademark of Eastman Kodak.