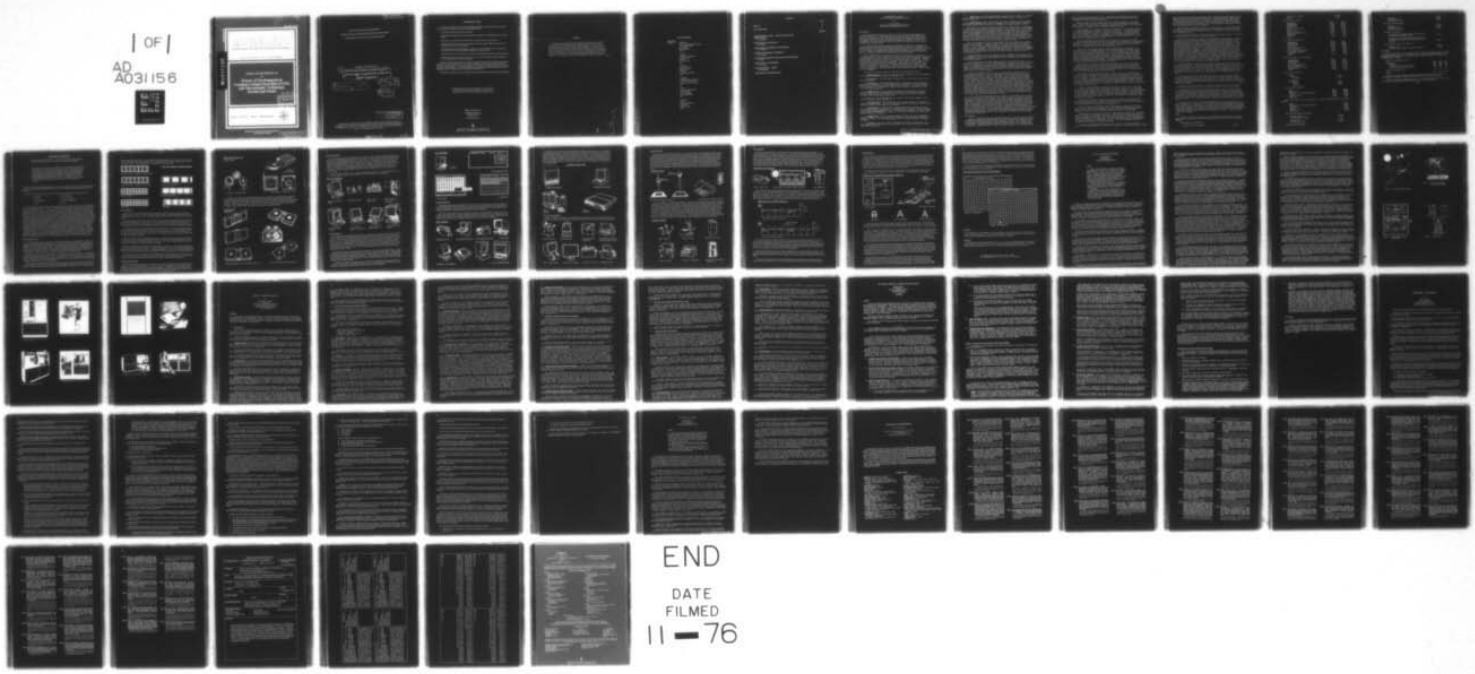
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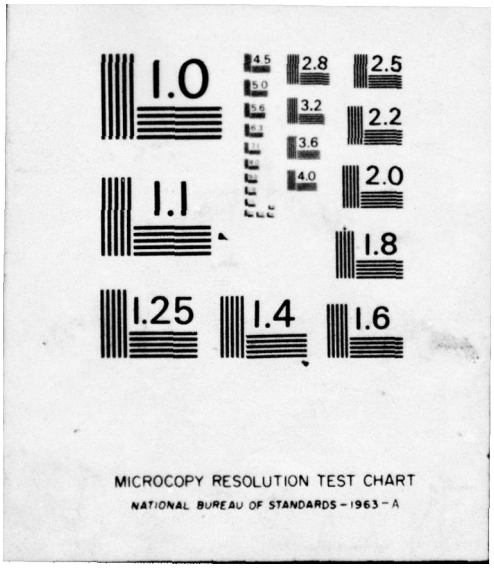
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AGARD LECTURE SERIES No. 85

on

Review of Developments in Computer Output Microfilm (COM) and Micrographic Technology, Present and Future

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PREFACE

Lecture Series No.85 is sponsored by the Technical Information Panel of AGARD and is implemented by the Consultant and Exchange Programme. The Lecture Series starts with the presentation of an up-to-date review of micrographic technology, Computer Input Microfilm (CIM) and Computer Output Microfilm (COM), as well as an indication of the market size and growth rate. After an account of the fundamentals of micrographics, COM recording techniques and recorders are described and CIM techniques reviewed. Other lectures cover indexing and retrieval techniques, systems design, alphanumeric and graphic applications. In a final paper, future trends in micrographic technology are indicated.

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MICROGRAPHICS AND COM
A STATE-OF-THE-ART AND MARKET REPORT

By

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INTRODUCTION

As lecture series director, I believe it is my job to set the stage for our five other speakers. I will, therefore, provide an overview of micrographics, computer input microfilm (CIM) and computer output microfilm (COM) at "jet speed" while my colleagues will cover the details and provide in-depth presentations of each segment of the system and the facts about many applications. I will also try to establish the scope, set the boundries and give you a good idea for how micrographics is being used today.

The information processing system has undergone an explosion. Bulging files, misfiled papers, long searches through millions of manila folders in thousands of offices all over the world, reams and reams of computer output, and expensive, complex on-line systems have strangled the typical modern business. Let's take a closer look at a typical information processing system and see where the micro-image can begin to increase the effective utilization of the entire system.

Source documents can be categorized as bulk file (unit data) or folder file (co-related data). Generally, bulk file consists of one type of document, and retrieval requires manual search of a paper file for one or more of these documents. Examples include checks, sales slips, time cards, stock certification, and the like. Folder file describes those groups of source documents which contain several types of inter-related data and require merging or updating. A key point in the definition of folder file is that folder file information requires inter-active updating. When a folder file becomes a dead record, or purged information, it is then considered bulk file information. Regardless of whether a source document is maintained in a bulk or folder file, the micro-image can provide two major benefits: space savings and file management.

The benefits of space savings are important to any growing business.

1. Opportunity Cost - The Micro-Image provides the opportunity to use expensive floor space for generating profit, not storing files.

2. File Location - The Micro-Image condenses files so that they can be located near the end user.

3. Duplication - Too many duplicate copies of dead records are a problem in many office environments. The Micro-Image solves the problem. The user can retain one microfilm copy and create paper copies only when needed. If duplicate copies of the entire file are required for several users, they can be generated at lower cost, occupying less space.

4. Expansiveness - Files can become so expansive that they not only occupy valuable space, but become unmanageable with both on-and off-premises storage. The Micro-Image can provide a 98 percent space savings, and virtually eliminate the need to selectively purge paper files.

The benefits of file manageability are benefits affecting the company's life-blood, the flow of needed information.

1. Operating Costs - Paper files are labor intensive, making for a waste of talent in an organization. The Micro-Image with automated filing and retrieval helps reallocate talent, saving money for the prospect.

2. Accountability - Files document business operations, providing the basis for answering customer, management, or interdepartmental inquiries. The Micro-Image provides audit trial control over files, and eliminates the national average of nearly six percent of misfiles and lost documents in the source document area. The Micro-Image provides file integrity.

3. Manageability - The Micro-Image organizes files so they are of manageable size and format. And it pulls these files together so that they can be easily co-related on request. The Micro-Image manages the file through automated information handling.

4. Security - Paper can be easily tampered with, stolen, or destroyed. The Micro-Image is discrete, easily and safely stored, and can be duplicated with extra copies kept off-premises.

PRECEDING PAGE BLANK-NOT FILMED

5. Convenience - The Micro-Image assures that the record is there, or it simply does not exist. Records can be accessed faster and more easily with any of the available formats.

6. Human Factors - Paper is essential. But after a message or order has been communicated and documented on paper, the manual filing process remains. Automated Micro-Image systems can also provide job enrichment to reduce employee turnover.

Microfilming of the source document can take place either prior to or subsequent to data capture. Microfilming can be performed in such a manner that the information is accessible through various techniques which will be described later in this report. However, one approach which is gaining prominence in the recent past is the filming of the source documents in random order, and the assignment of a film address, a roll and frame number. This film address is captured with the other information passed on to the computer which in turn creates an index to the address by any number of parameters which the end user might require. This index can be reported out on paper, or can be maintained on-line, and allows the user to access information from a random file with the assistance of the computer generated index.

After the information is processed and master files are updated, the computer produces a large number of reports. These reports are typically printed out on an impact printer on paper. Another approach is to maintain the report information on-line in a direct-access storage device and reference the information selectively through a computer terminal. The disadvantage of printing on paper is the tremendous time it takes - approximately 1,000 to 2,000 pages per hour - and the cost of paper and printing, and the problem of maintaining large volumes of paper reports for information retrieval.

The disadvantage of the on-line approach is the tremendous cost to store all the information in the direct-access storage device, transmit the information through a telecommunications system to the terminal, and the software to control the entire teleprocessing system.

A third alternative which has gained prominence in the past few years is a compromise between the two. Rather than maintain the information on-line at extreme cost, it is printed out; but not on expensive paper through a slow printer; but rather on inexpensive microfilm through a high-speed computer output microfilmer. Through this technique, users are finding that they can provide much more information faster to a wider number of users at a much lower cost then they could with either paper output or on-line CRT display.

We have seen where microfilm is used to capture source documents prior to or subsequent to data capture. We also see the part that microfilm can play as an output medium instead of a paper or a CRT image. These two disciplines can also be integrated to provide a total information file which incorporates both paper, electronic image, and a micro-image. Consider source documents which are filmed and the address of that micro-image is passed through the computer to an output report. That output report is produced on a computer output microfilmer, and serves as the index to retrieve the source documents on microfilm. Another group of source documents is captured in the same way, but their particular output report is printed out on hard copy. A third group of source documents are microfilmed, and their address is maintained on-line in a direct-access retrieval system. Now the user can retrieve source document information by either inquiring to a file with an on-line CRT which directs the user to the image on film, or the user can reference a hard-copy report which provides direction to retrieval to the source document on film, or the user can reference an index on microfilm created by the COM, which also keys the end user back to the source document on film.

To take this interrelationship one step further, a CRT terminal can be interfaced to a microfilm retrieval device so that when an inquiry is made to an on-line data base, the resultant micro-image of the source document can be electronically transmitted directly to the microfilm reader and the image subsequently displayed automatically. Systems of this type have been installed and operating for several years, and promise to proliferate in the near future. Now in order to better understand the advantages the micro-image can play in a data processing system, we will take a closer look at how microfilm is actually created and the various ways in which it can be retrieved. We will also look in more detail at the concept of computer output microfilming - how it is done and what advantages it provides over on-line access and paper printing. We will then review the advantages of computer assisted retrieval and project the future of the integration of microfilm and the computer over the next five years.

APPLICATIONS

The U. S. Social Security Administration operates the world's largest and most indispensable micrographics system, more than 30 million reports a year are filed. Individual accounts are constantly being updated or checked. This massive micro-filing-computer complex handles 300 million earnings items a year...virtually free of paperwork. The Administration keeps its records on 100-foot cartridges, each containing the complete records of 1,000 individual accounts. And we needn't worry

about records getting destroyed or lost. Administration personnel actually work with duplicate microforms at all times, while the original microforms are stored in complete security in underground vaults.

Another of many, many U.S. federal agencies using micrographics is the Patent Office, which fills over 25,000 orders every day for paper copies of microfilmed patent records. The entire file of patents, reaching back to 1863, is also available in microfilm for consumer use at a self-service microfilm center.

Law enforcement is, of course, a major user of microfilm. Increasingly police are finding micrographics helpful in criminal investigations. Faster identification of offenders improves the protection the police can give us. Micrographics helps right from the moment a suspect is apprehended. His fingerprint characteristics can now be displayed on a viewer and compared with those of sought offenders. Also, "mug shots" of wanted persons can be electronically retrieved from file to aid in identification by witnesses and victims.

Urban fire departments are also making increased use of microfilm. Mobile fire units now have complete microfiles of the interiors of large office and residential buildings in their fire districts. By viewing these, they are able to determine the location of sprinkler outlets, gas mains, firedoors, electrical systems and other features of the site where they will be fighting the fire.

Many of us first came into contact with micrographics at the library or in school where it is now commonplace to read an entire newspaper file without touching anything but a few simple controls. Also, at more and more libraries, people have become familiar with micrographics as a tool for checking books in and out by simply placing them under a microfilm camera. Modern libraries have books, trade papers, abstracts, reference materials, technical bulletins and similar documents available on microfilm for ease in locating, viewing and making printout copies. With the emergence of micropublishing, it is also possible for libraries to acquire, exchange and disseminate rare documents on microfilm, making their contents widely available without endangering the precious originals.

Micrographics is in use in virtually every phase of our lives -- even when shopping. If you hold a major credit card or a card from an oil company, you may be interested to know that your account is maintained on microfilm. One major company with more than 4 million card holders has cut information retrieval time for customer service down to 20 seconds by using microfilm. Yes, microfilm systems make for better customer service and cost savings.

Micrographics is doing a dynamic job for retail stores in aiding customers to choose color-coordinated rugs, wallpaper, slipcovers, draperies and all the other home furnishings. Available colors and prints can now be previewed by the home owner or interior decorator on a microfilm viewer without getting involved with paint chips or swatches. A growing number of stores handling appliance replacement parts are now using microforms instead of printed catalogs for speedy reference. Through microfilm, these catalogs are now inexpensive for manufacturers to produce and to distribute. Therefore, they are more frequently updated and the information contained more reliable and up-to-date.

And while we're thinking of things that go wrong, we'd like you to know that if illness or accident strikes, micrographics is there to help you too. Hospitals are placing entire patient files on microfilm for speedy lookup. It is now possible to retrieve vital patient data rapidly and to display it promptly at many key locations within a hospital complex. With such data on microfilm, doctors can speedily look up your records, including x-rays, if necessary. Micrographics not only eliminates the danger that your records might get lost, but also makes this information readily available when required.

While we're on medical subjects, did you know that more and more communities are setting up poison control centers using microfilm? Now the antidote for the many toxic substances found in the home, the garden and on the job can be called into view instantly for rapid response to an emergency call.

And, to continue in the medical field, the day is near when each of us will carry around a wallet-sized microfilm card containing our complete medical record. With this vital data readily available, hospital personnel can respond quickly in emergency situations, which can mean the difference between life and death.

Remember the last time one of your major appliances broke down? The oil burner maybe -- perhaps the refrigerator or oven... One of the big problems the repairman had in the past was finding the nomenclature and description of the broken part by thumbing through thick catalogs. Now, most repair agencies use microfilm catalogs to locate information in just seconds. In fact, some firms have even equipped their service vans with portable microfilm libraries so that the repairman can find the information, and repair procedures on the spot.

Speaking of home appliance maintenance, let's think of a super maintenance task -- like the giant Boeing 707, and the 747 jumbo-jet. With a daily need to dissem-

inate information world-wide concerning the care, operation and maintenance of these giant aircraft, Boeing now publishes more than 17,000 microfiche per week using a computer output microfilm system. In doing this, they have reduced, from 12 days to just 48 hours, the amount of time it takes to get published information where it's needed and saved more than 50% in costs. Now maintenance crews use a portable microfilm viewer right at the maintenance site instead of shuttling back and forth to a catalog library to get the information.

Also, through the capability of COM, it is now possible to produce alphanumerics and graphics on one microfilm frame directly from the computer. With this unique new technology, COM is used for producing circuit diagrams, scientific plots, maps and even animated moves.

The updating of drawings is simply handled with new computer input. Yes, micrographics has proved to be a boon to today's engineer.

Let's look at some of the results of COM, computer output microfilm. The world of banking is a prime example, because it has suffered for decades under immense volumes of paper records. Today, banks are probably among the foremost users of COM systems, which are serving in virtually every area of their operation. Installment loan departments, for example, now prepare daily account information records through COM. Now, an account record of let's say 50,000 loans which once took an hour's computer time to produce as a 1,000-sheet binder is now generated as a few easily disseminated microforms -- saving time and space and able to be retrieved in seconds for inquiry responses. COM is saving money for banks in lots of ways. Demand deposit account departments now process checks for clearing and collection, and debit and credit customer accounts with the aid of COM produced microfiche. They exchange data daily on corporate and institutional accounts between headquarters and branches. They generate trial balances, overdraft statements, account analyses and dozens of other items of information with COM systems. One California bank doing this saves close to $86,000 a year. Its depositor account list, once a 300-page binder, is now contained in two fiche, and the once-bulky current transaction file has been telescoped to two cubic feet -- thanks to COM.

Insurance companies, known for the torrents of paperwork they use have also turned to COM for help. One 3-½ million-customer firm uses COM exclusively to handle some 8,000 lookups a day. Now, they locate data and mail a hardcopy in minutes. Before COM the process could take 20 to 30 days. A big Connecticut firm is shrinking a 15,000 square foot file space for new policy application paperwork, that had threatened to double in 15 years, to a few square feet of COM-generated microforms. Now insurers are providing better and faster service to customers, branches and agents.

COM processing has found ready-made applications in the credit card field, handling procedures for credit and collections, for statements to member banks, and as backup in processing inquiries from cardholders. The great speed of COM makes it most valuable for on-the-spot checks of card validity and detection of inoperative accounts, freeing credit firms from the former need to handle slow moving and manually handled paper records.

On Wall Street and Main Street, brokers are bullish on COM -- those 30-minute ticker lags are purely due to paper -- and COM is helping to solve the problem.

One New York firm provides two hundred branches with daily reports of transactions and weekly and monthly summaries sent as first-class mail on COM-prepared fiche replacing what had been nearly five million pages of computer printout paper a week. Now, with COM, the paper files are replaced by compact microfilm cartridges and cassettes. Information is gathered and disseminated in hours instead of a week, retrieval and printout of information is accomplished in seconds, keeping the branches completely updated...and the firm estimates a savings of $150,000 a year on postage alone.

At this point, we have looked at micrographics at work in only a few of its present applications. But the futuristic applications of micrographics have already begun to appear in the community. In the home we may find family members consulting a microfilm library to get the news they formerly got from newspapers and magazines, to get up-to-the-minute stock market listings, nutritional menu planning and appliance repairing information...all available at the flick of a switch. Also in the home, young people are becoming familiar with micrographics and find it a superior substitute for textbooks.

USAGE

In order to give you a picture of how micrographics is being used in a more general way, let me give you some of the results of a recent survey by Infosystems magazine.

Major Usage for Micrographics

Active or daily reference	52.5%

Semi-active reference	29.5%
Storage	18.0%

Who Designs the System?

Organization	1975	1976
DP Department	33.2%	45.7%
Systems Group	28.5%	29.7%
User Group	26.4%	21.7%
Office Services Staff	15.8%	13.4%
Vendor	13.8%	13.1%
Records Manager	16.9%	12.5%
Micrographics Department	16.3%	11.7%
Engineering	10.5%	7.5%
Consultant	-	5.6%
Other	9.3%	8.0%

Who Recommends Equipment?

Organization	1975	1976
DP Department	26.4%	39.2%
Systems Group	18.2%	20.8%
User Group	21.1%	16.2%
Office Services Staff	16.2%	13.2%
Records Manager	14.6%	12.9%
Micrographics Department	13.1%	9.9%
Purchasing Department	7.1%	6.8%
Consultant	-	4.3%
Other	14.8%	14.9%

Who Is In Charge of the Equipment?

Organization	1975	1976
DP Department	19.0%	29.5%
User Group	22.1%	22.2%
Office Services Staff	17.9%	14.1%
Records Manager	13.6%	12.4%
Micrographics Department	17.0%	10.4%
Systems Group	4.2%	7.1%
Other	12.9%	18.2%

Kind of Microfilm Used

Camera	
Silver	84.9%
Dry Silver	16.0%
Duplicating	
Diazo	70.6%
Silver	32.0%
Vesicular	16.9%

Kinds of Microforms Used

Form	1975	1976
Microfiche	57.2%	70.8%
16mm Rolls (Including Cartridges)	79.8%	69.9%
Jackets	15.6%	20.8%
Aperture Cards	19.0%	19.6%
35mm Rolls	19.8%	17.0%

Here is the same type of information from a survey by Modern Office Procedures magazine.

Form	1976
16mm Rolls (Including Cartridges)	87.0%
Microfiche	84.4%
Jackets	39.0%
Aperture Cards	26.0%
35mm Rolls	27.3%

Who Does the Document Recording?

In-house Camera	63.6%
Outside Service Camera	21.1%
In-house COM	22.1%
Outside Service COM	54.5%

Who Does the Processing?

In-house	26.7%
Outside Service	60.0%
Combination of Both	13.3%

Who Does the Duplicating?

In-house	37.0%
Outside Service	50.7%
Combination of Both	12.3%

Operating Philosophy

Purchasing all equipment from a single source to insure total systems support	21.1%
Purchasing from several different manufacturers to insure having the ideal hardware for each function	78.9%

Do the Users Look to the Vendor For -

Hardware Only	28.6%
Hardware, plus design, training and support	71.4%

THE MARKET

The following data is from a recent study by Creative Strategies, Inc. Creative Strategies expects the worldwide market for COM recorders, microfilm readers and reader-printers shipped by U. S. manufacturers to grow from $139.2 million in 1974 to $496 million in 1979.

Total U. S. COM Market (Units)

	1974	1975	1976
Alphanumeric			
On-line	24	23	51
Off-line with front-end Mini	89	132	436
Off-line without front-end Mini	206	263	416
Graphic and Graphic Arts	55	58	112
TOTAL	374	476	1015

Creative Strategies expects worldwide shipments of COM recorders by U. S. manufacturers to grow from $52.2 million in 1974 to $199 million in 1979.

The total worldwide micrographics market is currently estimated at $800 million including all elements (hardware, software, service and supplies).

# # #

MICROGRAPHIC FUNDAMENTALS

By G G Baker, Senior Partner, G G Baker & Associates, 54 Quarry Street, Guildford, Surrey GU1 3UF. Micrographic Consultants and Publishers.

This paper serves as a general introduction to the technology of micrographics and describes the microforms in use in Europe, the equipment available and the concepts of recording, film processing and readout. Some of the common indexing methods are described and illustrated. Details and illustrations are also provided for film cartridges and cassettes, film duplicating equipment, jacketing equipment, fiche production equipment, automated fiche systems, aperture card equipment and microfilm cameras. Methods of COM recording are described and two popular fiche formats used for COM operations are illustrated.

Before considering the specific advantages of Computer Output Microfilm, it is necessary to question how any benefit can be obtained from reducing information to a size requiring substantial enlargement before it can be read.

The eight advantages which individually or collectively can justify the use of micrographics are:-

1. Economy
2. Accuracy
3. Space Reduction
4. Speed
5. Weight Reduction
6. Ease of Duplication
7. Computer Compatibility
8. Security

Economy results from efficient use of space and labour and lower duplicating cost when sets of documents have to be distributed to several locations. Other possible savings relate to computer time, printout paper, postal costs and freight charges. Accuracy is inherent in the photographic process, transcription errors are totally avoided. Information can be updated by total replacement thus avoiding errors caused by faulty amendment or update of records by users. Space reductions are inevitable when material is photo-reduced and these can permit the location of records where they are needed instead of where they can most cheaply be stored. Speed of access can be achieved by effective indexing, by bringing information closer to the user, by combining details from several paper files on one microform and by automated retrieval devices. Weight reductions are substantial with consequent economy in postage. Floor loadings are greatly reduced and this may be an important factor when information is to be located close to the users rather than in basement store or remote archive. Ease of duplication is a major benefit, especially when large quantities of information need to be distributed to several users. All copies are identical and an extra set can be produced virtually on demand, unlike printing processes which require an accurate assessment of the print run in advance. Computer compatibility is the main subject of this Lecture Series. COM permits data which is held in a computer system to be printed out at greater speed and lower cost than printout on to continuous stationery. More recently, CIM permits microfilmed material to be scanned and digitised to form input to a computer operation. Security is a well known advantage of microfilm. Duplicate copies can be stored remotely to ensure that the loss of one set does not result in the loss of the entire record, pages can not be removed from a microfilm record and film is less expensive to store in a safe or strong-room than bulky paper.

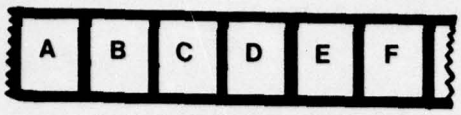
The Microforms in Use

There are basically 2 types of microform. Roll film with images in a continuous strip, usually 30 m long, and flat forms with either a single image or a limited number of images per sheet. Roll film is the original format and the first roll film camera for microfilm was installed in 1928 to photograph cancelled cheques - it was thus a security application. By 1933 the value of the technology was demonstrated in a US Court when a microfilm reader was used to display cancelled cheques and permit identification of the endorsements in a major fraud case. Since then the micrographic market has expanded rapidly and the annual value of the goods and services sold in Europe exceeds £100 million per annum.

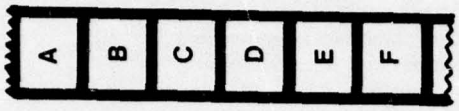
Roll film usually has a single row of images, it is then said to be in "simplex" format. If the pages are filmed edge to edge the film is in "comic-mode". If the pages are head to tail the film is in "cine-mode" and a microfilm reader incorporating a prism may be required to turn the image so that it can be read with comfort. Alternatively the entire film transport mechanism or even the reader itself can be turned through 90 degrees to permit film in cine-mode to be read.

Some cameras record the front and back of each page simultaneously and set the images side by side on the film. Such films are said to be in "duplex" format and a higher reduction ratio must be employed to produce them than is needed for the same information recorded in "simplex" format. A somewhat similar

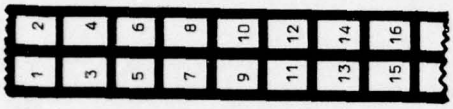
format is generated when the film is run through the camera to expose one half of the film width, the film is then reversed and the other half is exposed. The resulting film has two tracks of images which are said to be in "Duo" format. All of these formats are illustrated in the samples below.



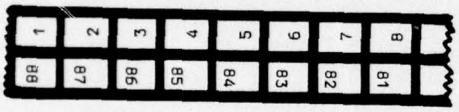
Simplex Format. Images in Comic-mode.



Simplex Format. Images in Cine-mode.

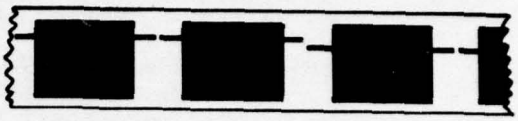


Duplex Format.



Duo Format

ROLL FILM FORMATS & INDEXING METHODS



Code-line Indexing

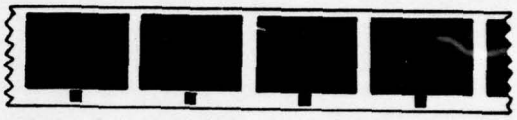
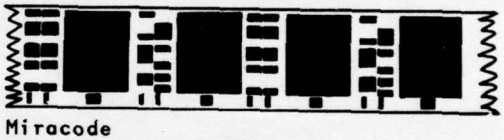


Image Count Marks



Miracode

Indexing Roll Film

An inexpensive and useful indexing method is provided by blank frames between each main group of images or every 100 frames. When the roll film is transported on a reader the blank frames show up as a flash of light on the screen and, by counting the flashes the operator knows which part of the film has been reached.

An index to chapters or sections can be provided by filming lines against the side of the each image, the position of the line indicating an index figure or letter. When the film is transported the lines show up on the screen as a dark grey line which appears to rise and fall on the screen as the index position changes. A scale against the edge of the screen enables the operator to see which section of the film has been reached.

An odometer can be used to measure the length of film transported. If an image is known to be 18 m from the start of the film it can be located with such a device quite quickly. In practice odometer indexing, like the two examples already described, is largely confined to the rapid location of a limited number of sections such as chapter headings or numerical steps. It is usually impractical to provide an index showing each page and its odometer reading.

Image count marks can be filmed under each image. A photo-electric cell on the reader screen detects the marks and operates a display which shows the number of images which have been transported. On the more complex readers it is possible to enter the desired frame number via a keyboard and the machine will automatically stop as soon as the required frame is reached.

Miracode is a proprietary system which uses a bar pattern on the film to provide binary coding for the image or group of images filmed beside it. A number of different parameters can be indexed for each image and searches can be for items having one or a combination of features. Information is filed in random order on the film because retrieval does not rely on the position of the image in relation to the others on the roll.

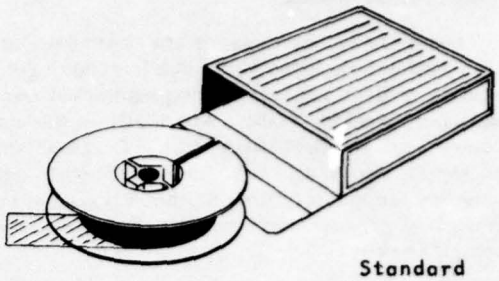
Most COM recorders can set image count marks below each frame when recording on to roll film. Some can set code line index marks and a few can set Miracode marks. These indexing methods can, therefore, be used for films produced from digital input as well as for films based on paper documentation.

Cassettes and Cartridges

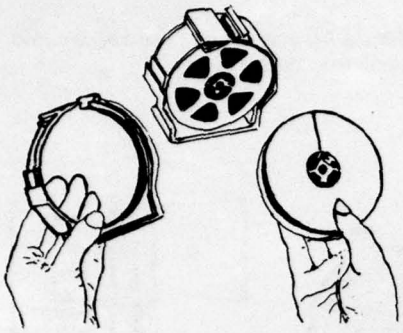
Simple systems use open reels of film, usually held in carboard boxes with the content of the film shown on the box. To speed the fitting of film on to a reader, and its removal after use, and to protect the film against dust while in store, the cartridge concept was developed. Cartridges have a single spool and the microfilm readers designed for use with them normally feature automatic film threading. An alternative to a cartridge is provided by a simple circlip which fits around a standard open reel.

CONTAINERS FOR ROLL FILM

(Single Spool)



Standard
Reel and Box



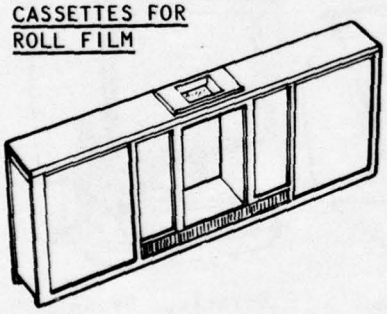
Circlip for Standard Reel

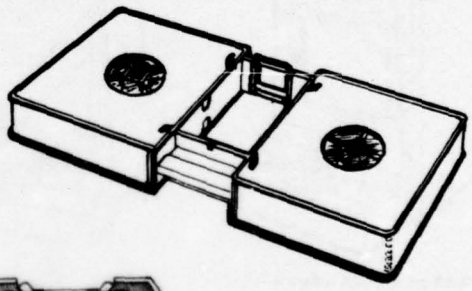


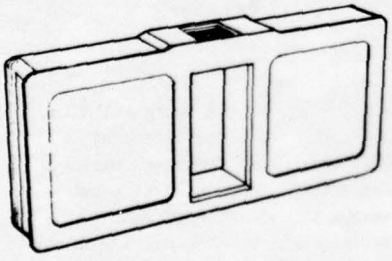
Cartridges for 16mm Roll Film

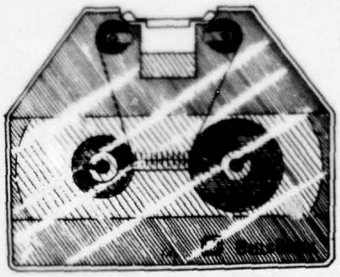
Cassettes are a more recent development and they form an alternative to the single-spool film holders. The cassette usually incorporates all or part of the film gate and, as the take-up spool is also integral, it is possible to simplify the construction of reading equipment while still providing instant loading and unloading facilities and automatic film threading. The penalty is the larger overall size of a cassette compared with a cartridge. Some cassettes hold 30 m of film, others are of more compact size and hold from 15 to 20 m. Virtually all of the cassette designs currently in use in Europe are illustrated below.

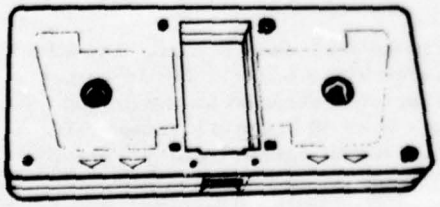
CASSETTES FOR ROLL FILM

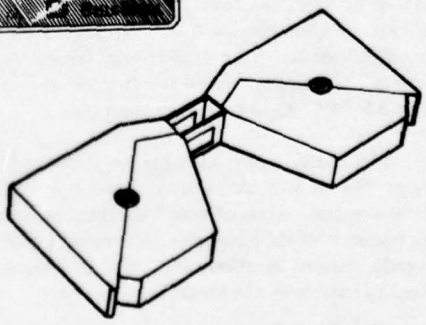












COMPACT CASSETTES 15 - 20 metre Capacity.

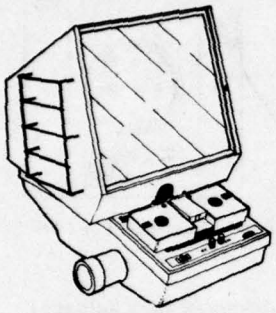
30 metre(100ft) Capacity Versions

Roll Film Equipment

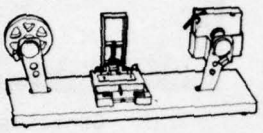
Cameras and processors are described later in this paper. Other equipment specifically related to roll film systems includes cartridge loading devices which may incorporate a screen to permit film editing while loading, roll to roll duplicating equipment and roll film splicers. High-speed roll to roll duplicators may incorporate a loop feature which allows the master film to circulate continuously so that it is repeatedly copies on to the duplicating film. Diazo or vesicular film is used for most of the copies produced in modern systems. Both materials can be handled in daylight, the main difference being that diazo copies are the same as the master film, so that a negative master produces a negative diazo copy, while vesicular is a reversing process and a negative master will produce a positive (black letters on a clear background) vesicular copy.

A small motorised cassette reader, an inexpensive hand-wound reader, a 16 and 35mm film reader and two reader-printers are illustrated below together with a loader and typical film duplicators.

ROLL FILM EQUIPMENT



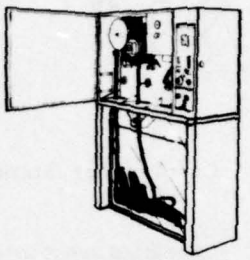
Motorised Cassette Reader



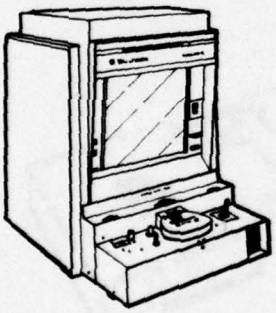
Cartridge Loader



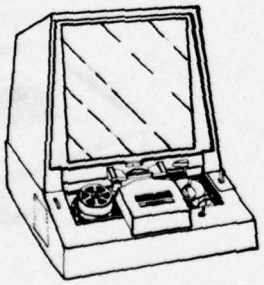
Roll to Roll Duplicator



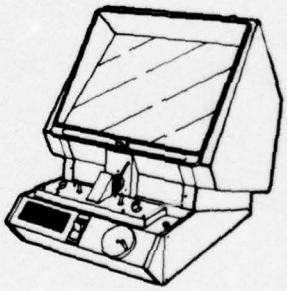
Roll to Roll Duplicator with Loop Box



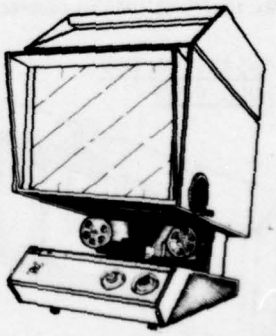
Cassette Reader-Printer



16 & 35mm Roll Reader - Motorised



Inexpensive Hand-Wound Reader



Cartridge Reader-Printer

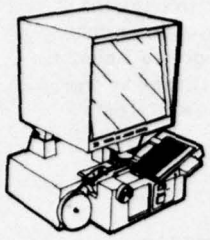
Flat Microforms

Three types of flat microform are in common use. The jacket concept holds strips cut from roll film which are inserted into channels formed by cementing together two very thin sheets of clear material at 16mm or 35mm intervals. The unique feature of this microform is its ability to accept additional material at a later date. It is much used for personnel files and correspondence files for this reason. A jacket filler is used for the loading of the jackets, it holds a roll of film and the image being inserted into the jacket can be seen - much enlarged - on an integral screen. Jackets can be obtained for 16mm, 35mm or a combination of 16 and 35mm film. A header strip is provided at the top of the jacket on which a title or index reference can be written or typed. A draft Standard has been issued for jackets and this favours the A6 (105 X 148mm) format.

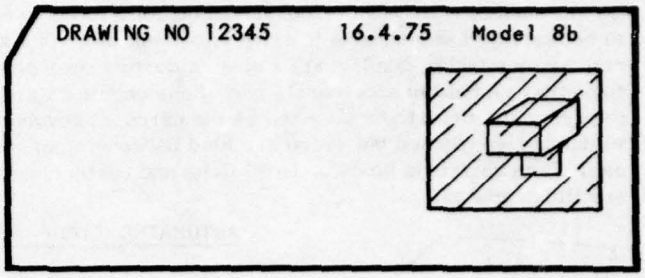
Microfiche are similar to jackets but all of the images are set on to the same sheet of film. It is not possible to add extra images to a microfiche at a later date as can be done with a jacket. The A6 format is now the only size allowed by International Standards. Various reduction ratios are used for the filming process and this results in a number of grid patterns. For documents a 60 or 98 image grid is generally used, filmed at about 20X or 24X respectively. For fiche produced from digital input - via COM - higher reductions are normally employed.

The third flat microform is the aperture card. This contains a single 35mm frame set into an EDP card which can, if desired, be punched for data processing. Aperture cards were developed for holding microfilm of engineering drawings and this is still their main area of application.

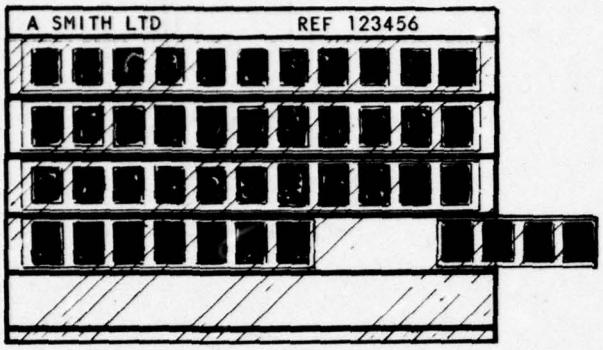
FLAT MICROFORMS



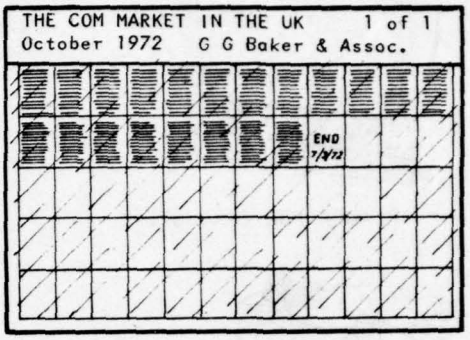
A Jacket Filler



A 35mm APERTURE CARD



A 16mm JACKET



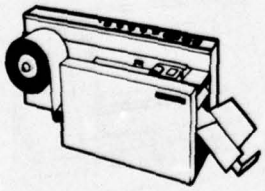
A MICROFICHE

Microfiche Equipment

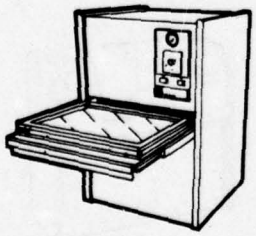
The illustration below shows an automatic fiche cutter which accepts a long roll of 105mm wide film on which microfiche have been recorded and cuts it automatically into 148mm lenghts to form separate fiche. Two types of duplicator, one with an automatic collator, are also illustrated. As with roll film, diazo or vesicular film is most commonly used for the production of fiche duplicates.

Reading and printout equipment for microfiche is available in many variations. The illustration shows a reader with a large screen, a compact lightweight reader with a small screen and a folding reader small enough to fit into a briefcase. Reader-printers provide prints at the touch of a button, most printout units employ the electrostatic print method but some use dry silver or electrolytic techniques.

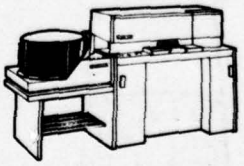
FICHE EQUIPMENT



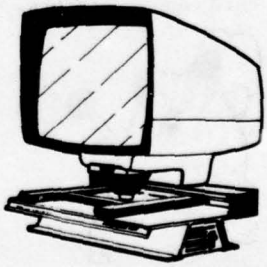
AUTOMATIC CUTTER



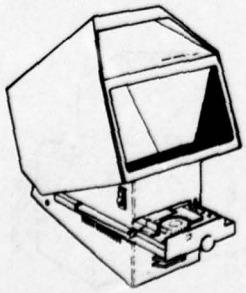
LOW VOLUME DUPLICATOR

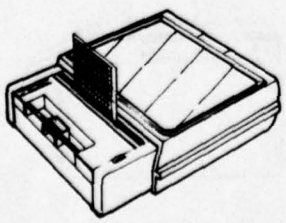


HIGH VOLUME DUPLICATOR

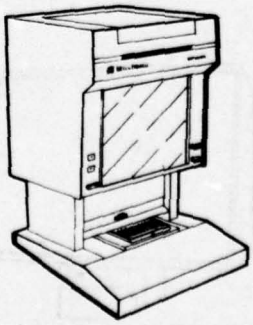


FICHE READER





PORTABLE FICHE READERS

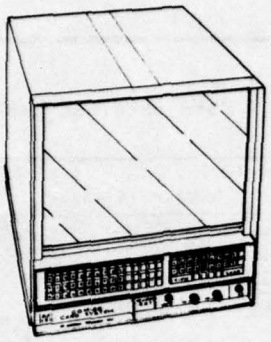




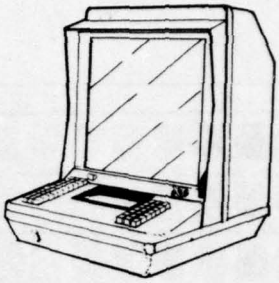
FICHE READER-PRINTERS

Automated retrieval devices have been developed to enable individual images from a set of fiche to be displayed in response to requestions entered via a keyboard. Some devices can also operate as remote terminals, displaying images on commands from a computer. Two methods are in use, the fiche may be held in a carousel, each fiche carries a metal strip at its head into which a code is cut to permit the fiche to be selected as the carousel revolves. The alternative uses cartridges of fiche which are unmodified but which are held between clear strips of film which have retrieval tabs at one end. Each cartridge holds up to 30 fiche and cartridges can easily be interchanged. These systems are illustrated below.

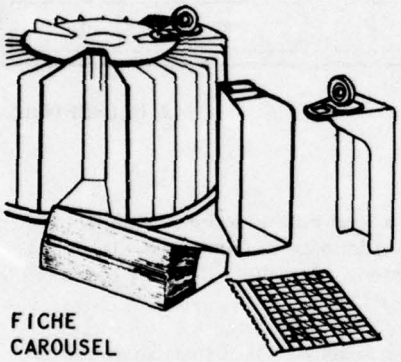
AUTOMATED FICHE SYSTEMS



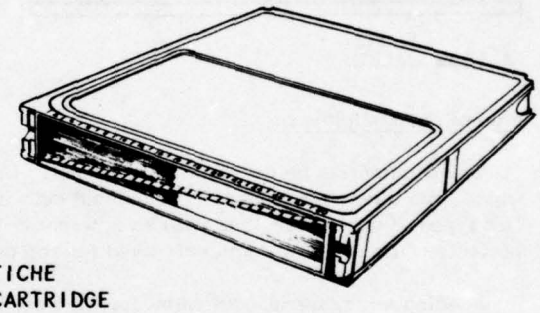
READER FOR CAROUSEL



READER FOR CARTRIDGE



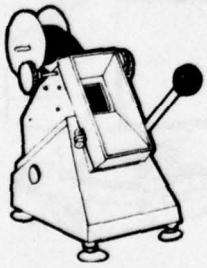
FICHE
CAROUSEL



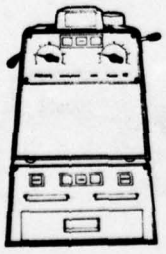
FICHE
CARTRIDGE

Aperture Card Equipment

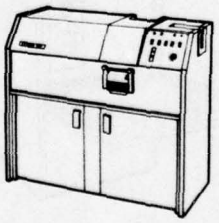
Equipment required for Aperture Card applications includes mounters to set the images into the cards, card copies, readers, reader printers and production printers for the rapid preparation of multiple copies.



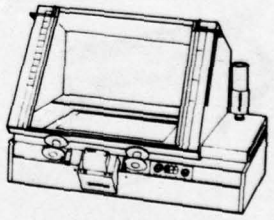
Ap Card Mounter



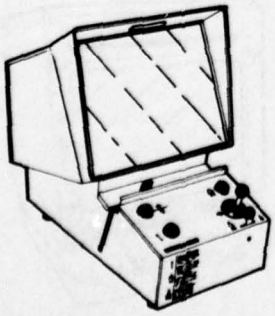
Card Duplicator



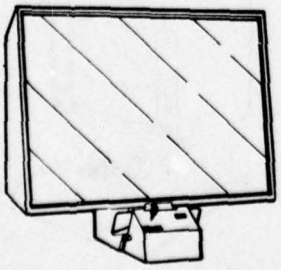
High-Speed Card
Duplicator



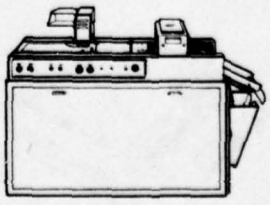
Enlarger-Printer with
Variable Magnification



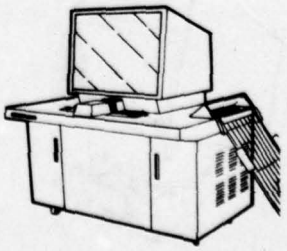
Small Screen Reader



Large Screen Reader



Production Printer

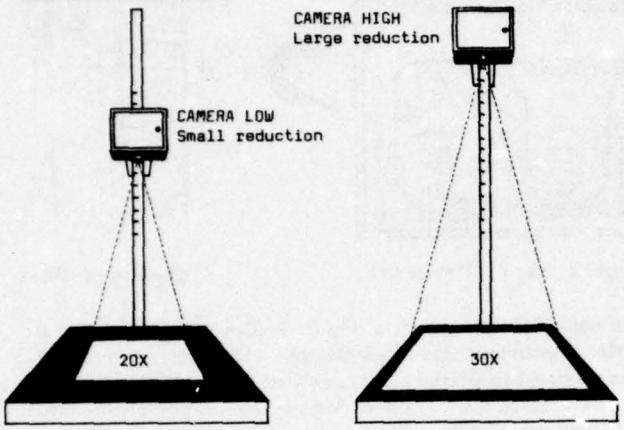


Reader-Printer

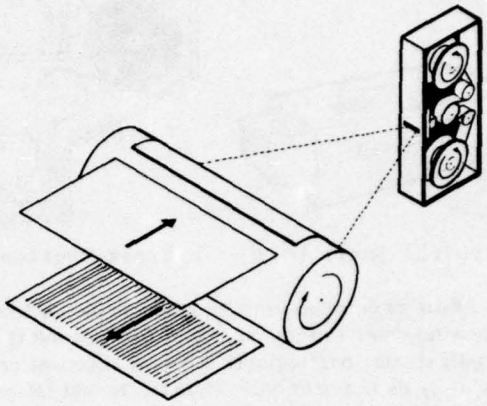
Document Filming

Cameras used for microfilming documents are of two basic types. Flat-bed or planetary cameras can accept most input and the film is exposed while the document and the film are stationary. Rotary or flow cameras can only accept loose sheets or continuous stationery and the film and the paper are in motion during the exposure. The speed of the film and paper is synchronised to produce a sharp image. Much faster speeds are possible with rotary filming but most rotary cameras have a fixed reduction ratio and the width of the film "throat" into which the documents are fed imposes another limitation on input. Planetary cameras produce the highest quality film, they can accept books, large originals and material printed on thick card, but they are hand operated and relatively slow. The reduction ratio of most flat-bed cameras can be adjusted, as shown in the illustration, by moving the camera head up and down the mast.

DOCUMENT FILMING



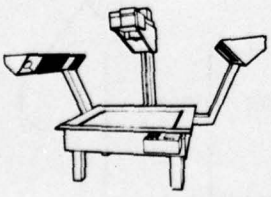
Flat-bed or Planetary Camera.



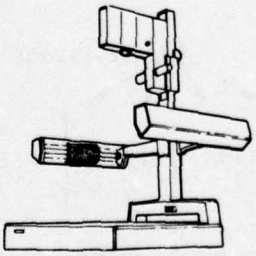
The Concept of Rotary Filming

Most 35mm filming is carried out on planetary cameras. Flat-bed cameras are also used for document filming on to 16mm when very high quality, elaborate indexing or bound originals are involved. A variation of the concept is the inverted flat bed camera which has a glass top on which documents are placed, face down, to be filmed from a camera in the base. Step and repeat cameras are used for the production of microfiche. They work from 105mm roll or cut sheet and set images in the regular grid pattern required. Provision is incorporated for the filming of an eye-legible title at the head of the fiche, usually at a 1:1 ratio from separate artwork. Rotary cameras are usually limited to 16mm roll but one model accepts 35mm roll. Inexpensive models are hand fed but more complex versions have automatic document feeds and may film at speeds of 150ft per minute or more. This enables them to film over 12,000 A4 documents per hour. Some rotary cameras are specially constructed for the filming of continuous stationery.

MICROFILM CAMERAS



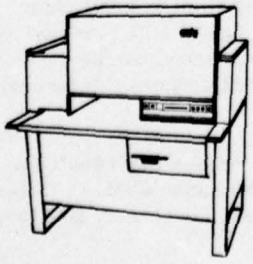
35mm Planetary



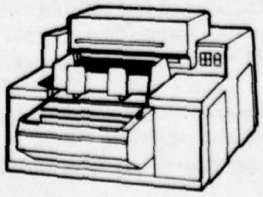
16mm Flat-bed



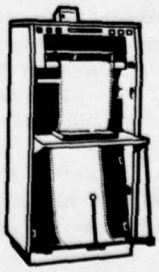
Inverted Flat-bed



Step and Repeat



Rotary for Documents

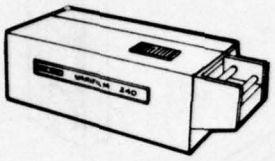


Rotary for Continuous Stationery

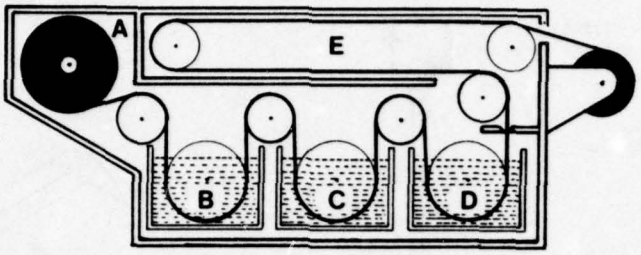
Film Processing

After film has been exposed in a camera it must be processed to develop and fix the images. A very simple processor is shown in cross-section below. The roll of exposed but undeveloped film is held in a light-tight chamber A. It passes into a tank of developer B which is maintained at a constant temperature with the aid of a thermostat. Tank C contains a fixing solution to stabilize the images, it may also incorporate a hardner to toughen the emulsion. The film then passes into a wash unit at D where it is washed before going into the drying chamber E and finally on to the take-up reel. The main disadvantage of such a simple unit is the lack of a rinse between the developing and fixing baths. This allows developer to contaminate the fixer and frequent chemical changes are desirable. Most microfilm processors have an extra tank, filled with a stop-bath solution, which fits between the developing and fixing tanks.

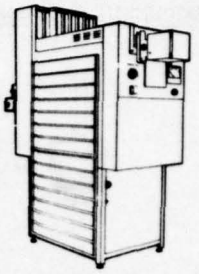
PROCESSORS FOR MICROFORMS



Typical Small Unit



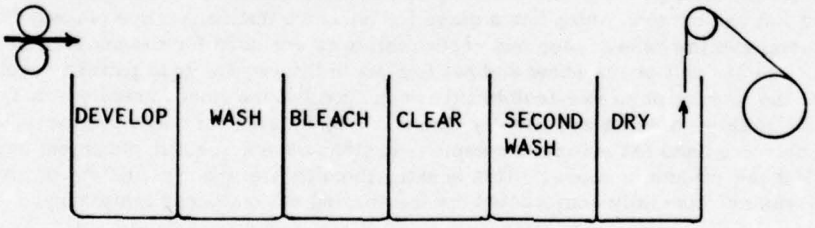
Cross-section Through a Small Processor



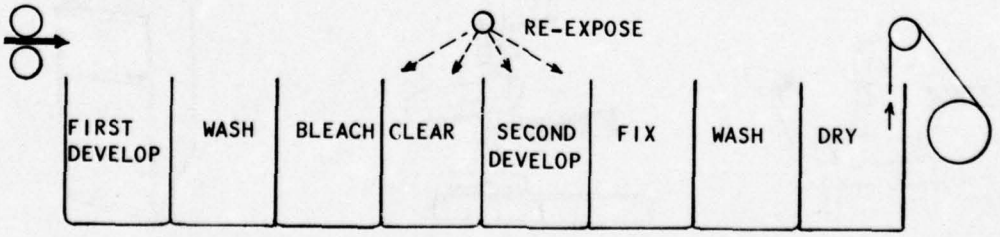
High-speed Unit

Film processed in units as described above will be conventional in that a negative film will be produced showing clear letters on a dark background if the original document was a normal printed page. For some applications, particularly COM, a reversal process is desired to produce a developed image of the same polarity as the original. Thus the bright letters on a CRT tube in a COM recorder appear as positive - black letters on a clear background - if the film is processed conventionally. Reversal processing produces a film showing clear letters on a dark background from COM film and this is often what is required.

PARTIAL AND FULL REVERSAL PROCESSING



The Partial Reversal Process



The Full Reversal Process

Reversal processing uses a bleach instead of the fixer stage which removes metallic silver from the film, this leaves the unexposed film areas almost unaffected and the resulting film contains clear information on a greenish-grey background if the partial reversal process is used. Full reversal systems re-expose the film after the processes described above so that the background areas can be developed to black silver. It will be seen from the diagrams above that the partial reversal process can be carried out in a smaller unit than is required for full reversal processing.

Monobath processing is used in some systems, especially when "instant" results are required. The developer and fixer are incorporated in the same solution. This system is often used when a processor is integral with the camera and it permits the production of film which is exposed, developed, fixed and ready for use.

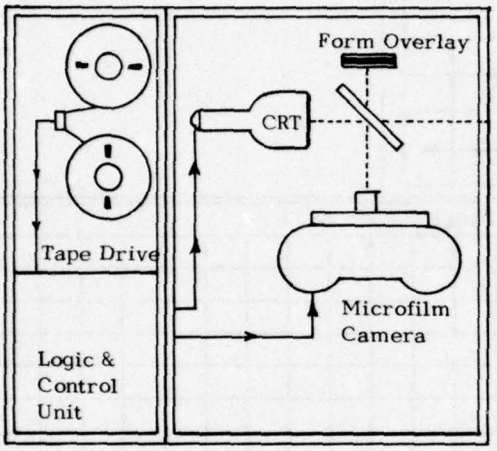
For archival permanence all traces of fixing solution must be washed out of the film and none of the instant systems provide this facility. International standards govern the quality of archival processing.

COM RECORDING

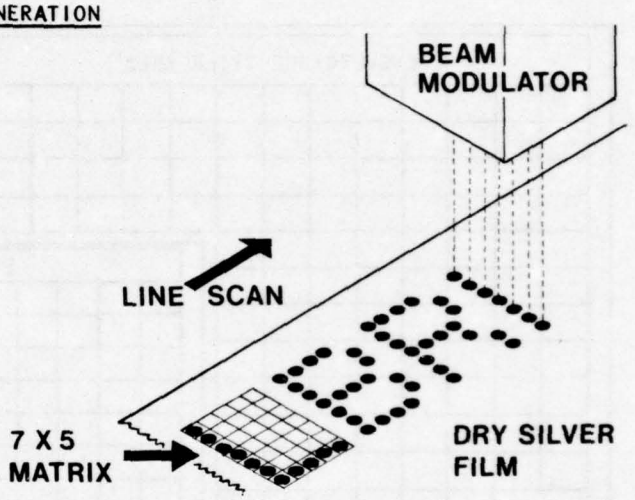
A COM recorder can operate as an on-line peripheral but most units work off-line from magnetic tape. A logic unit converts the digital information on the tape to an alphanumeric display on a CRT tube. Letters are filmed by a microfilm camera as they are displayed on the face of the CRT; when a page of text has been set the film is shifted to the next frame and the process is repeated. Repetitive data, such as fixed form outline, can be superimposed over the CRT setting via a projector which accepts a glass slide bearing the fixed text and which flashes once per frame. The concept is shown in the left-hand diagram below. Graphical material can be set on the CRT by some recorders which then function as very fast alternatives to graph plotters, usually setting their output on to 35mm microfilm.

Characters may be formed by a dot matrix. Superior letter forms are produced if the characters are vector-generated or "painted" by a series of short strokes. These techniques are shown below.

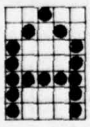
METHODS OF COM RECORDING AND CHARACTER GENERATION



A CRT Recorder



Laser-Beam Recording



Dot Matrix



Vector Generated



Stroke Generated

Other methods of converting digital input to microfilm output have been developed. Fibre optics have been used to channel light from banks of light-emitting diodes to produce the dot matrix, an electron beam has been used to "write" on to special film, but neither method is used in any machine in current production.

Lasers are used in two machines which are in current manufacture. In one the beam "writes" on to the film and it is deflected as required by a prism. In the other the laser beam is split into seven beams plus a control beam. The seven beams can be individually "on" or "off" and each character is produced in five stages, the beam patterns being used to form a dot matrix of 7 X 5 positions. In the example shown all beams were "on" for the upright stroke of the letter L and only the last beam was "on" for the subsequent four positions on the matrix. Letters are set along one line, the beam is then deflected down one line and the cycle is repeated until a frame is filled, the film is then shifted to the next frame position. The dry silver film used in the Laser Beam Recorder is thermally processed, no chemicals are required.

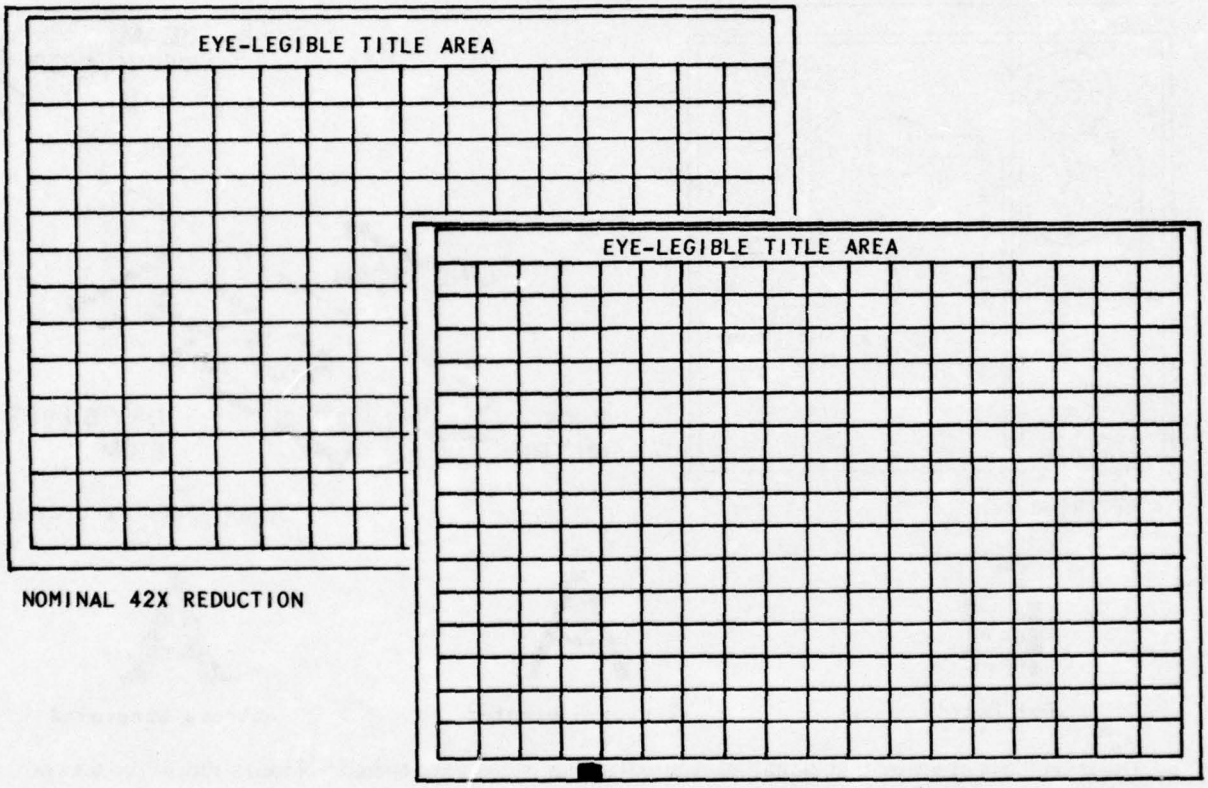
One recorder incorporates a full reversal processor and it delivers fully processed and dried fiche. Most recorders only expose the film which is subsequently processed in a separate unit. A modern trend is to incorporate a mini computer in the recorder to enable it to accept virtually any input tape. If this is not provided the input tape, especially for fiche production, has to be specially prepared for use for COM recording. Some recorders can accept an unmodified standard print tape and set on to 16mm roll or fiche without titles or index, but the production of a fully indexed and titled microfiche demands a specially formatted input tape or a front-ended recorder.

The reason why fiche production is more complex than roll is largely related to the need to set an eye-legible title at the head of the fiche and an index in the final frame or frames which provides a co-ordinate reference by row and column to the frame in which specific information can be located. The fiche camera in the recorder can move the film in two directions. It is normal for all of the images in the first column to be set, plus that part of the heading which appears above the first column, the film

is then advanced by one frame width, another part of the title is set and then all of the images in the second column, and so on until the final frame is reached. The final frame usually contains an index based on data accumulated during the allocation of data to specific frames on the fiche. It will be obvious that the many instructions required to produce such a fiche are not contained on a normal print tape. Fiche management software can be introduced into the output programme on the host computer, to produce a tape suitable for use on a "dumb" recorder, or an unmodified tape can be produced which can act as input to a recorder with a mini computer powerful enough to re-format the tape.

The COM fiche format currently favoured by International Standards contains 270 images and it is filmed at a nominal reduction of 48X. A 208 page format is also in widespread use, filmed at a nominal reduction of 42X. These formats are illustrated below.

TWO FICHE GRIDS WIDELY USED FOR COM RECORDING



Conclusion

The potential user of micrographics is currently offered a wide choice of microform, reduction ratio, indexing method and equipment. It is hoped that this paper has indicated why such a variety is desirable in order to ensure that the best possible solution to any problem is available.

References

The illustrations used throughout this paper are taken from a series of Guides published by the author's company G G Baker & Associates. These are "A Guide to Computer Output Microfilm" 1975. "A Guide to Microfilm Readers & Reader Printers" 1976. and "A Guide to the Production of Microforms"1974.

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COM RECORDING TECHNIQUES AND RECORDERS

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Micord Corporation
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SUMMARY

Computer Output Microfilm is created by converting information that is in the form of electrical or magnetic digital signals, generated by a computer, into signals that will control an energy source and thus expose images on film. Techniques employed today for exposing the microfilm utilize cathode ray tubes, light emitting diodes, electron beam units and laser devices. Techniques have also been developed for recording repetitive or exceedingly complex information using devices such as Xenon lamps to flash images onto film.

High speed generation of characters is accomplished in a variety of ways. Some Computer Output Microfilm devices also provide means for the high speed generation of vectors for creating lines, curves, and complex configurations.

This paper describes various techniques for the conversion of data, techniques for character and vector generation, and the means for implementing the concepts in COM recorders. Also included is a discussion of the various Computer Output Microfilmers available today. Mention is also made of the concepts of Computer Input from Microfilm (CIM).

The input to a Computer Output Microfilm (COM) device is an electrical signal directly from a computer or is information recorded on magnetic tape. In either case the information is in the form of discrete signals called digital information. The output of a Computer Output Microfilm device is a human readable, reduced size image on microfilm. The conversion of one form of information to the other is the prime purpose of the Computer Output Microfilmer.

There are two basic types of Computer Output Microfilm recorders. One is defined as an alpha-numeric unit and simply converts the computer generated information to letters and numerals in the manner of a computer printer. The second type of unit is called a graphic recorder and is capable of producing, in addition to letters and numbers, lines, curves, and complex configurations. These latter devices have the capability to place on film any representation that can be produced on a computer display.

The computer that we are familiar with handles data as a combination of "yes" and "no" signals. The code structure which is called binary because there are two states, is used in the internal operation of the computer. This binary code is maintained for operating output units. The COM device has been designed to accept information in this form. This information within the computer is in the form of an electrical signal. This electrical signal can be conveyed directly to the COM unit and we have what is known as on-line COM. The electrical signals can be converted to magnetic form as information on magnetic tape. This tape can then be the input to the COM device and we have what is known as off-line COM.

Whether the signals are electrical or magnetic they are conveying the same information. It includes the data which must be converted to images as well as special control information. The control information is that which determines the data location, film movement, and application from remote source of repetitive information.

There are various types of information that are recorded on film. There are various ways in which the recording may take place. The one capability that all Computer Output Microfilmers must have is an efficient method of generating characters. Some units will satisfy other recording needs such as lines and curves, heading information for microfiche, code marks for storage and retrieval systems, cut marks for automatically separating microfiche, or special code marks used in automatic duplicating systems.

Character generation is employed in all recorders. Many unique systems have been devised for rapidly creating characters. The earliest concept for COM was simply to photograph an image that was being displayed on a computer output terminal. The display was on a cathode ray tube and the characters were individually drawn on the face of the tube by connecting spot locations. An improved version of this concept is still utilized in some COM units.

The quality of a character that can be produced can be related to the limitations of each generating technique employed. In the case of the vector or line drawn characters, the quality is determined by the matrix of points that are addressable on the cathode ray tube. In the case of present day recorders the CRT matrix may vary from a 512 point by 512 point to a 16,192 by 16,192. The more points available means the smaller the character capable of being created or the higher quality the character type may be for an equal size.

The generation of vector drawn characters is controlled by a series of electronic circuits within the COM. The code that is input will select a particular circuit for an individual letter and the circuit will

actuate the cathode ray tube controls to draw the character. However, if the COM unit has a separate vector generator, any character or symbol can be drawn using computer program codes to control the cathode ray tube directly.

The speed of generation using the vector method is adequate for nearly any need. When speed of generating characters is discussed it should be recognized that creating the characters is only one part of the recording process and that the many other functions which the COM unit must perform will dictate the total speed of operation or what is a better measure, the throughput of the device. It is my belief that when the speed of character generation is greater than 30,000 characters per second the throughput can not be improved appreciably by increasing the speed. Speeds in this range are capable of being obtained with units drawing characters in this manner.

A technique which is used in creating graphic arts quality characters is sometimes called painting characters. Here vertical strokes are made very close together and, thus, literally "painting" in the body of the character. To visualize the quality possible with a COM device with an addressable point matrix of 16,192 by 16,192 one might imagine creating 200 characters across the face of the tube and leaving equal spaces between characters. The letters then could be made with 40 strokes. This technique produces ultra high quality microfilm. Actually, there is no manner presently for making higher quality micropublished material than with a high quality graphic COM unit.

Early techniques for producing characters was both slow and of relatively poor quality. To overcome these problems Stromberg Carlson now Stromberg DatagraphiX, utilized a special cathode ray tube known as the Charactron Shaped Beam Tube. (Charactron is a registered trademark of Stromberg DatagraphiX) This tube has an internal matrix of characters through which the electron beam is directed. The extruded beam is then directed to a location on the tube face and thus literally stencils a character on the tube. This technique is very fast and can produce quality characters. The matrix can also be made with a set of characters unique to any particular customer or need. One must however maintain a spare tube because of this uniqueness. It should be noted that the "characters" of the matrix can include vectors such that graphics can be accommodated with the Charactron approach. **(See Figure 1)**

An interesting technique employed in a unit not marketed at this time utilized the concept of the Charactron tube without the tube. In this instance characters were placed on film and a cathode ray tube was used to scan across the character. The light transmitted through the film was detected and used to activate another CRT which was scanning in synchronism across the microfilm to be exposed. The CRT was therefore writing a direct copy of the original character on film. This technique allowed for a very large data base of characters rather than the limited matrix of the Charactron. It was however slower and the quality of characters was limited by the sweep capability of the second cathode ray tube.

A totally different approach to character generation is by using light emmitting diodes (LED'S). The recording concept used has a matrix of 35 light emitters in a 5 by 7 arrangement. The coding system will determine which of the 35 lights are lit and thus what character is to be exposed. In the only commercially available unit using LED's the light is transmitted to the film using fiber optics. Although in practise a series of four characters are exposed at one time, this technique is slower than that using a cathode ray tube. It, however, is less complicated and thus less expensive. The character quality is limited by the 5 by 7 matrix. Actually, only upper case characters are possible with this size matrix. **(See Figure 2)**

All of the techniques discussed so far use light to expose images on film. One approach which uses a much more powerful energy source is the electron beam recording method. In the cathode ray tube a signal activates an electron beam. This beam is directed at the phosphur on the face of the tube. The energy from the electron beam activates the phosphur resulting in the emanation of light. The beam of light exposes the silver halide film. Development of the film results in the image on the microfilm being visible. With electron beam recording, there is no phosphur and no light. The electron beam exposes the film directly. This method makes available much more energy for exposing the film and thus allowing use of much slower reacting films. The use of dry silver film requires heat only for processing rather than chemical processing which is cheaper, cleaner, and permits a faster turn around time. Since the film must be in a vacuum for exposure there are some additional difficulties associated with this process. A limitation of this technique is that the image must be a positive appearing image whereas with chemical processing a reversal process allows one to obtain a negative image. **(See Figure 3)**

The latest technique developed uses a laser. Laser beam recording utilizes again a great amount of energy available to expose film such as dry silver film for the microfilm master. As in the case of the recording using electron beams, the beam of energy is scanned across the area and exposes when on and not when off. The commercial unit available uses an Acusto Optic Modulator creating seven writing beams which are switched on as required five times for each character. The possibilities using lasers are extensive. The beam can be smaller than a light beam and thus make finer lines and characters. The energy potential should make possible exposing nearly any so called slow film. Absolute control of the beam is still difficult, however.

As previously indicated there are two basic types of COM. The alpha-numeric units utilize one or another of the described techniques for recording the characters that have been determined by the computer. There is also a need for lines and column heads. The computer printer accommodates this need by having pre-printed forms on which to record the computer generated data. COM devices use pre-printed forms also which are on film or glass. Using an alternate optics path the form is flashed with such as a Xenon light to superimpose the information on the computer generate data. The forms flash technique is used with COM's that record by cathode ray tube, light emitting diodes, electron beam, or laser beam. **(See Figure 4)**

The second type of COM unit is called a graphic COM. It has much more capability to record complex items primarily because it includes a vector generator. The circuitry for a vector generator provides for automatically connecting lines between specific points in the master matrix of the cathode ray tube exposure area. The highest quality COM's have 16,192 by 16,192 discrete addressable points. Special circuitry has been developed which allows not only a straight line that will connect two selected points but also arcs and circles. This makes possible the creation of charts, graphs, drawings, sketches, and other complex

arrangements of symbols and lines. It also has made possible the generation of graphic arts characters for printing and publishing.

There are a variety of special recording requirements that have been accomplished by COM devices. Both roll film and microfiche are exposed in various units. With microfiche it would be convenient if the header information defining the contents of the fiche could be recorded at the same time as the document data. This is possible using special computer programs and creating the required larger letters by means of a large number of small elements. A second requirement of microfiche is for cut marks. The 105mm roll is exposed with a number of microfiche. The addition of cut marks makes it possible to automatically separate the various fiche. A third type of special recording for microfiche is the code for automatic duplicating. Here a special code is written in a unique location on the fiche for recognition by an automatic duplicator allowing for control of the number of copies that will be produced. The recording of the cut marks and duplicating codes can be done by flashing the information or, on the graphic recorders, by direct recording.

Coding for storage and retrieval systems can be recorded directly onto the film by these COM devices. Such systems as Image Count, Code Line, or any of the binary code systems can be directly applied. Again this information is applied by flashing with the alpha-numeric recorders and either written or flashed with the graphic recorders.

A very special recording technique is that for color images. The Information International FR-80 has been modified for certain customers to produce color output. The cathode ray tube has a phosphur which will produce white light and there is a series of three filters to split the light into primary colors. Three separate recordings are made for exposing each image on color film with each of the filters used in sequence. The result is a high quality color presentation. The use of color expands considerably the utilization of COM. Commercial micropublishing will find it to be most valuable when micropublishing for the home and school market becomes a reality.

The majority of Computer Output Microfilm recorders are manufactured in the United States. The largest number of recorders now being sold are of the alpha-numeric type. A review of the companies distributing or manufacturing units shows a wide choice for the prospective customer.

The first company in the COM field and the one with the largest number of installations on a world wide basis is Stromberg DatagraphiX. Although originally in the graphic COM business, the present line of equipment is of the alpha-numeric type. Units available are of the on-line type, off-line with magnetic tape units, and units that have a additional mini-computer on the input for reformatting material and producing indices. Units are available for roll film production or microfiche. Also available is a device with in-line processing of the film. Recording is done using the Charactron tube.

Another company distributing an alpha-numeric COM is Eastman Kodak. With choice of roll film output or microfiche, and with a choice of a front-end mini-computer these units have found use in Service Bureaus as well as in-house operations. Bell and Howell manufactures and distributes the recorder formerly of Pertec. It is a conventional off-line unit and records with a cathode ray tube. A front-end computer is available. A third unit using conventional recording techniques is the Quantor COM series distributed also by NCR. Quantor was the first to perfect in-line processing. Although units are available for roll film the emphasis is on fiche. Again a front end mini-computer is available.

Memorex provides an on-line COM device, simple, inexpensive, and using the recording technique of light emitting diodes and fiber optics. There are also two European companies with alpha-numeric COM's, Computer Instrumentation of Great Britain and Hell of West Germany. The latter unit is also distributed by Siemens. In Japan Fuji distributes a similar type of COM.

There are two other companies distributing alpha-numeric units, each also distributing graphic devices. Cal Comp utilizes cathode ray tube recording. The 3M Company has a unit using electron beam recording and one using laser beam recording. Cal Comp has a quality graphics recorder and 3M has the Beta Systems units formerly of Beta Instruments.

In the area of high quality graphics COM, Information International distributes units for the printing and publishing field as well as the general COM market. In Europe three companies have recorders available. In Great Britain there is Laser Scan, in Scotland there is Ferranti, and in France there is Benson.

Specialty COM's are also available. Applicon is a company that obtained the marketing rights to the Singer line of high quality graphic COM recorders and made them a part of their automatic Drafting System for engineering and architectural drawings. Autologic is a company that produces photocomposition equipment and have modified units to have a 35mm microfilm output. Harris Corporation developed a laser recorder that produced in addition to a conventional microfiche, a holographic representation of the data in a strip at the top of the fiche. This made the fiche machine readable as well as human readable.

Any discussion of COM would not be complete without a mention of CIM. Computer Input from Microfilm has been in use for many years but has not become an economically viable alternative as yet to human input to the computer except in special cases. The technique generally used is to scan the microfilm with a cathode ray tube beam and determine whether there is dark or light area on the film. Computer control of the CRT beam allows line following techniques and matching techniques for faster interpretation of configurations on the film. Optical Character Recognition (OCR) when combined with CIM has provided a significant breakthrough in reading of signatures, hand print and foreign texts. The primary distributer of CIM systems is Information International.

COM and CIM have had an impact on the information processing field. Techniques for reading and recording have been refined to the point where the quality is better than the requirements placed on the equipment. Better utilization of the present equipment will expand COM and CIM use and in turn reduce costs. The future will be more affected by innovative utilization than by technology.

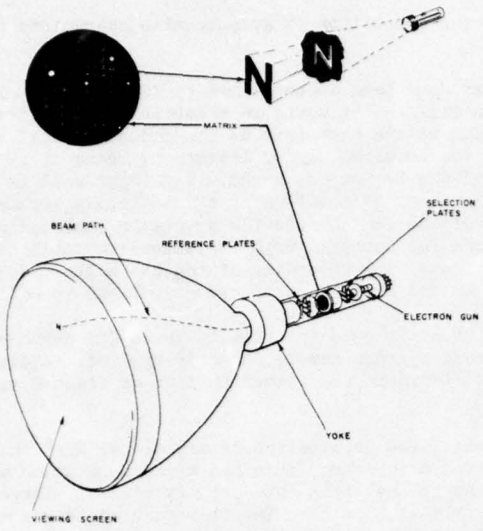


Figure 1. Charactron Shaped Beam Tube

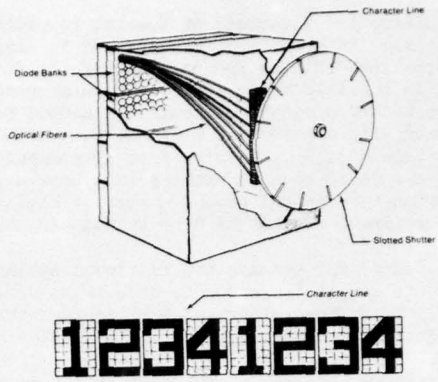


Figure 2. Fiber Optic and Light-Emitting Diode Systems

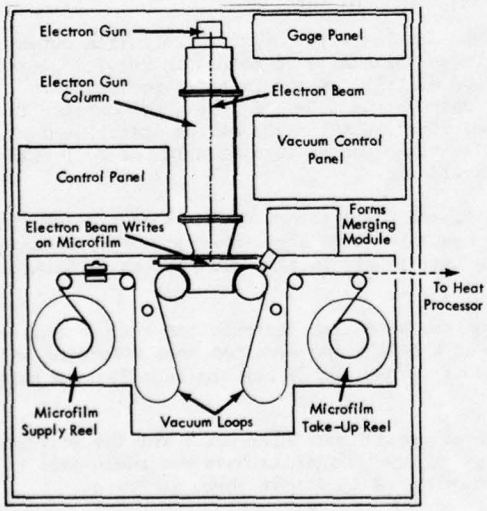


Figure 3. Electron Beam Recording on Microfilm

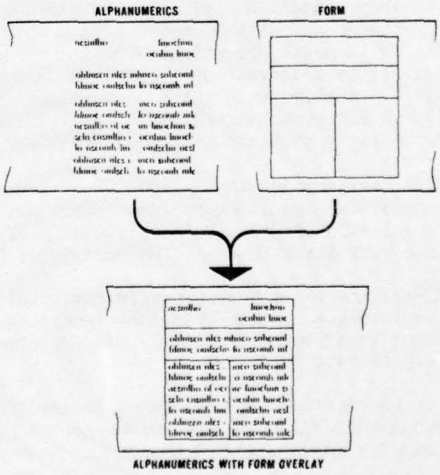
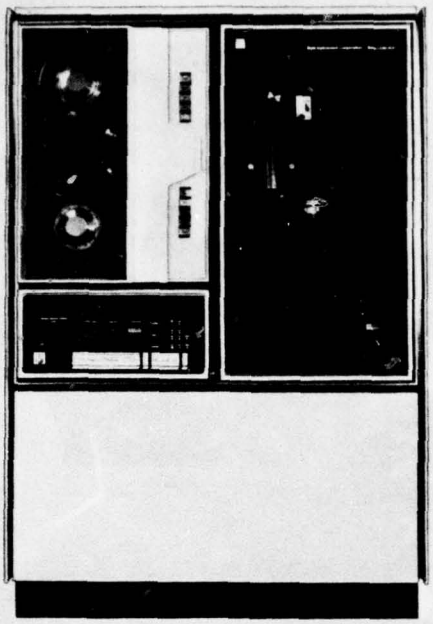


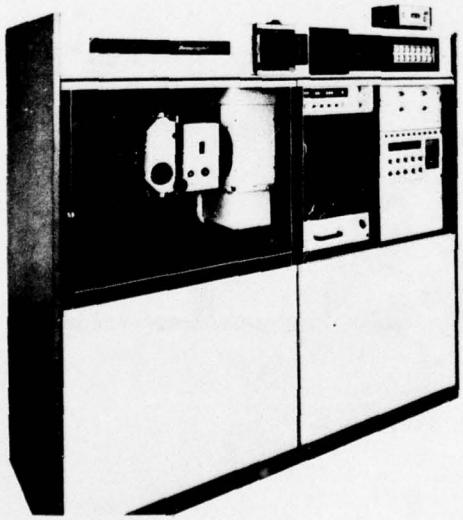
Figure 4. Forms Overlay



3M Beta COM 400



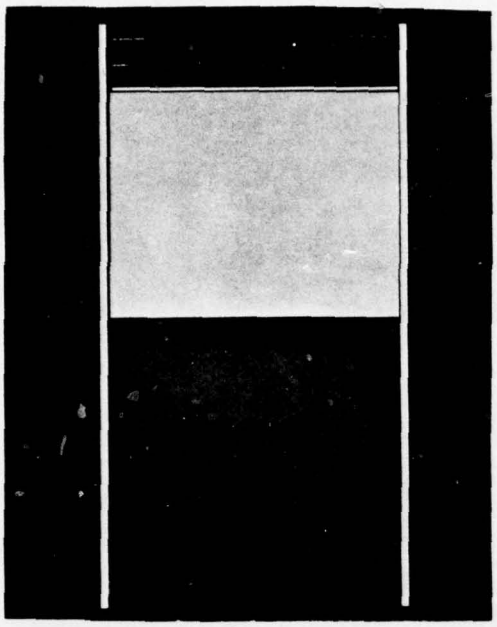
Bell & Howell PTI-]300



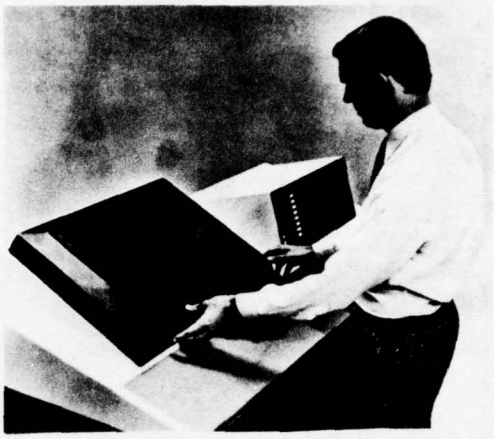
Stromberg-DatagraphiX 4440



Kodak KOM-90



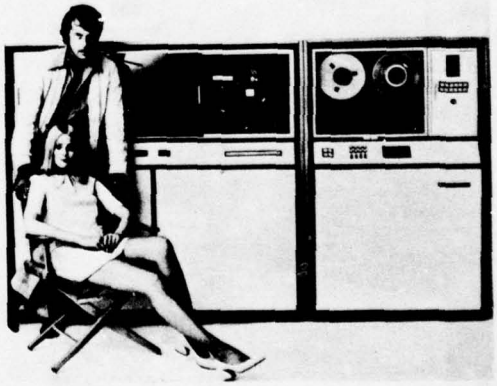
Memorex 1603



Quantor 100



Information International FR-80



CalComp 1670

INDEXING & RETRIEVAL TECHNIQUES

by

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Abstract

A review of the state-of-the-art in available storage and retrieval methods and techniques used with micrographic systems. Roll film, fiche and aperture card systems with their manual, semi-automatic and fully automatic retrieval equipment are evaluated, analyzed and compared. The relationship of updatable microfilm to storage and retrieval systems are explained and evaluated.

1.0 Introduction

The field of microfilm information systems has had a dramatic growth within the past decade. The increased interest has been brought about by the prolific usage of computer output microfilmers (COM) and the courtship and marriage of computer processing and microfilm technology.

Tracing the general development of microfilm systems, we find that there are three major phases of evaluation that we may define. These are the archival stage of development; the active systems; and now the interactive systems.

Archival Systems. The earlier requirements for microfilming records (over 40 years ago) centered around the need for the preservation of vital documents. Very seldom was there a need to refer to these records; they were filmed primarily for security against fire, floods or other forms of destruction.

The need for retrieval of these filmed documents was minimal and therefore simple. All records were in file order by date, or number, or by alphabet. The retrieval, therefore, was equivalent to the paper-drawer file system from which the film was recorded.

The user still operated with the paper files while the microfilm files were stored remote to the office where the information was needed. The need for microfilm was only when the functioning paper file was missing, destroyed or worn from usage.

Active Systems. The shift from archival systems to active systems came about when the users found it easier to handle the microfilm files instead of the bulky paper files. This was first seen in abundant use with engineering drawings recorded on aperture cards. The handling of large sheets of engineering drawings gave way to the 35 mm frame inserted into the hole of an IBM tab card.

Recently, many filmed files are now in usage in place of their paper equivalents. Microfilm files, generated from source documents, or from the computer via COM, are now used in the office as the information source, and the paper files either destroyed or preserved in a remote location (a reversal of usage as seen from the archival phase of development).

Inter-Active Systems. The newer developed systems make judicious use of both the microfilm file and the capabilities of the computer. The combined (or hybrid) systems take advantage of the computers ability to perform logical functions, mathematics, and the capability to update information very quickly. The microfilm file in these modern systems are used for their advantages of permanence, high density storage, economical storage and ease of distribution.

The need for better retrieval methods has increased once the film file started being used in either active or interactive systems. Unlike the simple archival system, the active/inter-active system requires more speed and sophistication.

Using the paper version of the file relied heavily upon the eye-brain-intelligence of the searcher to retrieve the desired document. Most cataloging aids were large, eye readable designators on drawers or in folders. Once microfilmed, the searcher lost the convenience of using his ordinary sensory faculties. The documents are reduced in size to such an extent that the searcher can no longer see the pages without special viewing equipment. The user, also, can no longer determine where on the file to find the desired page. The microfilm no longer provides the convenience of manipulating through the file in search of the document.

It is not, therefore, surprising to see the microfilm file compared to a computer generated magnetic tape, or magnetic disc file. In the case of digital data, as a magnetic tape, or discs, we also find documents recorded so they are not readable with the human eye--and even worse in a binary code which is unintelligible to the ordinary office clerk. Very sophisticated search techniques and equipment are needed in these cases and we see more and more of these indexing ideas being applied to the microfilm files.

The microfilm file has characteristics that lie between the paper file and the magnetic storage file; and utilizes indexing techniques from both the records management and the electronic data processing systems.

2.0 Roll Film Indexing and Retrieval Methods

One of the earliest microforms used for recorded documents was roll film. Usually a roll of 100 ft., 16 m.m. or 35 m.m. wide film onto which up to 10,000 images (or pages) were photographed depending on the reduction ratio of the camera lens. Roll film files are produced by the standard rotary, planetary, continuous forms or COM recorders.

The advantages for roll microfilm were noted as beneficial to applications of continuous, historical, large volume files. These roll film files are compared to a magnetic tape computer file. The need to retrieve the information accurately, and quickly from either type of file is analogous.

There have evolved many ideas and methods for finding a given document on a roll of film. These schemes range from simple visual aids that quickly identify the group of desired documents, to complex codes that identify the exact documents. These methods include:

- Flash Cards and Odometers
- Code Line and Blip Code Indexing
- Sequential Indexing
- Digitally Coded Film Systems
- Computer Aided Systems

2.1 Flash Cards. Flash cards in a microfilm file is the equivalent of separators used in a paper file to identify groups of documents. In a microfilm file, these separators are microfilmed in their appropriate places; the separators contain large eye readable characters that define the group of documents that follow. These characters may spell out the month, the year, beginning account number, an alphabetic designation or any other convenient identifier. Once a searcher finds the flash card image designating the desired group, the user then proceeds on a "page to page" basis as he (or she) would do in a paper file.

The advantage of using the flash cards is that no special viewing equipment is needed to view the system. All that is required is that the filming operation be organized to include the flash cards or designators in their correct sequence in the file.

2.2 Odometer. The odometer is an instrument which measures distance traversed. In the case of automobiles, miles are measured by the odometer; in the case of microfilm roll film readers, odometers read a relative number corresponding to film footage. These odometers, though not exact, are used to bring the user closer to the desired information. Odometers are used many times in conjunction with the flash cards.

External cross references are needed to tell the user the corresponding odometer reading and the desired information being sought. Odometers are usually modifications to standard roll film viewers.

2.3 Code Line Indexing. Code line indexing was introduced to further assist a requestor in finding a microfilmed document. Three horizontal bars are included between the frames on the microfilm. Each of the horizontal bars represent a range of numbers. The lowest bar represents the 0-100 range (10, 20, 30, etc.); the middle bar is the 100-1000 range (100, 200, 300, etc.); and the top bar is the 1000-9000 range (1,000, 2,000, etc.). Each of the 3 bars are positionally oriented along the width of the film so that a corresponding number (say #1510) would place the top bar at the 1000 position, the middle bar at the 500 position and the lowest bar at the 10 position.

As the film is scanned in a viewer, the horizontal bars between the frames gives the illusion of continuous lines across the entire screen. By placing an edge scale on the viewer screen, the user can advance the film until the bars line up with the scale at the desired number. The user can get to within $\pm$ 10 frames of the exact position.

The edge scales are plastic strips that can be affixed to any screen provided the corresponding magnification ratio was used. The code lines are placed onto the film via the recording cameras (including COM).

2.4 Blip Codes. Blip codes are used in conjunction with equipment that allows the investigator to recover the exact frame in his search. The blip is a photographic mark (black or white) placed under each and every frame and resembles a sprocket hole that is imaged with the frame. It is sometimes referred to as an electronic frame counter, or a digital odometer. The blips are recorded by the recording cameras or by the COM.

By placing a mark under each frame, equipment can be built that will count the marks and therefore assign a sequence number to each image. Equipments (Eastman Kodak IC-5, 3M PAGE SEARCH, B & H Synchro Search, etc.) can count forward, count backwards, advance +1 or -1, and clear and reset the counter to any number via the associated keyboard.

With the use of an external cross reference, the operator determines the exact frame number, keys in the number and the viewer advances the film, counting the blips until the desired number occurs, then stopping on the document. Further searches can be made on the same roll by simply entering into the keyboard the corresponding frame numbers.

In these systems, the cross reference index may be eliminated if the file itself is sequential in character with no missing numbers. By clearing the counter and resetting it with the first document number in the file (as in the case of an invoice number), the operator need now only enter the keyboard with the desired document number. A beneficial direct access system results.

2.5 Sequential Indexing. Many file systems are not sequential in character, or would not like to be forced into a sequential system. Checks that are returned to a bank, as an example, would take too long to place in any sequencing order before filming. It is therefore desirable to film these in random order but imprint upon them, before filming, an artificially created sequential number that can be used for an internal cross reference to the document. The generated cross reference index (usually computer generated) contains the details about the document and its internal reference number for retrieval. The retriever can then use any of the simpler look up methods for recovery of the document--since they are in simple ascension order. He may also use the blip code method for added speed of recovery.

Sequential indexing with a corresponding cross reference has also been used to provide an updating capability. When updates or new information is entered into the file, it can be added in terms of new rolls of film. The cross reference index is corrected to show the new location of the material in terms of its internally generated reference number.

Sequential indexing in combination with blip systems, and in combination with computer systems have been utilized in a wide variety of complex computer indices to a microfilm file.

The sequencing numbers can be placed on the documents externally (manually) to the cameras, internally by the cameras or placed on the frame by the COM or planetary cameras.

2.6 Digitally Coded Film Systems. Blip systems which only place a mark under each frame, can only count. They have little intelligence to do anything more. If the count and the document number is not in correspondence, the blip counter doesn't know it. Digitally coded information recorded on the film which tells "what" the document is, rather than just "where" it is (as in the case of the blips), is more powerful as a retrieval tool. Two such approaches have been offered by Eastman Kodak in their MIRACODE System and in their latest ORACLE System.

2.6.1 MIRACODE Systems. The MIRACODE System places an array of code columns (14 binary bits in a column) in front of the desired document. The code column represents 3 decimal digits and an array of up to 15 code columns (15 - 3 decimal digits) can be used to describe the document. Each code column can be a designator defined as 3 decimal digits (as 277 designating a company name). Elaborate search parameters may now be set into the system, as seen in personnel files, law enforcement searches, research reports, general accounting files, etc. Logic functions of "greater than," or "less than" can be included along with the "and" "or" equations of Boolean Algebra. The searcher need only define his or her parameters, or key words, in terms of these prestructured 3 decimal digits and the equipment will search for the document anywhere on the file. A random access search very similar to a computer magnetic tape search results. Placing the codes on the film is done at a planetary camera, adapted with a keyboard onto which the operator enters the information. The codes take up linear distance along the film thereby reducing the available film used for document recording. Approximately 5 code columns requires the space of one recorded document on film. The code can be placed on the film via COM also.

2.6.2 Oracle System. Another digitally coded roll film system has recently been revealed by Eastman Kodak. In this system, a series of vertical bars (resembling the Universal Product Code) is placed under each document. The bars represent 8 digits and can be used for document numbers such as invoices, purchase orders, sales slips, etc. Like the MIRACODE, a random access system is inherent with only 8 digits instead of the 45 digit capability of MIRACODE. Most important, the digits are located under each frame, not taking away linear distance for the filming of records. In order to fit the bars under each frame, a 32x reduction is required but that should not deter any user. Another advantage claimed with this system is the ability to handle sequencing files that have missing numbers--or gapped files.

The recording of the bars is done at a specially built planetary camera with a keyboard entry system associated with it. An equivalent keyboard is associated with the retrieval unit and a direct access entry system results without the need for any external indices.

2.7 Computer Aided Systems. The need for an external index for use with a sequentially numbered file, or a blip system has resulted in the hybrid use of computers and microfilm. Computers can conveniently generate these required cross reference listing and easily update, remerge and resort new information into the listing. They make, therefore, a good choice to do the indexing function. Also with the advent of on-line CRT terminals, the index can be either a paper print or a CRT display.

One such system, the 3M Microdisc System provides that arrangement with a self-contained mini-computer with disc storage, a CRT terminal device, and their blip coded Page Search microfilm retrieval unit. Eastman Kodak will provide the same capability around their IC-5, and B&H has an arrangement for their Synchro Search units. Other manufacturers have similar configurations which marry the blip technique of roll film retrieval to the computerized on-line cross reference indexing.

One manufacturer, Ragen, carries the process one step further and automates the selection of the exact roll of film. The selection of the desired roll of film in the previously mentioned systems is done manually. In the Ragen System, by the use of a 10 level, 30 bin carousel arrangement housing 300 rolls of film, a completely automatic roll film system is provided including mini-computer, disc storage, film storage and film entry devices.

3.0 Microfiche Indexing and Retrieval Methods

Microfiche has been termed in the past as a "people file." The indication was that it was used for a selected group of meaningful documents as found in a personnel, or medical, or student, or policy holder, etc., file. Handling and distributing a selected number of pages on fiche was deemed better than disturbing a large roll of film for the use of a few documents.

Today, however, because of the ease of producing microfiche on a COM machine, and because of the economic cost of fiche readers, fiche systems are being used where roll film would ordinarily satisfy the requirements. Also fiche systems have an advantage over roll film systems when it comes to the retrieval mode. Fiche systems have been compared to computer magnetic disc storage and retrieval systems.

Microfiche (4" x 6") can contain up to 1000 images in a fixed array depending upon the reduction ratio used. The fiche usually contains a title area identifying the general fiche parameters and an index frame specifying the parameters for each page of the fiche.

Fiche are generated precisely by a step and repeat camera, by a COM device or by various non-precise methods such as jackets, strip-up or adhesion techniques.

3.1 Manual Fiche Retrieval Methods. The use of the title area and the index page of a fiche has given rise to many useful, simple retrieval systems. This "two step" look up is conveniently arranged through the use of a variety of microfiche storage devices ranging from easel type binders, trays, drawers and standard power files. The operator in search of a microfilmed document, looks at the titles of the fiche to select the correct one, then looks up the index frame to find the exact page. The process is equivalent to finding the folder, then the page within the folder. The speed-up in retrieval as compared to a paper file is seen in the handling of smaller size packages and the centralization, at one's desk, of the entire data base. Retrieval for paper records in a standard office environment may range from 40-100 look-ups per day (capability per worker). A manual microfiche retrieval system could double the production time to approximately 200 look-ups per day per operator. Variations on these numbers are obviously dependent upon the exact nature of the application.

3.2 Semi-Automated Fiche Retrieval Systems. A number of fiche retrieval methods are in use to speed up the retrieval of an individual fiche. Some of the semi-automatic approaches to the problem include the Bell & Howell Fiche Finder System and the Addressograph Multigraph System 95.

Both approaches house subdivisions of the total fiche file into smaller units. The B & H Fiche Finder has a tray of 100 fiche as its basic unit, the A/M 95 has a cartridge of 30 fiche as its basic package. Once the unit is placed into their respective devices, location and selection of an individual fiche is done with the aid of positioned tabs uniquely defining one of the many stored fiche. The B & H unit only selects the fiche for remote viewing. The A/M 95 places the selected fiche into the self contained viewer at the index page. The user then selects the desired page and keys it into the viewer which moves to the correct grid position within 5 seconds.

When the search is completed, the A/M 95 unit replaces the fiche back into the cartridge and is ready for another selection or ejection of the cartridge. The cartridge is ejected and a new cartridge can be inserted.

3.3 Automatic Fiche Retrieval Systems. A self contained automatic fiche retrieval system is offered by Image Systems Inc. known initially as their CARD unit, with later versions called their MENTOR, and QUESTICON Systems.

The heart of the system is a carousel-like arrangement containing up to 750 fiche onto which is affixed a metal clip. The metal clip contains a binary code which is punched out of the metal. When the 750 fiche are in place, they resemble a coded drum.

When a selection is made, the drum rotates 360° and the sensors look for the selected fiche, then places it in the viewer at the index frame. The page is then chosen by keying in the grid position. Another fiche may be selected whereupon the fiche in the viewer is returned to the drum; the drum rotates until the newly selected fiche is found and placed into the viewer--all within 10 seconds.

Updated fiche can be inserted into the drum in any location since the rotating and sensing of the drum is equivalent to a random access searching function. Systems have been connected to a computer and an internal computer supplied as one of the available configurations.

4.0 Aperture Card Indexing and Retrieval Units

Aperture cards are adaptations of IBM standard tab cards with a hole (aperture) in them to insert a filmed image. The original intent was to use the punched card through a sorting type machine to retrieve, from the deck of cards, the desired image. Usually there is one image per card, and the punched card identified the drawing number, sub-assembly number, etc.

Today, few designers rely on sorting machines for aperture card retrieval. Instead, systems have evolved that edge notch the card in a manner similar to the old key-sort techniques. The edge notched systems (ACCESS and GAF) place up to 9 characters on the edge of the tab card (or a carrier) and load up to 4000 in a tray. All cards are searched simultaneously through a keyboard entry and the selected card or cards are ejected from the file for remote viewing. Cards can be replaced anywhere in the file because they will all be tested in the next search. Updating is simply replacing a card in the stack. Encoding is also simple by a special crimping type cutting machine manually operated after setting in the desired code with the keyboard.

Aperture cards today are no longer confined to a single image but can be designed to contain a multiple array of images to satisfy the user's application.

5.0 Updatable Microfilm Systems

Sophisticated, computer assisted retrieval systems were developed for certain applications because there was no convenient method for updating the file. The field of updatable microfilm systems has had a slow development with some interesting new concepts and equipment available only during the last few years. If a viable method of updating existed, where information could be added on to a file in convenient locations, or old information could be erased and new information recorded in its place, then the need for computer indexing to the microfilm would be lessened. Insurance policy holders is a good example of the requirement to update, erase or add-on new information to a file. Hospital records, student records, personnel files, etc., are other examples that are now being accommodated with microfiche jacket systems, or a computer index to a film file.

Since updatable microfilm systems are so closely related to many of the major retrieval applications in use today, I have included this review and discussion of the subject. There are 3 major efforts in existence today (commercially available) that address themselves to the updatable files. These are the microfiche jackets, the Scott 200 System, and the MICROX System.

5.1 Jacket Systems. The microfiche jacket consists of a 4" x 6" carrier containing 5 to 7 channels--into which a strip of 16 m. m. film can be inserted. This manual insertion (or stuffing) of film is, thereby, the process used for adding on new information to an existing fiche. Deletions can be conceived by the same process of extracing the frame; and replacing it with a new frame. To say the least, a tedious, labor consuming, "prone to error" type of task.

However, since it was the only method available for "adding on" or replacing pages, it enjoyed much success and is used widely today for those applications requiring the updating function. The jackets have expanded their capabilities and are now available in various sizes (3" x 5", 3" x 8", 4" x 6" etc.), with combinations of channels (both 35 m.m. and 16 m.m. on the same fiche), and now, in combination with aperture cards, or 4" x 5" cards called "fiche cards." The variations all aimed at solving a specific application through the use of standard filming technique (16 m.m. or 35 m.m. roll film) and then the selective stuffing operation into a jacket microfolm.

Duplicate copies can be made from the microfiche jackets and used as working copies until the master jacket is updated and new duplicates are made for distribution.

Because of the channel (or sleeve) arrangement, good duplicates are not optimum. Making contact prints through the sleeve does not put the unexposed duplicating film in direct contact with the master film. Two alternate methods, using the jacket principles, has been available to improve the print qualities. These are the pin-strip and the Molex arrangements.

5.1.1 Pin-Strip Method. To avoid the interferring sleeves in a microfiche jacket, the pin-strip method uses a metal frame with pins on the edge. The same strip of 16 m.m. film that would be stuffed into a channel of a jacket is stretched across the metal frame and pinned on the edge. This free floating arrangement of the 5-7 film strips can be reproduced in a contact printer without the interference of the channel layers of a microfiche jacket. Micro-publishers of catalogues and books find this very desirable

since the duplicate copies are of high quality, compared to a jacket, and updates and changes are still possible.

5.1.2 Molex Method. The Molex method also avoids the use of the sleeves (or channels) of the jacket system but uses a clear plastic single sheet carrier. Similar to a commercial artists lay-up board, the strips of 16 m.m. microfilm are placed on the clear plastic sheet and effectively glued down by the phenomena of "molecular adhesion."

Duplicates can again be made with an "emulsion-to-emulsion" contact producing high quality prints. Additions can be "pasted" on in any unused portion of the sheet. Deletions can be stripped off the sheet as well.

All the jacket type systems required the filming of the source documents first--as roll film, then handling the film (stuffing, pinning or pasting) to create the final fiche master. It is the handling of the strips of film (in some cases a single image) that is undesirable in any modern information system. The need for a better, automatic type solution is still needed.

5.2 Scott 200 System. The Scott Graphic Co. demonstrated at the last 2 National Micrographic Association conferences, their updatable, add-on microfiche systems.

The equipment is a basic step and repeat camera that produces 4" x 6" fiche in standard NMA 98 frame format. The heart of the system is the non-silver film they have developed. The film, known as Organic Photo Conductor (OPC), has the property of being re-exposed and re-developed allowing new images to be recorded in unused areas of the master fiche. In addition, overprinting can be accomplished to overlay words like "VOID", "CANCEL" etc. on an existing frame. The system does not erase any already exposed frame. It can only overprint an exist frame or add on a new frame in an unused area. It is properly classified as an "ADD-ON" system.

Scott Graphics and A. B. Dick have recently formed a new entity called A. B. Dick/Scott whereby the A. B. Dick Corp. would be responsible for the production of this equipment and Scott Graphics would retain the marketing and research function of the product.

With the use of a step and repeat camera, an operator can in one location, create a new fiche master, add a frame to an existing master, overprint an existing frame on a master. The multistep, manual process of microfiche jackets has been challenged by a central, semi-automatic process with the ease of adding on new frames and overprinting old frames.

Duplicates can be made from the master OPC as standard diazo, or vesicular, or silver films, so that the working copies are no different than any fiche copy used in present systems.

For those applications with the need for updating fiche, this method holds promising expectations.

5.3 MICROX System. Another available system that directs its efforts toward the updatable microfilm files is from a company known as the MICROX CORP.

The equipment used by Microx is also a basic step and repeat camera producing the NMA standard 98 frame fiche. The film master is also a non-silver film and is known as Photo Plastic Film (PPF). Developed in the research labs at General Electric, MICROX has the license to manufacture the film for commercial use.

The film operates by exposure to ultraviolet light which causes the electrostatic field on the film to alter in proportion to the light pattern. By placing the film over specified heat treatments, the plastic deforms and is set (like a thermo setting plastic). The deformations are viewed in a special reader (whose light path is oblique to the image). Since the image itself is not like the normal transparency, it cannot be viewed on a standard viewer. Prints, however, made from the master, are standard diazo or vesicular film and can be viewed in standard readers.

To erase a frame, in place, the frame itself is placed over a heat block which effectively melts the plastic flat in that area, resulting in no deformations--resulting in no image. A new image may be placed in exactly that frame, that has been flattened, by the same process of exposure and heat treatment--without disturbing the remaining frames of the fiche. Overprinting can also be accomplished resulting in an erasable, overprinting and add-on system. So now, a frame of information can be replaced, in the same place as the old information was located.

With such a system, the need for external indexing of where information is located is reduced since the pages will always remain in the same location.

Recently Microx and Bell & Howell have made an arrangement to commercially market the product and it is expected to be available to general industry by next year.

Now that the general industry possess all the technical tools to use microfilm in any form as part of an information system, it is only left to the creative imagination of the systems designers to find, for any given application, the optimal solution.

THE SYSTEMS APPROACH TO COMPUTER OUTPUT MICROFILM

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SUMMARY

The use of COM has been primarily based on the need to escape from the avalanche of paper emanating from computer systems and to minimise the escalating costs of printing, duplication and distribution. The scope for the systems analyst to apply his experience to the tasks to be 'dumped' to microform has been inhibited by the need to accept existing page layouts in order to effect the transfer from paper with the minimum of time and effort to maximise savings. However even within these limitations there are design options open to the analyst and these are identified and explored with a view to optimising benefits and cost savings.

With new or proposed computer systems analysts are in a position to optimise the many advantages of COM in output systems. The range of COM techniques and hardware features, together with the systems implications, are discussed.

The potential for developing novel output systems utilising the particular advantages of COM is discussed.

Before discussing the system design aspects of COM I must state that although I am a UK Civil Servant operating in the Central Computer Agency, the views expressed here are personal and not necessarily those of the Agency.

I would like to start with a word of caution: before considering the use of COM it is as well to remember that the clear ability of microforms to miniaturise bulky documents and reports can also be used to perpetuate the production and retention of unwanted and unnecessary material. Microforms should never be used as a substitute for a wheelbarrow and bonfire. To avoid this pitfall a thorough appraisal of the need for the stated requirement is a prerequisite of any systems study and can often result in the achievement of the largest savings of all - by eliminating the requirement!!

Accepting that a valid requirement exists and that COM offers a possible cost-effective method of meeting all or part of the task we then need to take a fairly basic decision. Is COM to be used as a simple line printer dump technique for converting an existing paper file to microform or is it to form part of a comprehensive system exploiting the advantages and minimising the disadvantages (often not discussed) of this novel technique. Often time constraints may dictate the former approach and in this case the system design work can be restricted to:-

(a) Decision for on-line or off-line COM. In view of the likely time constraints unless an on-line COM facility already exists within the organisation, off-line working offers the greatest flexibility with the wide range of devices and bureaux services offered. The main advantages stated for the on-line device is its lower capital cost and simplicity of operation in place of a line printer - its output on roll film being a direct facsimile of the line printer page.

(b) Choice of microfilm - roll film or fiche. The relative advantages of each have been dealt with by previous speakers but remember that this decision is a fundamental one not readily reversible. There appears to be a current fashion to use microfiche for all applications, but roll microfilm can be more cost-effective in certain areas and is always worthy of consideration. If doubts exist a short trial and demonstration to potential customers can often be a worthwhile investment. If on-line COM is being considered this will necessitate the use of roll film as no on-line fiche systems are available.

(c) Magnetic tape formatting. If an off-line recorder is to be used it will be necessary to organise the data in a suitable format on magnetic tape for COM recording. Here another decision has to be made - either to reformat the output using COM software on the host computer if the recording is to be by a basic 'dumb' recorder, or to use standard output tapes on an intelligent front-ended (mini-computer controlled) device. The choice is not a simple black or white decision but some of the factors to be considered are:-

(i) Is the host computer running time significant in the installation (ie is there spare capacity or is the system at full stretch already)?

(ii) Does the task involve large tape files or is it one to be repeated frequently? Large tape files may involve long reformatting times for dumb COM and it is often possible to use a systems tape in a packed format on less tape reels on an intelligent COM device. Where a job is to be run frequently (eg a daily accounts update) it may well be worth while to embody the COM reformatting as a module in the standard software output routines.

(iii) If the indexing and titling routines required by the task are complex can it be achieved on the more limited core store of the intelligent COM or does it require the larger capacity of the host computer.

(iv) How finalised is the output layout - or is it in the nature of a trial? Variations in layout can be achieved readily from the one output tape on the intelligent device but almost all changes on the dumb COM require a separate magnetic tape.

Whilst at one time the cost per thousand frames of COM output was considerably higher when produced on intelligent devices this is now not so (certainly in the UK) and any decision taken should be based on other factors. In addition the choice was at one time dictated by the machines available from the selected vendor or bureaux but it is notable now that all vendors offer an intelligent version of their product and most bureaux possess an intelligent device.

(d) Film processing. This is an area in which the systems designer plays only a small part. In the absence of professional knowledge or experience within the organisation the advice of the COM unit vendor is best taken. If the original camera film is to be used for viewing in the system an option of positive reading (obtained from conventional film processing) or negative reading (obtained by reversal film processing) is available.

(e) Type and method of duplication. The various materials and techniques currently available have been discussed by other speakers and in summary the choice here is between diazo and vesicular materials and between positive reading and negative reading duplicates. This is an emotive area and decisions have often to be made on subjective rather than objective information and one either takes other users experience or makes an intuitive judgement. Alternatively the user can be given the choice - current costings show little difference between the two materials and users will normally prove their own choice right (for them!!)

Choice of microfilm viewing and/or printing equipment

The selection of the hardware will require particular care and some of the systems design parameters are:-

(i) Choice of enlargement ratios - should the image be viewed over size, at nominal size, or can a reduced size image be used. An analysis of the user requirement is essential, covering the need for continuous or casual viewing, the ambient lighting, the desk space available etc.

(ii) Front or rear projection viewers - previous speakers have explained the differences and relative advantages but the systems designer may well have to consider the less technical but important factors for selling the system. Does the appearance of the viewer fit the environment eg rear projection viewers can look similar to computer Visual Display Units (VDUs) - front projection viewers - never. Is there a requirement to refer to external hard copy at the same time as microfilm viewing - some types of front projection viewers can make this easier.

So far I have dealt with the limited systems design parameters involved in the transfer of a paper file to Computer Output Microfilm utilising primarily the speed, compaction and ease of reproduction and distribution to save both time and money. Whilst this area of line printer dumping will always represent a significant proportion of the COM market it must from a systems standpoint be considered as an expedient rather than a systems solution. In directly transferring the output of a system designed for a line printer we are also transferring the drawbacks eg long record lines (because that gives the maximum output speed on a line printer).

I would now like to turn to the design parameters open to a systems analyst considering COM for a new or proposed system and to suggest some new approaches to output systems using microforms. Whilst some of the more basic features of COM have been dealt with in the previous section let us now consider the wider options available without the constraints of an existing line printer formatted magnetic tape.

(a) Format. COM is basically a character generating system and theoretically at least capable of producing an infinite variety of page sizes, line lengths and number of lines. In practice the emergence over the years of national and international standards has reduced the common options for business alpha-numeric recorders (as opposed to graphics recorders) to the basic 132 character line with 64 lines per page

- 8448 characters to the page, and up to 160 character line with 86 lines per page - 13760 characters to the page. It is as well for the analyst to be reminded at this stage that nothing in life is for free and in this case the increased character density is achieved only at the expense of smaller characters - effectively changing the nominal reduction ratio. On a standard 48 reduction microfiche the 160 character lines, 86 line page is nearer to 65 reductions in character size terms.

At this stage it would appear that on page layout we have merely exchanged the constraints of a line printer for a new set of COM constraints. So far as the production of microfiche or film to the standards is concerned this is largely true. However in closed loop systems when adherence to a standard may not be relevant or even desirable the analyst has much more freedom as most COM devices will accommodate a range of column and row arrangements on microfiche and allow a wide variation in frame sizes and spacing between frames on roll film.

Where layouts can be accommodated within existing standards (eg by placing two smaller pages within one nominal standard page) this is always to be preferred as the majority of microfilm ancillary equipment has been designed around the standards.

In the case of roll film page sizes these can be varied more readily and continuous abutting pages (scrolling) produced where desirable. Although the higher reduction ratios of 42X and 48X are available on roll film the analyst should bear in mind the problems of organising, retrieving, viewing multiple track images on roll film.

(b) Character styles - Here the improved design options open to COM users begin to show. Although alpha-numeric recorders are restricted to the one character style (or font as it is normally described) it is often possible to produce it in 3 ways, normal, bold or italic (ie sloped). In some cases the degree of boldness - usually achieved by re-imaging the same character - can be varied. Although on some machines the variation between italic and normal is not great the availability of three styles can be used to improve the appearance of the data, to highlight important sections and generally improve the readability of the material.

(c) Forms design and layout. The ability to use a form overlay in COM devices provides an opportunity to enhance the appearance of the output at a relatively low cost and to effect changes in a time frame not possible with printer output. For work not requiring sophisticated rulings or headings, simple boxed outlines or dotted horizontal lines at intervals to break up a large area of print, are available off the shelf from the majority of COM manufacturers.

A point to be remembered by the analyst is that most recorders have the ability to impose or suppress the overlay by software. However the use of more than one overlay on a COM run can involve serious time penalties in removing, inserting and possibly aligning new slides.

(d) Indexing and retrieval aids. The whole area of indexing and retrieval techniques has been dealt with in some detail and I will therefore confine my comments to general principles relevant to system design.

If the microfiche is conceived as a clean canvas with a grid layout on which the analyst can paint - the permutations of arrangements, title, column headings, row identification are limited primarily by the analyst's imagination.

It is possible to vary the titling in many ways - for instance reverse printing of the main microfiche title for emphasis and the use of eye readable characters for column headings, row identifiers or even on individual frames within a microfiche.

The microfiche does not have to be recorded as a series of finite pages, if the information is a continuous listing the unit of data could be one column with its own eye readable heading and the data running continuously from top to bottom of the column.

On roll film a similar variety of eye readable frames is possible but the scope for innovation in data layout is more restricted by the strictly serial nature of film - the primary choice being between cine and comic modes of recording.

(e) Software and hardware. This section could usefully be sub-titled 'to front-end or not to front-end that is the question' as the hardware decision to purchase or use an 'intelligent' or 'dumb' COM device will control many of the software options open. One consolation to the analyst is that the acceptance by the COM manufacturer of the modularity concept in design and construction means that most machines are enhanceable and that contracts can be negotiated with options for subsequent upgrading of a 'dumb' device by the addition of a mini-computer and its communications peripherals.

It is difficult to generalise on the parameters to be used for this intelligent/dumb decision but as a rough guide a few large and continuing tasks indicate a dumb unit and a wide variety of smaller and/or changing output tasks indicate an intelligent unit.

A major but non technical aspect may well be the organisational view on centralised or decentralised computer processing. If it is desired to restrict the spread of

small machines and concentrate the power on one mainframe with one programming language then 'dumb' or even on-line COM is the answer. If distributed processing is the fashion then 'front-ended' COM may well be seen as an intelligent computer subsystem which can be exploited to minimise mainframe involvement on output systems.

There is no one 'right' way and with external factors often dominant (eg company policy or the existence of COM facilities elsewhere in the organisation) the analyst may well find his way ahead already determined.

If the 'dumb' COM path is to be followed then the machine to be used or purchased must be selected and while this could be the subject of a separate session a few simple rules are:-

(i) Define clearly the output tasks to be performed - these should be formally written up and agreed with the user.

(ii) Produce output magnetic tapes for representative sample tasks and obtain satisfactory demonstrations from all serious contenders.

(iii) Ensure that adequate software for your computer system exists in a suitable form (eg magnetic tape, cards) to perform current and likely COM tasks.

For the 'intelligent' machine the above rules also apply but the question of available software assumes a far greater importance, particularly if the analyst foresees the transfer of some or all formatting functions from the mainframe to the mini. If, for example, tape editing or the unpacking of packed fields is required, the availability of a compiler for the mini may become relevant.

Throughout the design phase the analyst must remember that the object of the whole exercise is to satisfy, in a cost-effective manner, a user requirement. The user does not see the software or the magnetic tapes - he normally only sees the completed microfiche or roll film. It is therefore essential that the less glamorous stages of COM production, eg film processing and duplication, be subject to sound quality control at all stages.

It is regrettable that in many computer systems the output stages have been the most neglected area, resulting in badly laid out and poorly printed data on large unwieldy sheets of paper. One of the problems addressed by analysts has been the restrictive nature of line printer output and the need to use multiple carbon copies. Computer Output Microfilm provides the analyst with an opportunity to design an output system to match the sophisticated computer system from which the data emanates - providing he or she will take the trouble to learn about and use the range of facilities offered by this developing technique.

Exploitation of COM in output system design

Up to this point we have been considering the application of COM to meet a known and defined requirement. I would now like to discuss COM as an ADP output technique, to consider its virtues, and finally to examine how these might be used in novel output systems.

The main attributes of COM are

(a) The speed of conversion of machine readable data to human readable form either in words or line drawings.

(b) The ability to intermix text with drawings; on alpha-numeric machines by using form slides, on graphics machines by recording on the Cathode Ray Tube.

(c) The wide range of layouts available including page size, typographical fonts and spacing.

(d) High quality image with low cost duplication and distribution.

(e) Wide range of ancillary equipment including high speed printout on paper or production of paper plates for conventional printing.

Some examples of possible systems utilising all or some of these attributes are:-

(a) Concurrent publication on microfilm and paper - this method of publication permits a number of paper copies to be printed from printing plates produced direct from microfilm, to meet a known demand, and also for microform copies to be produced (at a lower cost) where desired. The master film can be held to meet future demands either by duplication on film, or by low level printout on microfilm reader/printers, medium level printout on production printers or for higher demands (eg a reprint) by production of further paper plates and off-set litho printing.

(b) Production of technical publications on microforms with both line drawings and text using typographical fonts, proportional spacing etc to produce high quality images in a compact form readily duplicated and disseminated at a low cost. A number of applications of this type of system are now appearing in the automotive industry.

(c) To provide a novel solution to the problem of providing a variety of output form types to a large number of customers each day, avoiding cumbersome multiple line printer runs and expensive manual sorting and collating of output for subsequent mailing. Using a graphics COM recorder it is possible to hold in the mini-computer core store a digitized version of a number of output form layouts including all the fixed text data (column headings, title, instructions and notes etc) which can be called on demand and displayed and recorded on film. The computer system COM output tape organised in customer order can produce first a name and address frame (for use as a label) and then call the form type required, completing the variable data (eg delivery dates, product, description, quantity etc) from the output tape. This process can continue until all the forms required for that customer have been committed to film - the procedure is then repeated for all customers. The resultant film is converted to paper on a high speed (80ft per min) production printer and the cut sheet output is now ready for mailing - in addressee order complete with address labels. The film can be duplicated if necessary and used for internal reference thus avoiding the retention of paper copies.

CONCLUSION

I hope I have demonstrated conclusively that COM is not just a convenient expedient permitting the production of large paper output files to be perpetuated, but that it is also an output systems tool of some sophistication.

Although representing the major interface with the user, computer output systems have often not truly reflected user requirements. This has primarily been due to the lack of flexibility of paper output devices and the need to sacrifice appearance and layout to maximise throughput. COM provides the analyst with a new high speed output tool with a range of options to help satisfy that most important element of any computer system - the user.

APPLICATIONS – ALPHANUMERIC

by

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We live in a fast changing world, one in which technological advances have become a way of life.

Commonplace are programmable shirt-pocket calculators capable of performing functions possible only on large scale computers a few years ago.

While consumers play "PONG" thanks to a microprocessor hooked to a TV set, scientists, after a 400-million mile Viking space voyage are chemically analyzing the Martian soil.

The foundation of this change primarily is routed in electronics technology, which has moved from the vacuum tube to large scale integrated circuits in 20 years. This development has restructured completely the fields of computation and communications.

The 2000 instruction per second computer of 1956 has been replaced by systems capable of 2 million or more instructions per second – an improvement of 1000 to 1. This dwarfs what we consider significant achievements in other industries. The SST, for example, is only 5 times as fast as its propellor driven counterpart of 1956.

Equally dramatic, and of far more impact on society is the 1000-to-1 decrease, during the past 20 years, in the hardware costs to perform a computing task. Last year, for example, tens of thousands modestly priced mini-computers were installed. Typically one of these provides the computing and storage capacity of large complex computers of the late 1950's. In aircraft terms, this would equate to buying today's 747 for the price of yesterday's Piper Cub.

The "bigger, faster, cheaper" aspects of computers are well known – and highly publicized. The computer industry has spawned – and users have absorbed – a bewildering series of computer generations, operating systems, languages, and concepts.

While these achievements are impressive, I question our understanding of their combined effects on the organizations they are designed to serve. Because it was fast and cheap, the computer system became the "central exchange" and "general warehouse" for much of the vital data used in the daily life of a business. More personalized lines of people-to-people communications have become replaced with ties to the "systems". The computer, in many cases, has become the hub of a spoked wheel of corporate communications.

Thus the data processing industry's vigorous and continuous pursuit of advanced systems designs – and management's acquiescence to their use – intensifies dependence upon this new method of corporate communications. As a result, the data processing industry must logically redefine its responsibility. Belatedly it must recognize a much broader role than "computing". Data processing is, in fact, now rapidly evolving into "information processing".

"Information Processing" has three major components:

(1) the acquisition of data and their transmittal to a central site,
(2) computing and information storage, and
(3) the distribution of information in a usable form to the end user.

In the past 15 years most of our emphasis and expenditure of resources has been devoted to the computing function. This has been a natural and necessary process. The computer became a way of life – accepted in many organizations as a vital function. As the computer industry pumped out increasingly more powerful and cheaper systems, enormous effort was required by the user to preclude his becoming technically overwhelmed and his computing resources from becoming economically obsolete.

For example in the transition from the tube to the solid state era in the 60's many users had no option other

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than upgrading. The maintenance on a purchased first generation vacuum tube machine often exceeded the combined rental/maintenance of a second generation solid state machine.

With noncompatible software the one-time reprogramming to accommodate upgrades was massive. Many users expended more software manhours in conversions and maintenance than in the application of new programs.

As the 70's unfolded, and significant strides were made in software compatibility from one machine to its successor, programmers were freed from predominantly housekeeping activities to production activities.

Added to this surge in programming availability were still more powerful systems. The result: a huge gap in our ability to compute versus our ability to handle related input/output functions. Data entry became a bottle neck and at the other end users became engulfed in a sea of hard copy.

The computing/electronics community, having helped create this problem, eagerly and confidently sought solutions.

In data acquisition, for example, key driven devices were improved. Optical character recognition equipment was made faster and more reliable. The advent of the micro-computer enabled automatic acquisition of data at its source – as in point of sale recorders, bank teller terminals, and automated equipment in manufacturing and distribution industries.

Paralleled developments in electronic communications made economically feasible the automatic transmission of much of this data to a central site. Some of the gap between data capture and computing capacity has been closed, and the future looks bright for continued improvements in the field.

Far more crucial is the enormous gap between computing and storage and the distribution of its end product – information. While early batch computers were often limited by their output medium, principally hardcopy printers, the system of the 1970's far outstripped distribution facilities. While computer power grew by the hundredfold, the line printer moved from 150 to 2000 lines per minute. Multiple printers produce impressive masses of paper – but as we have found, in many instances, not in adequate form to meet information distribution requirements.

The gap between information availability and distribution techniques will continue to grow. We can anticipate gains in printer technology (in particular page printing systems), remote terminals, and the communications systems to support them. Improvements in digital output technology, however, will be overwhelmed by the rapid growth in data bases available and the requirements for their dissemination. Several trends, already well established, lead to this conclusion.

(1) Our data bases (the warehousing function of the hub of the wheel) are cumulative in nature. Although most companies pursue vigorous file retention programs, the total amount of data continues to grow at an alarming rate. Tape libraries – non-existent 20 years ago – have grown to thousands, and in some cases, to hundreds of thousands of reels. It is interesting to note that one of the must successful areas for commercial software packages has been in computer programs to manage tape and disk file libraries.

(2) The need to make this information available, often in unorthodox forms, to a variety of end users continues to grow. Data availability is often the competitive edge in the business environment – from product design and specifications through customer service.

(3) Governmental regulations and new business practices have placed an enormous records retention burden on industry.

Consider, for example, the automobile manufacturer who must be able to notify owners of their cars that an unsafe condition exists because of faulty parts or assembly processes. Equally severe are the direct reporting and records retention policies placed on companies who are either regulated by governmental agencies or who do substantial governmental contracting.

In addition to the expanded reporting requirements of the IRS, EEOC, OSHA, etc., these companies must maintain, in a rapidly retrievable form, detailed records on virtually every aspect of their business. "Rate cases" and contract negotiations extend for years after the fact.

Recently four US Shipyards and the US Navy have been in active negotiation to settle over 1.5 billion dollars in claims, many of which are tied to the effects of detailed contract changes made by the Navy over five years ago. Detailed proof of the effect of design changes and construction schedules over a five year period is necessary to support such claims. A California manufacturer, dealing primarily with the government, generated paper documentation which physically weighed more than their product prior to conversion to microforms.

(4) There has been an increased awareness of the value and significance of data – particularly in areas of advanced technology. No better example exists than that of nuclear power plant construction. A single

power plant involves 6 to 10 million documents – all potentially significant. Here, for the first time the data processing community has been forced to recognize its limitations in capacity and economics. There appeared to be no viable way of digitizing, indexing, and distributing the various documents. These, in addition to sheer magnitude, encompass many form charts, reports, works and personnel records, video recordings, instrumentation recording, etc. Although a complete solution to this individual problem has not yet been developed, it will lie outside of computing technology as we know it today.

Again, as with input, it seemed logical to turn to the "electronics" industry to solve the problem of distribution of information. Data are available at the computer, and the computer's logic could be used to index and locate information as required. Thus improved storage, computing, and data transmission facilities recently led to the accent of the "on-line" system.

In many cases, the on-line approach has met real user requirements economically. Airline reservations systems are the most widely notable example. These systems legitimately require:

(1) immediate availability of information,
(2) the indexing and search capability of the computer, and
(3) the logic of the computer to make a decision.

And airlines pay dearly for this capability.

In many instances, however, the on-line or "electronic distribution" system has not totally solved the total information distribution function:

(1) In spite of improvements in technique, equipment, and communications facilities, the equipment and operating expenses of on-line systems are very high – particularly where multiple users must have access to large volumes of data.

(2) Both the software and systems support necessary to support a true "on-line" system are enormously expensive and complex in context with the functions they support. Oftentimes the full extent of this cost is not recognized. Typically the incremental portion of an OS cost, applicable to online operations, is buried within the total operating system cost.

It is clear that the data processing community must make use of more than computer technology if it is to adequately serve its rapidly emerging role as the manager of information. What is needed is an integrated systems approach using multiple technologies – IN WHICH EACH TECHNOLOGY HAS ITS ADVANTAGES EXPLOITED AND ITS DISADVANTAGES MINIMIZED. There are a number of technologies which are proven, integrated into systems, and in use today, which should be considered by the systems designer as he approaches an application. Graphics, video storage and retrieval, and microforms are among these.

Of these technologies, the most advanced in COM: computer output to microfilm. COM's history has been very similar to that of the computer industry. In its first generation, roughly through 1970, its growth was limited by hardware, software, and knowledge in its use. Early applications, often sponsored by Records Management groups, supplemented or occasionally replaced the line printer. COM's advantages were obvious. Despite the fact it introduced a new medium to the data processing community, it gained increasing acceptance and use. First generation users saw in COM a fast cheap printer and a duplicating function.

- We are all familiar with the paper replacement benefits reaped through COM. For example, a statewide health insurer with approximately 560,000 members, and processing 3500 claims daily, finds that with COM their storage space requirements have been reduced 90 percent. Daily claims processing would generate more than 1000 pages of hardcopy. They now generate only five 4" x 6" fiche.

Retrieval time to answer requests for information regarding policies is down by one-third. And the insurer saves over 100 hours of valuable computer time monthly.

- A manufacturer of electronic parts for aircraft recovers 80 hours of CPU time monthly on its 370/125 with its COM. The alternative was an expensive computer upgrade as CPU usage was approaching 400 hours monthly in this three-shift shop.

Hard copy amounting to 65 feet of net filing depth monthly is now contained on a stack of fiche measuring only inches in height.

More than $1700 is saved monthly, as paper form costs of $17 per thousand have been reduced to $3.30 per thousand with film.

Most importantly, material control coordinators in this huge manufacturing facility now use local viewing stations instead of having to walk half a block to reference central hard copy binders.

- An east coast city of 900,000 population solved its paper bottleneck by COMing its hospital, retirement, water service, payroll, education and voters registration records.

Just one of these reports in hard copy used to require approximately 40 hours of CPU time and is now produced in less than 9 hours.

Copies which used to cost $45 per thousand on hardcopy now cost only $5 per thousand with film.

Previously the city literally "warehoused" paper records. Now they are contained in one cabinet and record storage space has been converted to much needed office space.

- A medical test laboratory finds that with COM its 8,000 daily medical tests, which used to generate a five-foot high stack of paper, are now confined to a two-inch stack of film.

Resulting savings in film costs vs. paper amount to more than $300 daily.

Because of a legal seven-year retention requirement for medical test records, a separate building would be required to warehouse records with the prior paper system.

A monthly transaction list, which used to require 12 hours of CPU time, is now printed in less than one hour.

Yes, paper replacement, or phase I COM testimonials, are well established. What about COM's second generation, which has been evolving during the past five years?

An increasing body of users – now sponsored by data processing – have become aware of COM's enormous potential when it becomes an integral part of a systems design. The inherent advantages of COM – speed, cost, ease of distribution – have been integrated with the data preparation and indexing capabilities of the computer. Large, inexpensive data bases are distributed to individual users – indexed to support the retrieval needs of individual users. In this environment, where the combined advantages of both computer and microform technologies are fully exploited, many companies have realized very powerful systems providing logically distributed information at modest expense. Consider, for example, Preferred Risk, headquartered in Des Moines, Iowa and organized in 1947 as America's first insurance company to underwrite automobile coverage for non-drinkers. Only total abstainers qualify for a Preferred Risk automobile policy. In addition the company offers fire, home owners and other property and coverage. A mutual company, Preferred Risk's premium income in 1975 was $53 million. It insured 250,000 fire and casualty policy holders when it adopted COM.

Preferred also assumes little financial risks in managing its customer information.

Let's briefly explore the development of their system. As many of you know, there are several typical methods employed by fire and casualty companies when retrieving information to an agent or policy holder request.

Traditionally, you can request a policy folder – a time-consuming process. In addition, it requires constructing current policy status from many individual papers – an invitation to inaccuracy. However, folders restrict access to policy information to one person and thus one department at a time.

You can scan a transaction list – a list, for example, of all policies in premium arrears. Obviously, this alternative may not represent fresh information – premiums may have been paid on some policies since the last batch list.

Or in some installations you may request a computer printout of policy status. Again a major problem: your answer, available the next day, typically will appear in abbreviated form and therefore may not be complete.

And, of course, assuming an online, and expensive computer you may initiate an inquiry through a terminal and gain an immediate answer. Again problems exist: the data is skeletonized – it's not uncommon, therefore, to revert back to archival days and also request a policy folder for historical information – in effect relying on two systems.

In Preferred Risk's preCOM days personnel could request the policy file folder but also could exercise an option to request a computer printout of policy status (available a day later).

Typically, there were problems management was anxious to eliminate:

- Too often a policy was not available from central files. Someone else was using it.
- The inevitable misfiles of any central filing system results in lost files, or at best, delayed retrievals. And again, typical of paper records, individual documents could become misplaced within the folder, and occasionally without the folder, also delaying disposition of a request.
- As in any labor intensive system, clerical costs were high.
- File updating was cumbersome. A file could be "out" when a change notice is received.
- Furthermore audit trails were difficult to accomplish.
- Space was becoming a critical factor.

- Policy history information, often required when dealing with an agent or the insured, was available only by reference to the policy folder . . . and then by time-consuming reconstruction.

Given these problems, Preferred Risk management established objectives for a new system. In essence, any new system must render information contained in a policy file in a format that is:

- readily accessible,
- easily understood,
- current, and
- cost justifiable.

Certain constraints were also placed upon their contemplated system:

- it must be simple with a minimum of conversion effort,
- incremental equipment and programming costs must be minimal, yet
- labor costs had to be reduced, and
- retraining of personnel could not pose serious problems.

In the approach taken, the first step was not simply to evaluate alternative systems and related equipment.

Although during recent years the company gradually expanded the ratio of coded to uncoded information in its data base, an analysis revealed that further coding would yield added efficiencies. Efforts in this regard resulted in a data base containing approximately 85 percent coded to 15 percent uncoded information.

The implications were enormous. By increasing codeable, thus computerized information, to 85 percent, Preferred Risk estimated that requests for policy status information answered by computer by-products could increase from 92 percent to 97 percent. And similarly requests requiring physical reference to policy folders could be reduced from eight to three percent.

The 63 percent decrease in manual retrieval and filing results in impressive and recurring savings in clerical overhead.

If more reliance was to be placed upon computer byproducts the question then faced was a choice of systems: upgrading the batch computer with online capabilities or adopting COM.

Typically, data processing costs in the fire and casualty industry run from 2 to 2.5 cents per premium dollar in predominantly batch installations. In predominantly on-line installations, processing costs average 3 to 5 cents of premium income.

Furthermore, on-line costs tend to be understated. On-line installations usually transfer data entry costs to using departments, e.g. underwriting, claims, etc. A check by Preferred Risk of major property and casualty companies using on-line computers revealed most of these carriers still extensively pull policy folders.

Preferred Risk's eventual choice of COM typically fit the cost profile. The existing batch computer operation cost 2.5 cents per dollar of premium income. COM added 1/4 cent to the costs, but resulted in operation savings of 1/2 cent.

The net savings equates to $250,000 or close to one dollar per outstanding policy. And, like an annuity, this dollar per policy saving occurs annually!

Predictably, the on-line option was estimated to cost 4.5 percent of premium income. Implicit in Preferred Risk's operational savings with COM is better utilization of its computer. Prior to COM, computer use was approaching capacity limits – the threat of a computer upgrade was imminent.

Usage was peaking at 94 percent during the evening shift, clearly not allowing much time for housekeeping. The heavy nighttime use was due to the processing of prior day shift requests for policy information in order that resulting status printouts would be available by the next morning.

Since policy information is originally computer-filed – its electronically eligible for transfer to film. Thus information is available at using departments. Thus data entry departments are not burdened with excessive and costly requests for information. Thus the evening shift is relieved of excessive request processing.

Preparation of COM film is typically offline from the computer. It's automatically prepared from computer tape. The computer outputs at tape speeds, 10 times faster than Preferred Risk's impact printer speeds. And computer usage is less skewed: peak load during an evening shift is down to 85 percent. And the life of a 370–135 has been extended in lieu of opting for a more expensive 370.

As a result of a five year plan of applications has been totally computerized on a mainframe *thought* to be inadequate three years ago!

And the perennial growth in the DP budget finally was arrested.

Furthermore, Preferred Risk's data base was refined, a prerequisite for an effective COM or on-line operation.

The microfiche system used at Preferred Risk is updated via the index sequential system.

An index sequential system design is frequently used to simulate an on-line system. It minimizes costs by only outputting records that have change. The latest version of the complete record is located by consulting an index which is produced each time the file is updated.

The Preferred Risk experience suggests that managers of information pause before thinking automatically that on-line systems are a logical upgrade. COM, logically integrated with computer systems, as we have seen, provides economic solutions to information distribution in realistic time.

Industries are saturated with companies that potentially can realize savings similar to Preferred Risk. And the transition of many countries from an industrial base to a service society accelerates this phenomenon.

In 1970, in the US for example, 48.3% of the labor force was white collar, up from 37.5% in 1950. As this trend continues, a similar percentage of blue collar workers are creating the production base that supports white collar workers.

Interestingly white and blue collar domains historically have approached the subject of productivity differently. The office spends an average of $2,000 on capital equipment per employee only. Factories, on the other hand, spend $25,000 per employee.

Blue collar workers, existing in an industrial engineering environment, increasingly have seen their efforts supported by machines. This has been accompanied by increasing productivity per employee and reduced labor content in end products.

White collar executives, on the other hand, have "pyramided" tasks and, as a result, more people continue to report to them rather than less.

Ironically, today's office, with its burgeoning work force, uses filing systems that basically were designed 100 years ago. Current white collar workers no longer visualize filing and finding as an "in-pursuit". No wonder the executive frustration when trying to find immediately important documents and, likewise, clerical distress experienced by those responsible for retrieving documents.

The need to achieve office productivity has never been more acute. We are indeed fortunate that the marriage of computers and micrographics provides the tools that enable the application of industrial engineering principles to the office.

The beginning of COM's third generation, which we are experiencing now, is closely tied to the most recent advances of the computer industry: the development of the mini computer and emerging distributed processing systems. Rapidly declining computer prices permit the physical as well as logical marriage of COM and computer disciplines. Automatic COM retrieval devices, indexed and physically driven by mini and micro computers can access fiche data bases, containing analog and digital information. This offers an unparalleled opportunity to exploit both computing and COM technologies to their fullest.

Some devices of this type are commercially current and in active use. Inexpensive distributed mini computers with disk storage provide convenient and rapid accessibility to files of up to a million pages. Flexible indexing, under enhancement as the power of mini computers grows, can be tailored to individual user requirements.

With the third generation of COM, other areas of opportunity for better servicing the "information processing" function begin to emerge. In many cases, we have badly warped existing systems in order to digitize information required by the end user, but not used in computation or indexing. With an integrated system approach a smaller percentage of the total data required needs to be converted to digital form. And data, which cannot presently be digitized – such as photographs and maps – can be readily added to information bases and distribution networks. Converted directly to microforms, original documents need only that part of their contents digitized that is necessary for their retrieval and computation.

Such an approach directly enhances all components of information processing:

(1) reduced time, cost, and complexity of data entry, standardization efforts, if any, in this vital and important area,

(2) reduced cost and complexity of the central computer system, and

(3) obvious improvement in the information distribution function.

Though the second generation of COM advances have yet to be explored by most users, it is in fact a reality with proven credentials. And COM's third generation is emerging.

Thus we, connected with COM, *are* closing the output gap. And, in doing so successfully, are earning additional managerial responsibility for data flow and communications.

COM APPLICATIONS - GRAPHIC

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SUMMARY

With the advanced design of today's Computer Output Microfilm recorders the possible applications for use are almost limitless. Nearly any symbol, or character can be created. Where the high speed computation capabilities of the computer and the excellent storage and retrieval capabilities of microfilm can be used, the graphic COM recorder can do the job best.

Application areas range through business, finance, engineering, graphic arts, printing, publishing, education, and scientific research.

The types of recordings range from charts and graphs of financial records, engineering drawings, chemical reports, and satellite recordings, to color charts, printed circuit masters and animated movies.

The original Computer Output Microfilm unit was a graphic type unit. Scientific data at the time could be processed at a very rapid rate but there was no way to efficiently preserve the information. Plotters were very slow. However since there was the need for abundent information, the scientists would sit before a cathode ray tube display and try to analyze the information on a real time basis. Finally the concept of photographing the CRT face and preserving the information for later analysis was considered. Since that time there has been a constant improvement in the equipment until today any image possible to be created by the computer and displayed can be recorded on film. The development of software for controlling the computer and the COM has made possible information processing that is not able to be done in any other way.

The scientific community continues to find the graphic Computer Output Microfilmer a valuable tool. Data is evaluated and graphed in many diverse ways such that complete analysis is possible. The recording and duplicating of information allows distribution to many other scientists for their evaluation and comments. Medical hypotheses can be made and compared with existing data.

Communications from satellites need to be recorded. A most efficient method is the use of COM. Often the data needs wide distribution and microfilm copies makes that easily possible. When the United States was sending men to the moon there was an immense amount of data being collected and sent back to earth. It was determined that a COM graphic unit was better able to record this data directly than any other means.

Engineers, architects, and designers have found COM to be of great value. Computer Assisted Design (CAD) is an ever more popular approach to design. The ability to rapidly place this information on film for duplication, distribution or enlargement increases the value of the system. Design of tools, mechanical parts and even auto bodies has been done by computer and using COM has made possible many needed comparisons of alternatives.

An interesting design concept and one in which the microfilm was not used primarily as an information storage and retrieval tool involved women's dress design. A design of a new line of women's dresses can be entered into the computer. Programs are developed to relate the various characteristics of the design to the various sizes of dresses that might be needed. When the computer has carried out the computation of design all of the various sizes are recorded on 35mm film. The film can then be placed in a photographic enlarger directly over the material to be cut. The pattern is followed for each of the many sizes needed.

A method of improving the dissemination of documentation associated with engineering drawings was needed. That documentation which related directly to engineering drawings regarding changes etc. has previously been distributed in paper form, while in large installations the drawings themselves have been distributed on aperture cards. This often resulted in the drawings arriving many days before the associated material. The approach taken was to place the associated documentation as multiple pages on a single 35mm film chip in an aperture card and distribute all of the information together. Graphic COM has the capability of exposing these eight to twenty pages as a single image.

A wide spread use of graphic COM is in the creation of maintenance manuals. It is possible to combine the data with sketches, drawings and charts. With a CIM unit that is capable of scanning and converting the graphic material into computer information, page structuring can be accomplished rather easily.

Other reports requiring large distribution are generated on COM. Those requiring special characters such as mathematical and chemical symbols can use graphic COM. This is very appropriate in the chemical and pharmaceutical industries.

In the field of finance extensive data is collected regarding activities of business. The most understandable form for this information is as graphs which shows trends. A solution to this recording problem has been the graphic COM.

Business management is often conducted more efficiently using PERT charts. The value of such charts is related to how current the information is. Using graphic COM these charts can be up-dated practically

immediately. Many other graphs and charts are used in plotting operations. Color capability, which high quality COM units have, increases the value of these charts.

The field of education has found the graphic COM able to do the job of making animated movies better than any other method. Principles of electricity, thermodynamics, and nucleonics can be demonstrated best by animation. COM provided the easiest controlled system for making the movies.

Although we look at microfilm as a storage and retrieval device there are other possible uses for the medium. Another one of these is the use of graphic COM generated film as an intermediate for production of printed circuits. There are several advantages to such a system versus convention manufacture of circuit boards. One can save on draftsman time and particularly turn-around time. One can produce quickly and inexpensively a single board for test and evaluation before going into production. One can also use a variety of manufacturing methods since the microfilm can be enlarged directly to the board or to an intermediate.

As we discuss intermediates a major use of graphic COM is in the making of offset masters for printing. There is a portion of the printing business which wants quality printing but does not need high quality printing. This has been called the area of utility printing. There often is also a need to up-date the information on a scheduled basis. A typical example would be a telephone directory. The system adopted uses the computer to format the material, a graphic COM to produce 35mm images of the pages, an enlarger-printer to make an offset master, and then an offset printing unit. This concept has spread to such items as technical manuals, illustrated parts catalogs, and airline guides.

In the area of micropublishing the use of graphic COM is expanding. For internal publication, for sales and maintenance information and for frequently changed publications the concept of microfilm has been accepted. If one is to use microfilm, the highest quality product is obtained by graphic COM. A second consideration is now being examined. The ease of reading microfilm images is a function of the quality of image, and quality of reader. The characteristics of the image might better be different than the image produced for paper. If a slightly different font or letter spacing can make reading microfilm easier, it is the graphic COM which can produce this result.

A number of applications have been discussed primarily to give general ideas. Each field of activity has its own needs. If careful analysis is made of these needs it will probably be determined that a graphic COM can produce images representing information formulated by a computer better than most any other method.

BIBLIOGRAPHY OF MICROGRAPHICS

RR 2 – January 1976

Prepared by National Micrographics Association
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This bibliography represents a selection of publications, from 1966 to 1975, covering many aspects of micrographics. The items are listed chronologically, using the same numbering system as NMA's *Micrographics Index*, with the first two digits representing the year of publication. Entries have the same accession number in the *Bibliography* and in the *Micrographics Index*. Entries are indexed according to subject again using the same system as the *Micrographics Index*. Additional information on the content is provided in the brief annotation which is a part of each entry. The bibliography does not include journal articles. These, together with additional books, pamphlets and reports, can be found in the *Micrographics Index* and its *Supplement*.

As the literature on micrographics grows, the character of a brief bibliography must change from a relatively complete listing to a sampling of the material available. This Resource Report provides such a sampling. The *Micrographics Index* is designed to provide a cumulative and comprehensive information base, with supplements or updates appearing each year.

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This manual, designed as an introduction to microphotography for archivists, defines the various types of microforms and their respective advantages and disadvantages. Microfilm equipment, archival operations, and storage and maintenance are also discussed.

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This concise review discusses microfilm uses in business, government, science, industry and education in non-technical terms.

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The book defines the technical information problem, discusses solutions, and shows how an effective information program can enhance the operating efficiency and economy of an organization.

69-0064 Kottenstette, James P., AN INVESTIGATION OF THE CHARACTERISTICS OF ULTRAFICHE AND ITS APPLICATION TO COLLEGES AND UNIVERSITIES. Denver, CO: University of Denver, 1969. 239p. Microfiche $.65, hardcopy $9.87. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 032 447.

Begun as an investigation of ultrafiche, this study developed into an evaluation of microform usage in general. The study attempted to identify factors causing negative attitudes and to develop an outline of measures for improving acceptance.

70-0046 COMPUTER HANDLING OF GRAPHICAL INFORMATION. Washington, DC: Society of Photographic Scientists and Engineers, 1970. 278p. $11.00. Available from Society of Photographic Scientists and Engineers, 1330 Massachusetts Avenue, NW, Washington, DC 20005.

These 18 papers cover graphic input techniques, interactive computer graphics, computer-microfilm interface, and computer output techniques.

70-0047 AN INTRODUCTION TO COM (COMPUTER-OUTPUT-MICROFILM). Bethesda, MD: Dataflow Systems, Inc., 7758 Wisconsin Avenue, Bethesda, MD 20014.

This description of the basic elements of a COM system includes appendixes listing manufacturers of COM recorders and service bureaus, as well as a 71-item bibliography.

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This handbook is designed to provide the prospective user or purchaser of microform retrieval equipment with a basis for comparing available equipment. An appendix lists equipment manufacturers and distributors.

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This booklet presents guidelines, based upon approved standards and practices, for selecting and preparing records for microfilm publication, to help ensure the archival quality and usefulness of the publications.

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70-0055 Giles, Louise, A RESEARCH PROJECT TO DETERMINE THE STUDENT ACCEPTABILITY AND LEARNING EFFECTIVENESS OF MICROFORM COLLECTIONS IN COMMUNITY COLLEGES. Washington, DC: American Association of Community and Junior Colleges, 1970. 248p. Microfiche $.65, hardcopy $9.87. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 040 708.

This report on Phase I of a three-phase project covers the planning and methodology and selection of course materials to be microfilmed.

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This basic micrographic handbook is designed to provide information and assistance to educational institutions in planning effective applications of microform systems.

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A study of microform state-of-the-art and current research led to the development of two microfiche storage and retrieval systems, one for small users and one for higher volume users.

71-0063 LIBRARIES AND INFORMATION TECHNOLOGY: A NATIONAL SYSTEM CHALLENGE. A Report to the Council on Library Resources. Washington, DC: National Academy of Sciences, 1971. 84p. $3.25. Available from National Academy of Sciences, Printing and Publishing Office, 2101 Constitution Avenue, NW, Washington, DC 20418.

The report discusses current problems in the development of effective information systems and makes recommendations for future directions, with emphasis on the importance of making information available on microforms and coordinating microform with computer technology.

71-0064 Avedon, Don M., COMPUTER OUTPUT MICROFILM. Silver Spring, MD: National Micrographics Association, 1971. 232p. NMA members $7.50, non-members $10.00.

An overview of the COM field is provided, including a general review of COM technology, state-of-the-art summary, equipment guide, systems service company directory, review of several COM applications, results of an NMA survey of the COM field, and a glossary of terms.

71-0065 WHAT COM IS ABOUT. San Diego, CA: Stromberg-DatagraphiX, 1971. 18p. Free. Available from Stromberg-DatagraphiX, P. O. Box 2449, San Diego, CA 92112.

Diagrams, charts, and drawings illustrate COM processes and potential cost savings.

71-0066 Gordon, Ronald F., 16mm MICROFILM VIEWING EQUIPMENT GUIDE. Alexandria, VA: Defence Documentation Center, 1971. 92p. Microfiche $1.45, hardcopy $4.75. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151, Order number AD 718 000.

This descriptive directory of 16mm microfilm readers and reader-printers manufactured or distributed in the U. S. includes photographs and detailed specifications for each model.

71-0067 ADMISSIBILITY IN EVIDENCE OF MICROFILM RECORDS. Rochester, NY: Eastman Kodak Company, 1971. 116p. NMA members $6.00, non-members $10.00. Available from National Micrographics Association.

An authoritative source book on the legal aspects of microfilm reproduction of public and business records. Two appendixes are included – Summary of State Statutory Schemes and Table of Symbols, and Summaries of Statutes by States.

71-0068 MICROFILM: SEARCH FOR AN IMAGE. New York, NY: Quantum Science Corporation, 1971. 132p. $275.00. Available from Quantum Science Corporation, 245 Park Avenue, New York, NY 10017.

An analysis of present market and predicted growth by product and by application includes an outline of the biggest companies and a discussion of the competition with other media.

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The booklet covers the evaluation of all aspects of micropublications except their subject content, and includes micro-formats, film types, archival permanence, and resolution charts.

71-0070 Nelson, Carl E., MODERN DRAFTING TECHNIQUES FOR QUALITY MICROREPRODUCTIONS. Silver Spring, MD: National Micrographics Association, 1971. 38p. NMA members $3.50, non-members $5.00.

This book provides basic guidance for the preparation of drawings to be microfilmed. It covers materials, character font and size, spacing, and reduction and enlargement ratios. A discussion of standards includes a table comparing the provisions of government, national, and typical company standards.

71-0071 Costigan, Daniel M., FAX: THE PRINCIPLES AND PRACTICE OF FACSIMILE COMMUNICATION. Philadelphia, PA: Chilton Book Company, 1971. 270p. $10.00. Available from Chilton Book Company, 401 Walnut Street, Philadelphia, PA 19106.

FAX, the system by which anything in graphic form can be transmitted by radio waves or wire from one place to another, is discussed in depth, from its origins to its present status and the possible future developments. A list of the available commercial hardware and systems is included.

71-0072 Bernhardt, Homer I., AN OVERVIEW OF MICROFORMS: A REPORT OF THE ROLE OF MICROFORMS IN THE UNIVERSITY OF PITTSBURGH LIBRARIES. Pittsburgh, PA: University of Pittsburgh, Graduate School of Library and Information Sciences, 1971. 39p. $3.00. Available from University of Pittsburgh Book Center, 4000 Fifth Avenue, Pittsburgh, PA 15213.

A brief review of micrographic basics precedes a study of the types, formats, sizes and quantities of microforms held by the 25 libraries in the university system and the methods used for storing and handling them. Appendixes include an outline of costs for converting 30,000 microfilm reels to cartridges and a suggested standard format for reporting microform statistics.

71-0082 Aleamoni, Lawrence M., and others, THE EFFECTS OF USING COLOR MICROFICHE UPON ACHIEVEMENT IN A COURSE ON INTERIOR HOME DESIGN. Urbana, IL: University of Illinois, Office of Instructional Resources, 1971. 14p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 057 592.

The document describes an experiment which found no significant correlation between the amount of time spent on studying microfiche and achievement.

71-0083 Allison, V. M., and Frederick E. Sperry, THE DYNAMICS OF MICROFILM. Milwaukee, WI: University of Wisconsin, 1971. 42p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 051 651.

This paper describes the University's use of COM in the Office of Admissions and Records.

71-0084 Gaddy, Dale, A RESEARCH PROJECT TO DETERMINE THE STUDENT ACCEPTABILITY AND LEARNING EFFECTIVENESS OF MICROFORM COLLECTIONS IN COMMUNITY JUNIOR COLLEGES. Washington, DC: American Association of Community and Junior Colleges, 1971. 72p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 071 662.

This study found that five microform variables – mode, access, content, format, and image polarity – had no significant effect on student learning, and also confirmed that students using microforms learned as well as those using hardcopy.

71-0085 Grausnick, Robert R., and others, MICROFORM USE IN A TECHNICAL TRAINING ENVIRONMENT: AN EXPERIMENT. Denver, CO: University of Denver, May 1971. 80p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 056 484.

The study compares the use of hardcopy and microfiche in a technical training course and finds no significant learning difference. The subjects preferred negative microfiche and experienced no eye fatigue.

71-0086 Grausnick, Robert R., and James P. Kottenstette, A PERFORMANCE EVALUATION: MICROFICHE VERSUS HARDCOPY. Denver, CO: University of Denver, 1971. 62p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 056 483.

The authors found no significant difference in training subjects' performance from the use of hardcopy, positive microfiche or negative microfiche.

71-0087 Kottenstette, James P., and others, A GUIDE TO INSTRUCTIONAL USES OF MICROFORM. Denver, CO: University of Denver, 1971. 91p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 056 485.

The guide provides background information on microforms and guidelines for their use in an educational environment.

71-0088 Kottenstette, James P., and Robert R. Grausnick, AN INVESTIGATION OF THE ENVIRONMENT FOR EDUCATIONAL MICROFORM UTILIZATION. PHASE I: STUDENT USE OF CLASSROOM MICROFORM IN SUPPORT OF A SURVEY COURSE. Denver, CO: University of Denver, 1971. 45p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 050 603.

Positive student response resulted from a controlled experiment in which the assigned readings for a graduate study course in information science were microfilmed and made available to 11 students, together with individual microform readers for home use.

71-0092 Reilly, Raymond E., and C. L. Tipton, MICROFORM DISPLAY PARAMETERS AND SYSTEMS IN THE SHIPBOARD ENVIRONMENT. Fairfax, VA: Psytronics, 1971. 164p. Microfiche $1.45, hardcopy $3.00. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151. Order number AD-740 886.

This document reports the results of two experiments to determine the effect of various parameters on the legibility of rear-projected displays. Additional sections contain a survey of available equipment and a discussion of potential shipboard applications.

71-0094 Reintjes, J. F., and others, MICROFILM VIEWER EXPERIMENTS. Cambridge, MA: M.I.T., 1971. 70p. Microfiche $.65, hardcopy $3.29. Available from ERIC Document Reproduction Service, Computer Microfilm International Corp., 2020 N. 14th Street, Arlington, VA 22201. Order number ED 051 671.

This report describes two new designs for front-projection microfilm viewers – one a desk-top reader and the other a "mini-theater" design.

71-0096 OPEN FORUM: MICROPUBLISHING OF GOVERNMENT INFORMATION. Washington, DC: Information Industry Association, 1971. 39p. $3.00. Available from Information Industry Association, 1025 15th Street, NW, Washington, DC 20005.

Three speeches represent three points of view on the Government Printing Office micropublishing program – a librarian's, an information publisher's, and a micropublisher's.

72-0065 Chambers, Harry T., COPYING, DUPLICATION AND MICROFILM: SYSTEMS AND EQUIPMENT FOR USE IN BUSINESS ADMINISTRATION. Boston, MA: Cahners Publishing Company, 1972. 176p. $9.95. Available from Cahners Publishing Company, Inc., 89 Franklin Street, Boston, MA 02110.

In a survey of all aspects of copying from available systems to installation costs, the processes discussed range from duplicating to the use of microfilm and computers.

72-0066 GUIDE TO RECORD RETENTION REQUIREMENTS. Washington, DC: Federal Register, 1972. 91p. $1.00. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

This is the revised edition, in digest form, of a guide to the provisions of Federal laws and regulations relating to the keeping of records by the public. It tells the user what records must be kept, who must keep them, and how long they must be kept.

72-0067 Reichmann, Felix, and Josephine M. Tharpe, BIBLIOGRAPHIC CONTROL OF MICROFORMS. Westport, CT: Greenwood Press, 1972. 245p. $12.50. Available from Greenwood Press, Inc., Publishing Division, 51 Riverside Avenue, Westport, CT 06880.

Guidelines for bibliographic control on all levels and recommendations for alleviating present problems are presented, along with methods and procedures.

72-0068 MICROFILM SAVES MONEY. Belfast, Northern Ireland: Microfilm Association of Great Britain, 1972. 50p. MAGB members £2.00, non-members £2.50. Available from *Microdoc*, Science Library, Queen's University, Belfast BT9 5EQ, Northern Ireland.

Papers presented at a seminar held by MAGB in December 1971 deal with case histories in commerce, industry, local government, libraries, and accounting.

72-0069 Rice, E. Stevens, FICHE AND REEL. Ann Arbor, MI: Xerox University Microfilms, 1972. 22p. Free. Available from Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, MI 48106.

Although it was originally prepared to answer questions on micropublishing, this pamphlet covers most of the basics of micrographics, including microformats, reduction ratios, retrieval, and density and resolution.

72-0070 AUERBACH ON COMPUTER OUTPUT MICROFILM. New York, NY: Mason and Lipscomb, 1972. 152p. $10.00. Available from Mason and Lipscomb, Petrocelli Books Division, 384 Fifth Avenue, New York, NY 10018.

COM information is provided, beginning with its early history and describing the advantages, systems considerations, and technology. An extensive glossary and list of COM manufacturers are included.

72-0073 Lukac, George J., ed., COPYRIGHT – THE LIBRARIAN AND THE LAW. New Brunswick, NJ: Rutgers University Graduate School of Library Service, 1972. 210p. $3.95. Available from Rutgers University Press, New Brunswick, NJ 08903.

This presentation of the conflicting points of view about the permissible extent of photocopying contains the text of speeches presented at a symposium.

72-0074 Myers, John M., MICROPUBLISHING FOR THE BOOK PUBLISHER. Alton, England: Microinfo, 1972. 60p. $250.00. Available from Microinfo Ltd., The Post House, High Street, Alton, Hampshire, GU34 1BA, England.

The survey covers the economics of production and distribution of books and microforms and the market for micropublications in academic libraries in all parts of the world.

72-0075 PHOTOGRAPHIC EQUIPMENT AND SUPPLIES. P31. Cleveland, OH: Predicasts, 1972. 62p. $335.00. Available from Predicasts, Inc., 200 University Circle Research Center, 11001 Cedar Avenue, Cleveland, OH 44106.

This overall survey of the photographic market contains brief chapters on micrographic supplies and equipment. Forecasts are given for dollar volume of sales, with some analysis of the varying needs of different application areas.

72-0076 Nemeyer, Carol A., SCHOLARLY REPRINT PUBLISHING IN THE UNITED STATES. New York, NY: R. R. Bowker Company, 1972. 262p. $12.50., Available from R. R. Bowker Company, P. O. Box 1807, Ann Arbor, MI 48106.

This book provides a history of the republishing concept, together with a directory and evaluation of over 300 publishers presently active in reprint publishing. Production practices, formats, pricing, marketing, and distribution are discussed.

72-0078 RECOMMENDATIONS ON METHODS OF MICROFILMING MAPS AND PLANS. Hatfield, England: Public Service Microfilm Liaison Group, 1972. 23p. Microfiche $.50, hardcopy $3.75. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.

The manual covers procedures, film types, equipment, indexing and coding, and cost considerations. Relevant British national standards are referenced.

72-0079 SPECIFICATIONS FOR THE MICROFILMING OF NEWSPAPERS IN THE LIBRARY OF CONGRESS. Washington, DC: Library of Congress, Photoduplication Service, 1972. 17p. $.30. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Order number 3000-0055.

This pamphlet sets out specifications for the roll filming of newspapers, including the preparation of the files, image placement, reduction ratio, film stock, filming procedures, film processing and inspection, intermediate and reference copies, and storage.

72-0080 STORAGE AND PRESERVATION OF MICROFILMS. Rochester, NY: Eastman Kodak Company, 1972. 11p. Free. Available from Eastman Kodak Company, 343 State Street, Rochester, NY 14650.

The booklet discusses the composition and properties of film as related to film permanence and describes the essential requirements of good processing and storage practices, with information on the various hazards to microfilm.

72-0081 INFORMATION RETRIEVAL. Washington, DC: National Archives and Records Service, 1972. 132p. $1.25. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

An overview of the information retrieval field covers the application of modern information methods and equipment to improve the dissemination, storage, and retrieval of information. System and equipment selection are also discussed.

72-0082 UPDATABLE MICROFORMS SYSTEMS: A STATE-OF-THE-ART SURVEY. Hatfield, England: Public Service Microfilm Liaison Group, 1972. 21p. Microfiche $.50, hardcopy $3.75. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.

The report details the procedures, equipment needed, and advantages and disadvantages of different forms of microform updating in seven categories: jacketing, stripping, roll film splicing, the "Midas" system, COM techniques, unusual systems, and systems under development.

72-0094 INSPECTION AND QUALITY CONTROL OF FIRST GENERATION SILVER HALIDE MICROFILM. MS 104. Silver Spring, MD: National Micrographics Association, 1972. 26p. NMA members $3.50, non-members $4.50.

This NMA standard covers equipment, supplies, control documents, and test procedures for determining the quality of silver microfilm. Illustrations are provided showing possible defects on film, and a photomicrograph of a resolution chart is provided.

72-0099 MICROFILM IN THE OFFICE: AN INTRODUCTION TO MICROCOPYING. New York, NY: American National Standards Institute, 1972. 11p. $4.60. Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

The booklet offers basic information on microcopying, with emphasis on business documentation, and covers sensitized materials, filming, processing, production, storage and retrieval, and COM.

72-0100 SEMINAR PROGRAMME AT MICROFORUM INTERNATIONAL '72. London, England: Business Equipment Trade Association, 1972. 128p. $12.00. Available from Business Equipment Trade Association, Exhibition Department, 109 Kingsway, London WC2B 6PU, England.

A compilation of 17 papers covers the use of microfilm. Retrieval systems, and COM are among the subjects discussed in the areas of engineering and business systems.

72-0102 Williams, Bernard J. S., THESAURUS OF MICROGRAPHIC TERMS. Hatfield, England: National Reprographic Centre for documentation, 1972. 42p. $6.00. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.

This publication was designed for use with an operational information system containing technical terms used within the commonly established definitions of available standards and glossaries.

73-0054 MICROFILM FOR ACTIVE RECORDS IN LIFE INSURANCE COMPANIES. New York, NY: Life Office Management Association, 1973. 42p. $5.50. Available from Life Office Management Association, 100 Park Avenue, New York, NY 10017.

This is the report of a survey of 144 LOMA members concerning their present and planned use of microfilm. It includes three detailed case studies, a list of 27 companies using microfilm jacket programs, and 61 companies with COM programs.

73-0055 VAT RECORD STORAGE ON MICROFILM. Guildford, England: G. G. Baker and Associates, 1973. 48p. $3.75. Available from G. G. Baker and Associates, 54 Quarry Street, Guildford, Surrey, England.

An explanation of the recordkeeping requirements of the Value Added Tax (VAT) in England and the legal status of microfilm for record retention introduces a description of micrographic basics: microforms, document microfilming, COM, systems design, and service bureau vs. in-house considerations.

73-0056 INTRODUCTION TO MICROGRAPHICS. Silver Spring, MD: National Micrographics Association, 1973. 28p. $1.00.

This illustrated primer on the fundamentals of micrographics covers microfilm formats, roll microfilm, unitized microforms, duplicating microforms, using microforms, microform systems, and a glossary.

73-0058 A GUIDE TO MICROFILM READERS AND READER-PRINTERS. Guildford, England: G. G. Baker and Associates, 1973. 128p. $15.00. Available from G. G. Baker and Associates, 54 Quarry Street, Guildford, Surrey, England.

A discussion of microforms in use in Europe is presented, together with typical characteristics of microfilm reading equipment, and specifications and illustrations for 162 readers and reader-printers.

73-0061 AUTOMATED INFORMATION STORAGE AND RETRIEVAL FINDS NEW GROWTH MARKETS. New York, NY: Quantum Science Corporation, 1973. 150p. $650.00. Available from Quantum Science Corporation, 245 Park Avenue, New York, NY 10017.

This survey discusses COM, office automation, and industry/application cost analyses, compares computer and microfilm-based information systems, and forecasts the future of the major companies in this market area.

73-0062 MICROGRAPHICS GLOBAL MARKET SURVEY. Washington, DC: U. S. Department of Commerce, 1973. 11p. $1.25. Available from the U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

The survey provides information for U. S. exporters on the present and forecasted demand for micrographics supplies and equipment in 13 countries. Information for each country includes the legal status of microfilm, competitive environment, and technical standards. A three-year schedule of promotional events is included.

73-0063 Tauber, Alfred S., and Howard W. Hoadley, AUTOMATIC DOCUMENT STORAGE AND RETRIEVAL – A MARKET EMERGES. White Plains, NY: Knowledge Industry Publications, 1973. 181p. $395.00. Available from Knowledge Industry Publications, Inc., Tiffany Towers, White Plains, NY 10602.

This survey forecasts the market volume for 1973 and 1977, and discusses current technology and its implications for vendors and users. It also analyses companies now in the field and provides an outline of available equipment. Three microfiche contain product literature.

73-0064 Horder, Alan, USER EVALUATION OF MICROCOPYING SYSTEM PERFORMANCE. Hatfield, England: National Reprographic Centre for documentation, 1973. 87p. Microfiche $1.00, hardcopy $9.23. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.

Based on a Masters Degree thesis, this report reviews the development and use of the NBS and ISO Mire microcopy test charts and discusses the correlation of both with legibility.

73-0065 SPECIFICATIONS FOR THE MICROFILMING OF BOOKS AND PAMPHLETS IN THE LIBRARY OF CONGRESS. Washington, DC: Library of Congress, Photoduplication Service, 1973. 16p. $.40. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Order number 3000-00068.

This pamphlet sets out specifications for the roll filming of books and monographs.

73-0158 **Gordon, Ronald F., MICROFICHE VIEWING EQUIPMENT GUIDE. Alexandria, VA: Defence Documentation Center, 1973. 161p. Microfiche $1.45, hardcopy $4.75. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151. Order number AD-767 500.**

This descriptive directory of microfiche readers and reader-printers manufactured or distributed in the U. S. includes photographs and detailed specifications for each model.

73-0159 **Baumgarten, Jon A., US-USSR COPYRIGHT RELATIONS UNDER THE UNIVERSAL COPYRIGHT CONVENTION. New York, NY: Practising Law Institute, 1973. 172p. $10.00. Available from Practising Law Institute, 1133 Avenue of the Americas, New York, NY 10036.**

73-0160 ***U. S. INDUSTRIAL OUTLOOK 1974 WITH PROJECTIONS TO 1980.* Washington, DC: U. S. Department of Commerce, 1973. 385p. $3.40. Available from the U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Order number 0325-00004.**

The chapter on photographic equipment and supplies includes a brief discussion of micrographics.

73-0163 **Thomas, Woodlief, Jr., ed., SPSE HANDBOOK OF PHOTOGRAPHIC SCIENCE AND ENGINEERING. New York, NY: John Wiley and Sons, 1973. 1416p. SPSE members $31.50, non-members $37.50. Available from Society of Photographic Scientists and Engineers, 1330 Massachusetts Avenue, NW, Washington, DC 20005.**

This reference volume is intended for experienced and practicing engineers and scientists who possess a basic knowledge of their field. The 23 sections include chapters dealing with microphotography, holography, densitometry, processing methods, optics, photographic chemistry, silver halide emulsions, projection and viewing, all accompanied by numerous diagrams and tables.

74-0079 **Gaddy, Dale, A MICROFORM HANDBOOK. Silver Spring, MD: National Micrographics Association, 1974. 96p. $6.00.**

The publication includes an overview of the micrographics field, an explanation of microform basics, and a discussion of specific considerations in designing an educational microform system.

74-0080 **HOW TO SELECT A READER OR READER-PRINTER. Silver Spring, MD: National Micrographics Association. 1974, 20p. $2.00.**

This basic discussion provides a list of possible factors to consider, explains how to evaluate them for specific applications, and shows with text and charts the different reproduction processes used in reader-printers.

74-0081 **THE COM MARKET IN THE UNITED KINGDOM AND THE CONTINENT OF EUROPE. Guildford, England: G. G. Baker and Associates, 1974. 42p. $70.00. Available from G. G. Baker and Associates, 54 Quarry Street, Guildford, Surrey, England.**

This detailed market analysis includes present and predicted sales, consumption of supplies, alphanumeric versus graphic, service bureau use, pricing trends, and major companies involved.

74-0228 ***OPERATIONAL PROCEDURES FOR THE PRODUCTION OF MICROFORMS, MS110.* Silver Spring, MD: National Micrographics Association, 1974. 32p. NMA members $4.00, non-members $5.00.**

This NMA standard provides detailed instructions for all types of microfilming.

74-0231 **Barrett, R., REMOTE ACCESS TO ORIGINAL TEXT FOR INFORMATION HANDLING. Hatfield, England: National Reprographic Centre for documentation, 1974. 94p. Microfiche, members 40p., non-members 60p.; hardcopy, members £2.00, non-members £3.00. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.**

This report is based on the findings of a feasibility study of systems giving automatic retrieval and remote display of full text information held in microform storage.

74-0232 **MICROFORM RETRIEVAL EQUIPMENT GUIDE. Washington, DC: National Archives and Records Service, 1974. 94p. $1.50. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Order number 022-002-0034-1.**

The guide provides information about the most widely used microforms, discusses factors affecting equipment selection, describes equipment available for various microforms, and lists manufacturers.

74-0233 **MICROFILMING RECORDS. Washington, DC: National Archives and Records Service, 1974. 172p. $2.35. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Stock number 7610-00-387-9972.**

This handbook is intended to provide an overview of micrographics for Federal Government users. It provides records managers, management analysts, and systems designers with guidelines on when to microfilm, how to design a microfilm system, select the microfilm format that best meets user requirements, obtain quality microforms, and operate a microfilm system after its installation.

74-0234 **INCREASED USE OF COMPUTER-OUTPUT-MICROFILM BY FEDERAL AGENCIES COULD RESULT IN SAVINGS. Washington, DC: U.S. General Accounting Office, November 1974. 36p. Free. Available from U. S. General Accounting Office, 441 G Street, NW, Washington, DC 20548.**

This review studies the use of COM by Federal agencies, to determine whether COM could improve the efficiency and economy of computerized information systems, and to explore service centers as a means of providing COM services.

74-0235 **A DIRECTORY OF BRITISH PHOTOREPRODUCTION SERVICES FOR LIBRARIES. Guildford, England: Microfilm Association of Great Britain, 1974. 84p. MAGB members £2.00, non-members £2.50. Available from Microfilm Association of Great Britain, 1 and 2 Trinity Churchyard, High Street, Guildford, Surrey, England.**

This directory is based on questionnaires completed in 1972 and 1973. Entries are arranged alphabetically by geographic location, and the types of microform, camera, reader, and copies available are listed.

74-0236 **COM APPLICATIONS IN LIBRARIES. Guildford, England: Microfilm Association of Great Britain, 1974. 42p. MAGB members £2.00, non-members £3.00. Available from Microfilm Association of Great Britain, 1 and 2 Trinity Churchyard, High Street, Guildford, Surrey, England.**

This publication contains four papers, presented at a 1973 seminar, dealing with book ordering and cataloging COM systems in libraries.

74-0237 BASIC U. S. GOVERNMENT MICROGRAPHIC STANDARDS AND SPECIFICATIONS. Silver Spring, MD: National Micrographics Association, 1974. 432p. Members, microfiche $2.00, non-members $3.00. hardcopy, members $10.00, non-members $14.00.

Copies of 22 Federal Government standards and specifications for micrographics are included in this book, which includes items through November 1973.

74-0238 FUNDAMENTALS OF COMPUTER OUTPUT MICROFILM. Silver Spring, MD: National Micrographics Association, 1974. 24p. $2.00.

This primer on COM basics has chapters dealing with COM advantages and applications, basic components of a COM recorder, microfilm formats used with COM, COM recording formats, operational considerations for the COM program, using COM, and a comprehensive glossary.

74-0240 AUERBACH GUIDE TO MICROFORM EQUIPMENT. Philadelphia, PA: Auerbach Publishers, 1974. 168p. Available from Auerbach Publishers, Inc., 121 N. Broad Street, Philadelphia, PA 19107.

The catalog includes photographs, detailed descriptions, and comparative specification charts for readers and reader-printers, cameras, processors, duplicators, and COM recorders.

74-0241 A GUIDE TO THE PRODUCTION OF MICROFORMS. Guildford, England: G. G. Baker and Associates, 1974. 144p. $15.00. Available from G. G. Baker and Associates, 54 Quarry Street, Guildford, Surrey, England.

This book covers each step in producing and using microforms, with a brief description of current technology and processing, and line drawings and specifications for equipment currently available in the United Kingdom.

74-0242 Tatis, Rita, and Don M. Avedon, INDUSTRY SURVEY: COMPUTER OUTPUT MICROFILM. Silver Spring, MD: National Micrographics Association, 1974. 47p. NMA members $40.00, non-members $65.00.

This survey provides the results and analysis of the 1974 survey of present and potential COM users, and compares these results with the 1969 and 1974 surveys to establish trends.

75-0214 Barrett, R., MICROFILM AND FACSIMILE IN JAPAN. Hatfield, England: National Reprographic Centre for documentation, 1975. 58p. Microfiche, members 20p, non-members 30p; hardcopy, members £1.50, non-members £2.00. Available from National Reprographic Centre for documentation, The Hatfield Polytechnic, Hatfield, Hertfordshire, England.

The report includes information on present systems involving automatic microform storage and retrieval by direct and remote access, facsimile transmission and displays. It also covers current research activity in these areas and an appraisal of hardware in use or in course of development.

75-0215 A GUIDE TO MICROFICHE EQUIPMENT AVAILABLE IN EUROPE. Neuilly sur Seine, France: NATO, Advisory Group for Aerospace Research and Development, 1975. 112p. $5.25. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Order number AD-A010-701.

A listing of microfiche equipment is composed of six sections: cameras and camera-processors; processors; duplicators and printer-processors; reader-printers; readers; and cutters, reader-fillers, strip-up systems, inspection devices, and densitometers. Details and photographs of each piece of equipment are included.

75-0216 COMPUTER OUTPUT MICROFILM. Washington, DC: National Archives and Records Service, 1975. 48p. $1.05. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402. Stock number 7610-00-564-8076.

This handbook is intended to provide a broad understanding of COM for Federal Government users with a limited knowledge of computers, microfilm, and information systems, and to provide guidelines in the application, design, evaluation, and use of COM systems.

75-0217 Ballou, Hubbard W., ed., GUIDE TO MICROGRAPHIC EQUIPMENT. Silver Spring, MD: National Micrographics Association, 1975. Three volumes, 552p. NMA members $22.00, non-members $32.00.

This comprehensive directory of microfilm equipment includes a picture and detailed specification for each entry. It is also available in individual volumes.

75-0220 Costigan, Daniel M., MICROGRAPHIC SYSTEMS. Silver Spring, MD: National Micrographics Association, 1975. 250p. NMA members $12.50, non-members $16.50.

This in-depth reference book covers facilities, equipment, systems, search and retrieval aids, ancillary technologies, standards, cost and economic analysis, component selection, system design, hardware, and guidelines on "selling the system."

75-0221 Courtot, Marilyn E., *Microform Indexing and Retrieval Systems.* Silver Spring, MD: National Micrographics Association, 1975. 24p. $2.00.

This publication is designed to acquaint the new user with manual, semi-automatic and fully automatic microform retrieval systems, and discusses the factors to be considered when choosing a microform retrieval system.

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14. Abstract

Lecture Series No.85 is sponsored by the Technical Information Panel of AGARD and is implemented by the Consultant and Exchange Programme. The Lecture Series starts with the presentation of an up-to-date review of micrographic technology. Computer Input Microfilm (CIM) and Computer Output Microfilm (COM), as well as an indication of the market size and growth rate. After an account of the fundamentals of micrographics, COM recording techniques and recorders are described and CIM techniques reviewed. Other lectures cover indexing and retrieval techniques, systems design, alphanumeric and graphic applications. In a final paper, future trends in micrographic technology are indicated.

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P.T.O.

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Computer storage devices
Data storage
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Indexes (documentation)

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Microfilm
Photomicrography
Computer storage devices
Data storage
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Advisory Group for Aerospace Research and Development, NATO
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