Computer microfilm—A cost cutting solution to the EDP output bottleneck

by JOHN K. KOENEMAN and JOHN R. SCHWANBECK

Oppenheimer & Company
New York, New York

SUMMARY

Although the computer microfilm recorder has received little attention to date, this new output device represents a technological breakthrough which will have a major impact on the computer industry. Installation of a recorder generally results in a tenfold increase in the speed of computer output and a concomitant substantial reduction in CPU time which can result in major data processing and report production cost savings. As an added bonus, a microfilm system is the equal of most electronic time-sharing systems for information storage and retrieval applications. Consequently, we feel that computer microfilm, although little noticed thus far, represents a major industrial and investment concept.

The electromechanical line printer—heretofore the only practical means of obtaining hardcopy rapidly from the computer—has a maximum output rate of only 2,500 characters per second. But, the computer's throughput capability is 25,000 to 100,000 characters per second. Owing to the severe output bottleneck that results from this imbalance of speeds, the bulk of information ingested and produced by computers has, until now, essentially been locked on magnetic tape and not easily available to the computer user. With the advent of the computer microfilm recorder, which can produce output as fast as the computer can process data, this mass of stored information has suddenly become readily available in humanly readable form. One of the most important questions which must therefore be asked is: "How much information is stored on magnetic tape and how badly is it desired by the computer user?" Our field work has consistently shown that an early Xerox type phenomenon exists—user volume rises rapidly to meet capacity.

Because the microfilm recorder eliminates the computer output bottleneck, it also results in a major cost savings. This effect is most readily apparent in the data processing service industry, where a customer can now realize an approximate 40 percent to 50 percent reduction in his monthly service bureau bill if microfilm rather than continuous paper forms is accepted as computer output.

Even greater relative savings can be realized by companies with medium to large-scale in-house data processing departments. Overall, it can be shown that the lowest data processing costs, at all levels of use, are achieved when microfilm recorders are employed to produce alphanumeric or graphic computer reports.

Moreover, acceptance of computer output in film form automatically creates an information storage and retrieval system which is the equal of most electronic systems. Although microfilm has gained a bad reputation because of the poorly designed equipment and improperly processed film which library users have been forced to endure for years, newly introduced microfilm equipment can now easily provide the quality of image and speed of retrieval of the most expensive time-sharing terminals.

In addition to the standard data processing market, there is another separate and distinct market, that of pure information storage and retrieval, for which com-
Computer microfilm can compete very effectively because of its low cost. In fact, computer microfilm is frequently referred to as "the poor man's time-sharing." The service bureau charge for processing and producing one page of computer generated microfilm daily for one month is 10 percent to 40 percent that of storing one page of information on magnetic disc for the same time period. When the terminal and communications costs of electronic time-sharing systems are also considered, the cost advantage weighs even more heavily in favor of microfilm. In large measure, this dramatic cost difference is the result of the substantially greater density of data storage which film (1,000,000 bits/sq. cm.) enjoys over magnetic media (1,000 bits/sq. cm.). Thus, although highly optimistic forecasts have been made for the growth of electronic systems for use in information storage and retrieval applications, we feel that fundamental economic considerations strongly suggest that computer generated microfilm, instead, will become the most common (although, obviously, not the sole) method of computer information storage and retrieval.

Several other benefits are derived from the computer microfilm recorder which are normally of peripheral, but can on occasion be of prime, importance:

- An unlimited number of report copies can be obtained from one computer run with no loss of clarity; by contrast, only four or five truly readable copies can be obtained from a single run when an impact line printer and continuous paper forms are used.

- Owing to its compactness, microfilm essentially eliminates the problems and costs of computer report storage.

- Microfilm permits dramatic reductions in computer report transportation or communications costs.

Computer microfilm is not without certain drawbacks, however. A computer microfilm information system cannot be used in situations where the data base changes rapidly, such as in airline reservations or stock market quotations. It also cannot be employed where user interaction with the data base is desired. Additionally, paper possesses a distinct advantage as data processing output where computer usage is very light, or scientific applications (i.e., high computation—low output) are involved.

In summary, with the development of the computer microfilm recorder, the most efficient processor of information—the computer—has finally been directly linked with the most efficient means of information storage and retrieval—microfilm. User experience to date strongly suggests that very large and potentially vast demand exists for the inexpensive and fast access to computerized information that this combination provides. Indeed there is every indication that computer microfilm could bring about a real information explosion. Certainly all ingredients necessary for such pyrotechnics are present—a sudden quantum jump in the speed of information output, low cost, and ease of use (Exhibit 1). As a consequence, we feel that the computer microfilm service, hardware, and supplies industries will experience impressive growth over the near and intermediate term. Indeed, output of microfilm recorders, which should jump from 100 units in 1968 to about 400 units in 1969, presently is production limited.

The microfilm recorder substantially reduces data processing and report generation costs for all users

Although there are considerable variations in volume discounts and prime or off shift machine rates, a 50 percent cost saving is common when a data processing service organization customer changes from paper to microfilm as computer output. Similarly, cost reductions of 40 percent to 70 percent have been documented by heavy in-house computer users even though, in most cases, the availability of computer reports has been substantially increased as well. Although the relative cost savings of the in-house user and the service bureau customer are similar, the source of these savings is not. Whereas essentially all the service bureau cost reduction can be attributed to lower computer time charges, the bulk of in-house economies derive from labor and material savings. On balance, however, it can be shown that the lowest data processing costs are always obtained when a microfilm recorder is employed.

Service center cost reductions

To obtain 1,000 pages (and three carbon copies) of processed information, a data processing service organization customer presently accepting paper output will incur about one hour of IBM 360/30 machine rental at $65.00 per hour and a materials charge of $30.00 for continuous forms. Thus, total service bureau charges for the processing and production of 1,000 pages of information will total about $95.00 when paper is used as the computer output medium.

If, however, a change to computer microfilm is made, the cost of a similar run drops to about $40.00
to $45.00. Because the economics of large, fast computers can be used to advantage when the machine is no longer output bound, most computer microfilm programs are run on an IBM 360/65 or equivalent. Because the time necessary to process 1,000 pages of information on a 360/65 is about 0.2 minutes, total data processing charges at $600 per hour amount to only about $2 or $3. Conversion from magnetic tape to a single microfilm original can be accomplished for about $30.00 (three cents per original page), and the cost of three copies will add an additional $10.00 (3.3 mills per page). Thus, for comparable data processing and report production services, a computer microfilm service bureau will cost only $40.00 to $45.00, in contrast to about $95.00 for a traditional data processing service organization (Exhibit 2).

In-house cost reductions

In the next exhibit (3), it can be seen that although the installation of a microfilm recorder (SD4360) increases the fixed cost of a data processing installation about $2,000 per month, variable costs for materials are so low that the recorder becomes economically advantageous after 90,000 to 100,000 pages per month of output, or the equivalent of five to six machine hours per day of a relatively small four-tape System 360/30. Thus, an in-house installation operating two shifts can achieve a 25 percent-30 percent cost reduction through the elimination of machine shift premiums, labor, and materials savings. Extensive Army studies\(^1\) have shown that operating savings of 40 percent to 70 percent can be achieved when three-shift operation or multiple satellite computers with attached line printers are involved.

The magnitude of the demand for computer reports that is presently unsatisfied because such reports are considered uneconomical can perhaps be judged by noting that if the management of a corporation with as little as $15 million in annual sales desired detailed daily reports on finished parts inventory, accounts receivable, and unfilled orders, almost seven hours of computer time would be consumed in printing out these reports.\(^2\) Incremental costs of about $3,000 to $4,000 per month for materials and possibly $2,000-$2,500 for additional labor would probably thereby be incurred. Thus, although the utility of detailed management reports such as these is probably high,
we think it likely that the operational difficulties and the extremely high EDP costs necessary to produce such information have led many manufacturing companies to forego such data until now. However, with the installation of a computer microfilm recorder, the same $15 million company described above could produce the same reports at an incremental cost of only $400 to $500 per month for materials and no incremental cost for labor. Thus, the company would then find it feasible to produce these reports. Operating experience to date of computer microfilm recorder owners certainly would point toward such a conclusion.

Moreover, it is important to note that the cost curve of a computer microfilm data processing installation is essentially flat out to very large quantities of output (Exhibit 3). Thus, the corporate manager would now be able to obtain additional detailed reports almost instantaneously at virtually no incremental cost.

Experience to date indicates that most managements will quickly begin to utilize the full capacity of a newly installed recorder.

For example, in one case, a large insurance company installed a microfilm recorder in May 1967. Although the equipment operated only five hours per week when first installed, after approximately one year, utilization had increased tenfold to 50 hours per week. In another case, a manufacturing concern which began using prototype computer microfilm equipment in 1967 had increased its film consumption to 20 million feet per year (400 million pages) by 1967 and reached 38 million feet (760 million pages) in 1968.

The substantial savings in consumable materials, costs, labor costs, and machine rental are, of course, the three major cost elements considered in calculating operational savings (Exhibit 4).

Additionally, however, considerable savings in computer report shipping and storage costs can frequently be realized, although these expense elements have not been included in our calculations (Exhibit 5).

### Cost reductions for all users

In summary, then, by superimposing the costs of service centers (Exhibit 2) on those of in-house installations (Exhibit 3), it can be seen that the use of a computer microfilm recorder will always result in the lowest data processing cost at all levels of usage (Exhibit 6).

These facts should be apparent:

1. A computer microfilm service center is always about 50 percent cheaper than a paper service center, and this cost advantage probably will go higher.
2. A computer microfilm service center is the least expensive data processing alternative up to about 200,000 pages of output per month. (200,000 pages per month is the maximum output of a single shift working six days per week on a 360/30 with one attached line printer.)
Exhibit 6—Summary of cost comparisons: Computer microfilm recorder results in the lowest costs at all levels of usage

3. Beyond 200,000 pages of output per month, an in-house computer with a microfilm recorder is by far the least expensive data processing alternative.

4. An in-house computer/microfilm recorder can bring about a cost saving vis-a-vis a computer/line printer installation beyond about 90,000 to 100,000 pages per month, or only five to six hours of computer time per day, with paper output.

Thus, if decisions regarding an in-house capability versus utilization of a service bureau were always rational and financially sound, 100 percent conversion from paper to computer microfilm output could be expected. To anticipate a conversion ratio of 100 percent is, of course, unrealistic. Nonetheless, the pricing revolution which the computer microfilm service companies have brought about in the data processing service industry should result in very extensive use of the computer microfilm recorder in this segment of the computer industry. The small data processing user will be the primary beneficiary of the dramatic reduction in data processing service bureau costs. Similarly, medium-scale to heavy computer users will find the substantial cost and operating advantages of an in-house recorder sufficiently compelling to bring about heavy conversion to microfilm output in this market segment.

**Microfilm is the most efficient medium for storing and accessing generated computer data**

Computer microfilm is actually, by a wide margin, the most efficient and economical storage and retrieval system for computer generated information. Microfilm has always been superior to paper from a bulk handling and storage standpoint. With the introduction of the computer microfilm recorder, it can now also approximate electronic time-sharing systems in performance for the great majority of information storage and retrieval applications. Thus, computer output on microfilm can provide a simple, fast information system far superior to those currently in use. Indeed, computer microfilm service bureau managements indicate that it is not the substantial cost advantage of film over paper computer output which is most attractive to prospective customers, but rather its usefulness as an effective information system. The dramatic cost benefits, however, can be an extremely effective sales too, in getting the customer to consider microfilm seriously.

**Microfilm joins the computer era**

Development of the computer microfilm recorder has brought in its wake a flurry of product development activity aimed at greatly facilitating access to information on microfilm. Most individuals think of microfilm only as an archival medium—for storing outdated information for which a need might or might not arise at some time in the future. Actually, the active use of microfilm for the storage and retrieval of information in daily use has been practiced by some pioneering users and companies for years. For the most part, these have been extremely large users (e.g., Social Security Administration). We feel that in large part the reluctance to adopt active microfilm systems has been due to the fact that information in such systems had to be manually sorted, updated, and coded—a tedious and time-consuming task.

Now, however, this task has been eliminated through the development of computer microfilm coding systems which can provide manual access to one page out of 73,500 in one to five seconds.

Additionally, the speed and ease with which computer information can be obtained on microfilm has been increased from days to literally minutes. One manufacturer has adopted a marketing program stressing “on time” information rather than “real time”, which is, in fact, an accurate description. There is virtually no computerized information which cannot be obtained overnight in a fully useful, properly indexed format.
In sum, the user of computer microfilm has access to a “poor man’s time-sharing” information system, as some have termed it, with no addition to his CPU costs.

**Computer microfilm competes effectively against time-sharing**

Many feel that time-sharing will become the most common method of providing access to computer generated information. But, it can be shown that for most applications, the storage and retrieval of information electronically is very uneconomical relative to a computer microfilm system.

For example, in one specific application, a data storage capacity of 15,000 pages, to be updated daily, was required. The effective cost of this application on a commercial time-sharing disc file system equalled about $3.00 per page or a total of $45,000 per month. On microfilm, this same information can be updated once a day for approximately $0.60 per page or $9,000 per month—a storage cost reduction of almost 80 percent. Moreover, the time-sharing system would incur additional costs for terminal connect time and computer search time.

Therefore, we feel that microfilm, as a medium of access to computer information, will become much more commonly employed than time-sharing in the future. Time-sharing, however, will always be required for applications in which immediate interaction with the data base is desired.

Microfilm permits the storage cost savings just described because it has a significantly greater storage density capacity than the magnetic storage media used in time-sharing systems (i.e., disc packs and data cells). While it is only possible to store approximately 1,050 bits per square centimeter on computer magnetic materials, it is possible to store 1,000 times this amount; or over one million bits, on a square centimeter of microfilm.

In addition to storage costs, the relative disadvantages of time-sharing for information storage and retrieval include substantially higher terminal and communications costs (Exhibit 7).

As shown in the exhibit, a full page of information can be accessed in one to four seconds on the CARD device. To equal this speed with a time-sharing system a high-cost video terminal and Telpak-D communications line must also be employed.

As a result of these cost factors, microfilm is the more economical of the two systems for most normally encountered information storage and distribution problems. The surface illustrated in Exhibit 8 delineates the points (determined by file size, number of users, and update frequency) at which a microfilm system is roughly cost equivalent to an electronic information storage and retrieval system.

For the problems located within the surface, a microfilm system is less expensive; for those outside the surface, electronic systems are less expensive.

For example, the exhibit demonstrates that when information must be available to 200 users and updated every business day, a microfilm system is more economical for files of 14,000 pages or less. A file of this size could contain the daily closing stock quotations for the NYSE, ASE, and OTC market for over four years. Similarly, a 14,000 page file could contain all the records for payroll, personnel, and finished goods inventory (plus 10,000 accounts receivable records) for an average industrial corporation with sales of $800 million per year.

There are two types of commonly encountered applications for which microfilm is not a suitable replacement for time-sharing: when the user wishes to input, manipulate, and extract data at will, and when updating is required more than once a day, such as in transportation reservation systems (these cases are...
COMPUTER GENERATED MICROFILM VS ELECTRONIC COMPUTER SYSTEMS:
MOST ECONOMICAL INFORMATION STORAGE AND RETRIEVAL SYSTEM FOR MOST COMMONLY ENCOUNTERED APPLICATIONS...

Exhibit 8—Computer generated microfilm vs electronic computer systems: Most economical information storage and retrieval system for most commonly encountered applications

located above the update frequency = 20 times/month plane in Exhibit 8). Whereas time-sharing allows information stored in a computer to be updated immediately and made readily available in updated form to all users, with a microfilm system four to six hours is the minimum time one may expect for file update, preparation, and distribution.

However, in most other commonly encountered information storage and retrieval applications, computer processed data is required for informational purposes only, such as in referencing records to service a customer inquiry. In these cases, a microfilm information system is equally as effective and far less expensive than a time-sharing system.

Recently, hybrid information systems have been introduced in which a data base is stored on microfilm while recent updates and changes can be retrieved electronically from computer memory. These systems, which utilize the advantages of both microfilm and time-sharing systems, should find widespread acceptance in the future.

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