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Letter
Original

January 12, 1987

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Dear
NO ITEM TO INSERT
:

The key to office and white collar productivity is improved quality of informaiton and reduction in the volume of paper. Most attempts at office automation have, on the contrary, increased the volume of paper and generally lowered the quality of information content. Optical storage holds the promise of reducing (or at least controlling) the paper volume and improving the quality of information by giving ready access to historical data and enabling the processing of information that is currently produced on paper (i.e., noncomputer-processable).

INPUT's report CD ROM: User Applications looks at the current user evaluation of CD ROM and optical storage, examines the technological impact on current storage media, and proposes seven profiles of optical storage systems that have end-user applications.

As usual, INPUT welcomes your comments and queries. If you require further information, please call me at (415) 960-3990.

Yours sincerely,

Graham S. Kemp
Vice President

GSK:ml

Enclosure

CLIENT

_____

W/O#_____

CLIENT/JOB ORIGINALS

TO INCLUDE

- ☐ ARTBOARDS
- ☐ ORIGINAL COPY
- ☐ MAKE-READIES
- ☐ SAMPLES

Section 1

E.P. 9
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CD ROM: USER APPLICATIONS

NOVEMBER 1986

Published by
INPUT
1943 Landings Drive
Mountain View, CA 94043
U.S.A.

Information Systems Program (ISP)

CD ROM: User Applications

CD ROM: USER APPLICATIONS

ABSTRACT

The key to office and white collar productivity is improved quality of informaiton and reduction in the volume of paper. Most attempts at office automation have, on the contrary, increased the volume of paper and generally lowered the quality of information content. Optical storage holds the promise of reducing (or at least controlling) the paper volume and improving the quality of information by giving ready access to historical data and enabling the processing of information that is currently produced on paper (i.e., noncomputer-processable).

INPUT's report CD ROM: User Applications looks at the current user evaluation of CD ROM and optical storage, examines the technological impact on current storage media, and proposes seven profiles of optical storage systems that have end-user applications.

This report contains 105 pages, including 28 exhibits.

CD ROM: USER APPLICATIONS

CONTENTS

EXHIBITS

1 INTRODUCTION

I INTRODUCTION

A. BACKGROUND

- INPUT has followed the development of optical storage technology for over ten years, and numerous status reports have been published during that period. (See Appendix A for a list of past reports which analyzed the technology.) The ebb and flow of enthusiasm for optical storage is a good example of many new technologies today--there is often a tendency, in considering any new topic, to initially overrate the technology by emphasizing the interesting or amazing aspects of it; then, when we realize it does not meet our expectations, we tend to undervalue the true condition of the technology.

- While INPUT has attempted to avoid the extreme fluctuations in enthusiasm for optical storage, we have concluded that the technology is key in moving beyond the paper-based office systems. As a result of this conclusion, Impact of Upcoming Optical Memory Systems was published in 1983. The fundamental conclusions reached in that report remain valid today.

- However, since 1983, optical storage technology, while progressing on a predicted course of development, has experienced some commercial success as an audio recording medium (unlike the abortive attempts in video recording). This success has been accompanied by refined terminology for that portion of optical storage technology, and now everyone is talking about CD ROMs (Compact Disk Read Only Memory).

- In the belief that immediate opportunities exist in the information services industry for the application of CD ROMs, and that emerging optical storage technologies will begin to have significant impact in the overall information systems industry in the near future, INPUT decided an updating and extension of past optical storage research was desirable at this time.

B. SCOPE

- The research program focused on the potential impact of CD ROM on the computer services industry and resulted in the following series of reports:

  - Impact of CD ROM on Information Services covered the first products, applications, and vendor initiatives in approaching the market.

  - CD ROM Vendors and Services analyzed information services vendor approaches to integrating CD ROM into their offerings and potential markets for product and service offerings.

  - CD ROM User Applications (the present volume).

- This report is the outgrowth of the research and analysis for that report series. While it will review the CD ROM applications which are being emphasized and the services which are becoming available, it will also emphasize the importance of taking a broad systems view of these products and services. The objective of the report is to avoid either "overrating" or "undervaluing" CD ROM and emerging optical storage technologies.

C. METHODOLOGY

- In Impact of Upcoming Optical Memory Systems, INPUT, 1983, it was concluded that information systems managers, as well as information services vendors, were largely unprepared for implementing optical storage systems.

- Approximately 100 interviews conducted earlier this year with CD ROM vendors, information services vendors, and end users gave every indication that this continues to be the case.

- As a part of the present study, nearly 60 end users were interviewed using a structured questionnaire. The results from these interviews have been analyzed along with those obtained from the 1983 research project, and direct comparisons will be made where appropriate.

- In addition, the results of 39 vendor interviews and information from current technical papers and seminars have been reviewed against past INPUT research involving similar sources. The CD ROM products and services have been analyzed against the applications systems structure and technological forecasts which were presented in the 1983 INPUT study referenced above. Revised and refined user systems requirements for acceptance of both current and emerging optical storage technologies are developed based on the current state of user understanding, acceptance, and preparedness.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

- This Executive Summary is designed to help the busy reader quickly review the research findings of this report without having to delve into each section. Each of the key points is summarized as an exhibit with an accompanying script on the left-hand page. This format is designed to facilitate the use of the Executive Summary as an in-house overhead presentation.

- There is currently a pronounced lack of interest on the part of IS management in CD ROM technology and in optical storage in general. Considering the fact that optical storage has the potential for having a significant impact on all current storage media, including paper, this disinterest is not only surprising but alarming.

- The key to office and white collar productivity is improved quality of information and reduction in the volume of paper. Most attempts at office automation (office copiers, word processing, personal computers, and now desktop publishing) have increased the volume of paper and, despite cosmetic improvement, have generally lowered the overall quality of information content. Optical storage holds the promise of reducing (or at least controlling) the volume of paper, and, with advanced software support, could provide the means of improving the general quality of information.

A. WHO NEEDS OPTICAL STORAGE?

- The typical central DP facility currently has wall-to-wall magnetic disk drives installed and generates paper documents which enter the office environment. IS departments currently do not have CD ROM or other optical storage products installed, do not plan to install any, and seem generally disinterested in the technology.

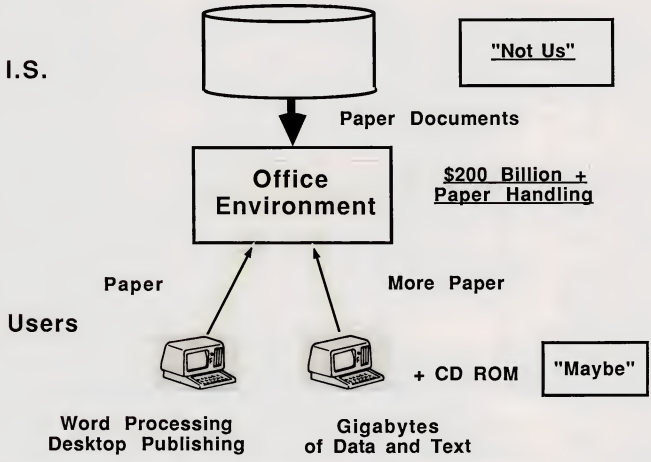
- End users at all levels (management, professional, and clerical) currently have the ability to generate enormous quanities of "pretty" documents, and major emphasis in office automation is currently directed toward improving this capability with desktop publishing. There is every indication that the quality of information content produced from distributed data bases is substantially lower than that produced from the central DP facility directly. Vendors are directing their CD ROM efforts toward end users, and this will result in enormous data bases being available on the desktop with exacerbation of both paper volume and quality control problems.

- The cost of handling paper in U.S. offices is currently estimated to be over $200 billion and rising. In addition, substantially more analysis time is being spent in screening out the meaningless (or even misleading) paper information which is being generated by office "automation" systems. The control of paper volume and quality is the key to improved white collar productivity. Optical storage has the potential for solving both of the problems which stand in the way of improved office productivity.

- Who should be interested in optical storage? Any institution which has the information handling problems described and any organization which has responsibility for doing anything about those problems.

INPUT®

WHO NEEDS OPTICAL STORAGE?



B. WHY AREN'T I.S. DEPARTMENTS INTERESTED?

- From among a menu of limitations of CD ROM (erasablity, read only, slow file conversion, access time, absence of IBM), IS management seems most concerned about three issues: the expense of file conversion, the lack of standards, and the lack of software.

- These are legitimate concerns, but there was also an underlying tone which suggested that CD ROM and optical storage were of low priority because today's problems were too pressing to worry about future technology. The types of problems IS management is concerned about today are departmental processing, end-user computing, micro-mainframe links, LANs, and connectivity.

- All of these problems are concerned with what was once simply labeled distributed processing. Distributed processing is specifically directed toward solving user problems in the office (paper processing and handling). Generally speaking, IS departments do not have (or want) responsibility for the paper-based systems and procedures; they are too busy wrestling with the "solutions" which have been proposed for the problem.

- Finally, after all of the explicit and implicit reasons were identified or inferred, an open-ended question reveals a fundamental cause for the disinterest in optical storage--everyone wants to know what IBM is going to do.

WHY AREN'T I.S. DEPARTMENTS INTERESTED?

What They Say -

- **Expensive Conversion**
- **Lack of Standards**
- **Lack of Software**

Practical Reasons -

- **Too Busy**
- **More Important Problems**
- **Not Responsible**

The Hidden Reason

- **IBM "Leadership"**

C. WHERE THINGS STAND

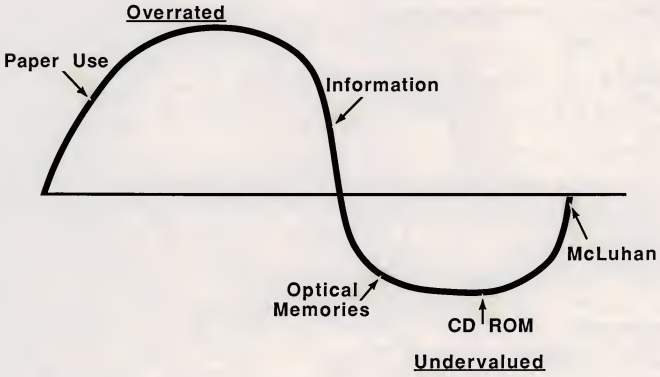
- Technological developments are first overrated and then undervalued. The importance of producing paper documents (and the use of paper itself) is approaching the apogee of the overrated phase of the cycle. Producing cosmetically better paper documents in greater volume is not going to improve productivity in the office. In fact, the point is rapidly approaching when current "solutions" will be identified as part of the problem.

- Optical storage, on the other hand, is at the nadir of the undervalued phase of the cycle, having already gone through the overrated phase several years ago. CD ROM is barely leading optical storage in gaining increased understanding and acceptance of the technology.

- The late Marshall McLuhan made certain observations about electronic versus paper media over 20 years ago. These observations, after an initial flurry of interest, were generally not understood and certainly were undervalued. IS departments are currently being confronted with the impacts of McLuhan's theories whether they understand them or not--the shortening of the time between thought and action can have unpredictable consequences as paper systems are converted to electronic systems. This, in turn, determines the quality (value) of information.

- Information as a "corporate asset" has been overrated because information systems have not produced promised results. There is the danger that data/information/knowledge will become undervalued with adverse impacts on the IS function far beyond the current slump.

WHERE THINGS STAND



D. DATA/INFORMATION/KNOWLEDGE

- It is important for IS professionals to understand the characteristics of data, information, and knowledge and to accept responsibility for improving the quality of the "systems" which process and store all three.

- At the present time, the following general conclusions can be reached about data, information, and knowledge:

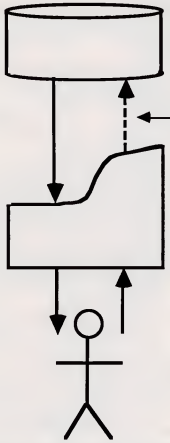
  - Data are the concern of the IS department, the processors are primarily mainframes, and the storage media is magnetic disk.

  - Information (despite the best efforts of data processing systems) is distributed primarily on paper, the processors for producing paper are primarily minicomputers and PCs, and the storage media are file cabinets, bookshelves, etc. End users are generally left to struggle with paper-based systems as they see fit (unless there is a "threat" to the IS function).

  - Knowledge is produced and stored in the minds and brains of human beings who increasingly are using computer/communications networks to obtain data and information. Users are the only justification for the existence of information networks and systems--information has no value without the human component. Users encounter increasingly complex systems as they deal with data and information.

- There is a missing link between paper information processing systems and computer data processing systems. What is missing is the ability of current data processing systems to capture information and knowledge which currently flows and is stored on paper. This should be the main concern of IS departments.

DATA/INFORMATION/KNOWLEDGE



	Predominant
Data	Processor: Mainframe Storage: Magnetic Disk
	Missing Link
Information	Processors: Departmental and PC Storage: File Cabinets
Knowledge	Processor: Mind Storage: Brain

E. THE POTENTIAL OF OPTICAL STORAGE

- Optical storage provides a means of capturing and rapidly accessing the vast amounts of information which are currently stored on paper (and micrographics) media and which are, therefore, lost to data processing facitities. It also offers the ability to process that data (impossible with paper or micrographic media).

- This can be accomplished (and justified) by the reduced storage costs of optical media compared to both paper and magnetic media and by the fact that 90% of the data captured and information produced by information systems is never used because of the volume and the media used for outflow (paper and COM).

- By capturing the paper information and making it available in electronic form, the volume of paper information will be reduced and the flow of information between and among human beings and computers will be improved in terms of both availablity (amount) but more importantly access. Boolean searches of paper files by humans are inaccurate and tiring and (ultimately) very costly. Optical storage allows the entire contents of (for example) 550 MB of storage to be searched in one second.

- The shift from paper to electronic media can be cost-justified based on reduction of the $200 billion currently being spent on paper handling alone, but it should also be justified based on better utilization of the data and information already captured and paid for.

- All of the above can be accomplished (or at least begun) with CD ROM. However, the real payoff will eventually be from having the information in processable form and being able to improve the quality of the content of information. This can only be done with advanced hardware/software systems.

INPUT®

THE POTENTIAL OF OPTICAL STORAGE

- Capture Information Currently Stored on Paper
- Reduce Storage Costs
- Reduce Volume of Paper Information Flow
- Reduce Cost of Paper Handling
- Have Information in Processable Form

F. SYSTEMS REQUIREMENTS

- Over the last five years, there have been quite remarkable advances in the peripherals which will be necessary to develop an integrated image processing system. Most of this development has been occasioned by the remarkable advances of microprocessor technology and the acceptance of the personal computer as a personal productivity aid in the office.

  - High-resolution displays have been developed in response to the requirements for superior graphics which have arisen from applications on intelligent workstations. The advances in microprocessor technology have been required to make the development of such displays economically feasible, and they are now available for more mundane image processing applications.

  - Desktop publishing as the logical outgrowth of conventional word processing also requires advanced graphics capability and print capability well beyond letter quality correspondence. The result has been dramatic advances in laser printers which are now the fastest growing printer market area.

  - Intelligent scanners and cameras are also appearing as the result of microprocessor advances, and fiber optics seems to have arrived just in time to provide the anticipated bandwidth necessary for office communications where paper begins to play a secondary role.

  - Indeed, the arrival of optical storage itself seems to be the last component required, and the various technologies (including erasability) appear to be arriving pretty much on the schedule predicted by INPUT over three years ago. Hardware is not a limiting factor in the development of advanced image processing systems.

SYSTEMS REQUIREMENTS

Hardware

- **Scanners/Cameras**
- **High-Resolution Displays**
- **Laser Printers**
- **Broadband Communications**
- **Continuing Development of Optical Media**

Software

- **D/I/K Management Systems**
- **Intelligent D/I/K Flow**

D/I/K = Data/Information/Knowledge

G. I.S. RESPONSIBILITIES

- Unlike personal computers where end users pioneered use of the technology, the complexity of a fundamental change from paper to electronic media will require the involvement of information systems professionals who are familiar with the specific requirements of their particular organization. The lead times to obtain benefits of optical storage is going to be longer than other major systems changes which have occurred, such as personal computers. The time to get started is now.

- At the very least, IS management can get started by taking responsiblity for all forms of optical storage technology, including CD ROMs. This implies the following:

  - A thorough evaluation and understanding of the potential technological impacts of optical storage.

  - An extension of the information systems view to include the paper work processes which extend from time of computer output (or receipt of paper documents) to the archiving of paper or micrographics images. In addition, it should be recognized that libraries are part of the information system.

  - An understanding of the finer distinctions of data, information, and knowledge with special emphasis upon quality.

- It is important to identify meaningful applications which can be cost-justified and implemented with minimum risk. The requirements for integrated optical storage systems extend beyond hardware and software. Important organizational and personnel considerations are involved in implementing such systems. Sensitivity to these issues is absolutely essential.

I.S. RESPONSIBILITIES

- Thoroughly Evaluate Technological Impact of Optical Storage
- Extend Systems View Beyond Current Computer Output
- Indentify Applications and Requirements
- Consider Pilot Projects on Some Scale
- Work with Vendors on Software Requirements

III CURRENT APPLICATIONS ASSESSMENT

III CURRENT APPLICATIONS ASSESSMENT

A. I.S. FAMILIARITY WITH CD ROM

- Only 4 of 51 user respondents to INPUT's 1986 survey currently had CD ROM (or videodisk) applications installed. The current applications included the following:

  - 3M videodisks were being used for marketing promotion in one company.

  - One respondent stated optical disks were being used for "education and training," but he was unable to identify the vendor.

  - Sony videodisks were being used by one company for "employee communications."

  - Another respondent reported that the Deltak training programs being used in the company incorporated the use of videodisks.

- In addition to the four companies which currently had applications installed, one respondent stated his company had installed a prototype videodisk system for retailing of consumer products a few years ago. It used an IBM PC and a Pioneer videodisk reader. The respondent stated it was more of a "novelty for people to play around with than an effective marketing tool." It was discontinued.

- It is obvious that these applications are of little interest to the IS departments. The question was generally greeted with about the same degree of enthusiasm as a question concerning the latest technological developments in slide projectors. This suspicion was confirmed when potential users were asked whether they had any plans for CD ROM applications. Only 2 respondents stated they had any specific plans for CD ROM applications, 11 stated they would consider the technology, and 34 stated they were not planning to use the technology in the foreseeable future (see Exhibit III-1).

- The actual responses to the question are even more discouraging than the numbers would indicate.

  - Very few of those rejecting the technology indicated they were familiar with either the technology or its possible application to the information systems for which they were responsible.

  - Of those who would consider the technology, the responses indicated the whole subject was of very low priority. For example:

    . One respondent stated his company might consider optical storage, but at present they were still evaluating the use of hard disks on PCs.

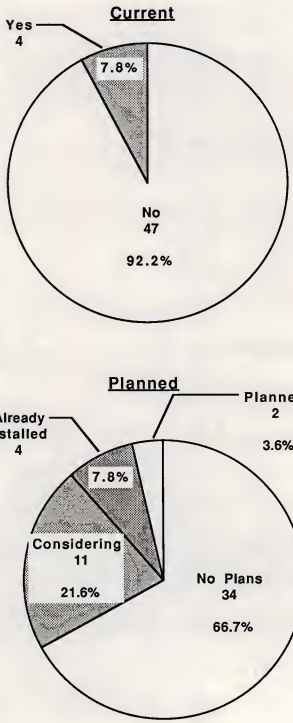
    . Another stated it was hard to project when they might use CD ROMs because they did not now have any applications in mind.

    . Several responded that they would "possibly" use the technology in the future.

    . Another respondent included in this category stated the interest would probably require "erasability."

EXHIBIT III-1

RESPONDENT APPLICATIONS



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- Only two of those "considering" CD ROM had definite ideas about possible applications--one for a library data base catalog and the other for aircraft maintenance manuals.

- Of the two respondents having "plans," one stated they would use a CD ROM in training for the use of PC software in the first quarter of 1987 and the other planned videodisk for PC-related training at some unspecified future time.

- The question concerning installed and planned applications of CD ROM was asked early in the interview, and it is obvious that IS management is generally unfamiliar with possible applications of CD ROM technology and is not currently giving much consideration to the subject. This is understandable when one considers existing problem areas facing most IS managers, such as the control of end-user computing, LANs, departmental processors, micro-mainframe links, productivity improvement programs, and rather tight budgets over the last two years.

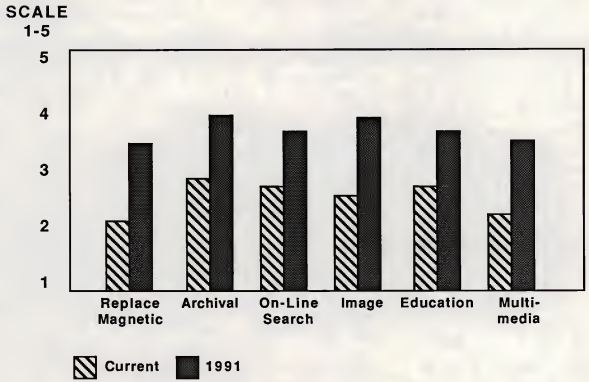
B. GENERAL APPLICATIONS

- At this point in the interviews, the current state of CD ROM technology (including its limitations) was presented to the interviewees, and they were asked to rate several general application areas as to their attractiveness at the present time and in 1991. The responses to this question are presented in Exhibit III-2.

  - The ratings were on a scale of 1 to 5, and INPUT's experience indicates such ratings tend to cluster within a "neutral range" of between 3.0 to 3.9 on this scale. That means 3.5 is the focus of central tendency rather than 3.0. In other words, average ratings of less than 3.0 indicate a negative reaction to the proposition (or product) and an

EXHIBIT III-2

RATING OF GENERAL APPLICATIONS



Rating: 1 = Not Attractive, 5 = Very Attractive

average rating of greater than 3.9 is required to conclude there is an unusually strong positive reaction. (This will be demonstrated and discussed in somewhat more detail in the next section.)

- Therefore, the reaction to current CD ROM technology is negative for all of the general application areas presented. It is unusual to get such universal rejection of any new technology for diverse general application areas. At the very least, neutral responses are to be anticipated on some of the suggested applications of the technology. Therefore, reaction of IS management to CD ROM technology seems to be surprisingly negative at the present time.

- When projected out to 1991, all of the general application areas except archival storage move up to the neutral range. This can be interpreted as being the deferral of "normal" interest in a new technology. The 4.0 rating for archival storage in 1991 is today's choice as the most promising application, but it barely escaped the neutral range.

- The results were just as discouraging when users were asked whether they could think of other general applications which would be attractive. Thirty stated "no," fifteen either did not answer the question at all or stated "unknown," and only six had any comments concerning possible applications (see Exhibit III-3). Even the six who had comments concerning application areas were extremely vague and usually felt they had no use for CD ROM. For example:

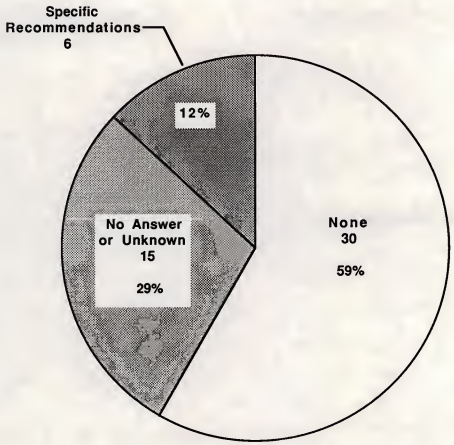
  - One respondent stated that while the company had no data in multiple locations, he could visualize the desirablity of downloading data in read only format.

  - Another felt that the primary use would be for "home data bases" assuming prices came down substantially.

EXHIBIT III-3

RESPONDENT RECOMMENDATIONS

Attractive Applications



- Two others stated the use was probably "unlimited" and that there must be specific applications they had not thought of.

- It was only after probing with yet another question concerning applications which might be most appropriate in the respondent's company that CD ROM application priorities began to emerge. These priorities generally conform to the ratings of attractiveness projected for 1991 (see Exhibit III-4).

  - Archival storage is mentioned as the most probable CD ROM application which will be implemented by 20 respondent companies.

  - On-line reference is given top priority by 11 companies, followed by 6 which mentioned education and training.

  - The other general applications of CD ROM technology received less endorsement by the respondent companies.

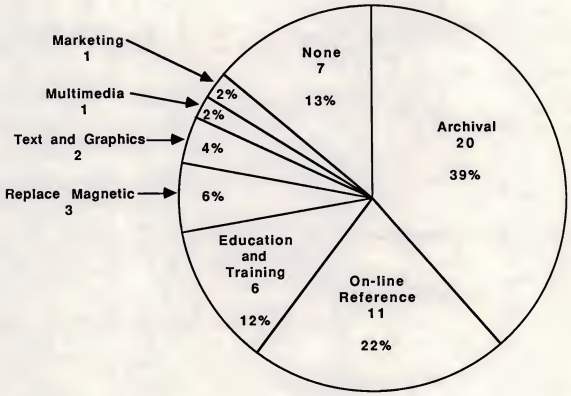
C. ASSESSMENT OF POTENTIAL

- When respondents were asked for their general thoughts about CD ROM technology, they responded in a manner which placed them into two general categories--those who had not given very much thought to CD ROM and gave no indication they were tracking developments in the technology, and those who indicated they were familiar with the technology and were following it. Respondents were distributed equally to these two categories with 26 falling into the first category and 25 in the second.

- However, it seems apparent that even among those who seem to be aware of the technology, the assessment which is being made is not of appropriate applications for the technology, but rather of the technology itself. Everyone seems to be waiting for something to happen before doing very much analysis of how the current technology can be used.

EXHIBIT III-4

COMPANY-SPECIFIC APPLICATIONS



- Why isn't a technology which has been billed as "the new papyrus" and which many (including INPUT) feel is the key to office automation being greeted with more enthusiasm? This is an important question. Substantial analysis and preparation is required on the part of both users and vendors if emerging optical storage is to be integrated effectively with existing computer and paper-based systems.

- At the present time, neither the solutions (CD ROMs) nor the problems (applications) seem to be very clearly defined. More importantly, both sides seem to be depending on the other for information and/or action. This is a serious problem.

- The remainder of this report will attempt to answer the important questions and to provide some tools to solve the serious problems.

IV TECHNOLOGICAL ASSESSMENT

IV TECHNOLOGICAL ASSESSMENT

A. THE POTENTIAL OF OPTICAL STORAGE

- INPUT has used the generic term optical storage to cover a variety of optical media which has grown to include:
  - Interactive videodisk.
  - OROM (Optical Read Only Memory).
  - CD-ROM (Compact Disk - Read Only Memory).
  - Digital videodisk.
  - CD-I (Compact Disk - Interactive).
  - Optical memory cards.
  - Write-once disks
  - Erasable media.
- While all of these media, technologies, and products have somewhat different application potential, they share characteristics which give them the potential

to revolutionize the way data and information are stored and communicated. Essentially, these characteristics are:

- Areal densities which are an order of magnitude greater than magnetic media. This translates directly into cost-per-bit and space savings so on-line computer storage will cost 1/10 as much as it does now and fit in 1/10 the space.

- Space savings exceeding two orders of magnitude when compared with paper documents and books. This results in the physical optical media being cheaper than paper, and the ability to represent information in digital form permits "processing" which translates into on-line optical storage costing 1/5 to 1/10 as much as a paper filing system (when all costs are included).

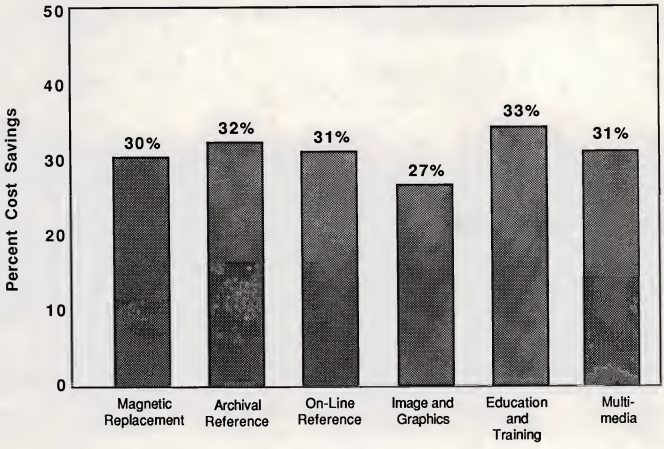
- Costs which are below computer-aided retrieval (CAR) of micrographic images. Improved processing capability (and human factors) of optical media systems result in costs which are about 1/2 to 1/5 that of an "automated" micrographics system.

- These potential cost savings of 50-90% are representative of those which have been predicted for optical storage systems (actually they are on the conservative side), and they obviously will vary substantiallly depending on the specific media and/or products being compared. In addition, there are certain other systems requirements in terms of access time and data transfer rates which must be considered. However, practically everyone is in agreement that optical storage has the potential for such cost savings in specific instances against the competing media (paper, magnetic, and micrographic).

- During the research for this study, we asked how much savings CD ROM would have to demonstrate in order to be attractive in the general application areas which were suggested to the respondents. The required savings for all application areas clustered around 30% (see Exhibit IV-1).

EXHIBIT IV-1

COST SAVINGS REQUIRED



- Over the years, it has been INPUT's experience that when asked for the cost savings required to switch vendors (for example, from IBM to a plug-compatible peripheral device), users normally report 20-25%. Therefore, it is assumed that the increase to approximately 30% in order to make optical storage "attractive" represents sensitivity to new and unproven technology.

- It is apparent that the "potential" savings being forecast for optical storage are sufficiently attractive to warrant the attention of users. However, CD ROMs are a limited subset of optical storage, and the current commercial products and service offerings do not appear to have very much appeal (or clear cost justification) to IS management.

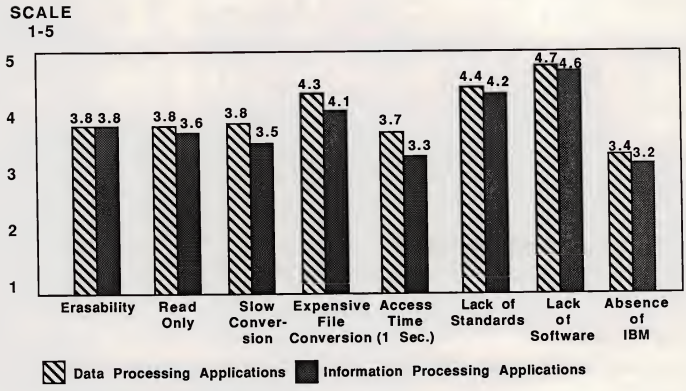
B. EVALUATION OF CD ROM LIMITATIONS

- The limitations attributed to CD ROM are fundamentally those which have been associated with optical media over the last ten years. Interviewees were asked to rate these limitations for both data processing (encoded data) and information processing (text and images) on a scale of 1 to 5 where 1 is not considered important and 5 is considered to be very important. The results are presented in Exhibit IV-2.

- It is readily apparent that while the respondents were negative about the general applications for CD ROM (see Exhibit III-2), they have strong opinions about some of the limitations of CD ROM. It is obvious that these sets of ratings are related. Remarkably (for it is not claimed to be sound statistics), combining the ratings from the two exhibits shows a normal distribution (around the previously mentioned tendency for the midpoint of 1-to-5 ratings to be 3.5 rather than 3) and depicts graphically the negative reaction to optical storage and the extreme sensitivity to specific perceived limitations (see Exhibit IV-3).

EXHIBIT IV-2

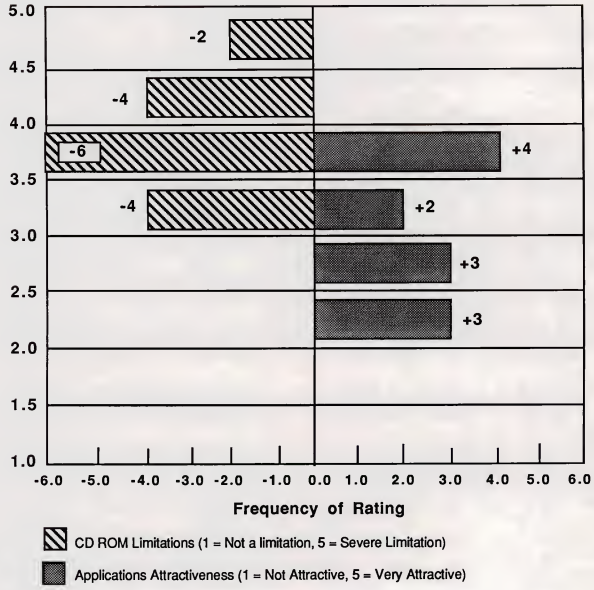
RATINGS OF CD ROM LIMITATIONS



Rating: 1 = Not Attractive, 5 = Very Attractive

EXHIBIT IV-3

DISTRIBUTION OF RATINGS



- This observed phenomenon of 1-to-5 ratings tendency to cluster in a range between 3.0 and 3.9 warrants some additional study. Too frequently, such ratings are ordered and published as if the difference between a 3.8 and a 3.5 rating makes one product or service significantly better than another. INPUT's long experience with 1-to-5 ratings does not substantiate such conclusions.

- In fact, it has been our experience that it is difficult to discriminate between items which fall within the neutral range or to attribute any great significance to items unless they fall out of the 3.0 to 3.9 range. Therefore, there are three significant, perceived limitations of CD ROM at the present time, and they apply to both data processing and information processing (accounting for the six items in Exhibit IV-3).

  . Expensive file conversion.

  . Lack of standards.

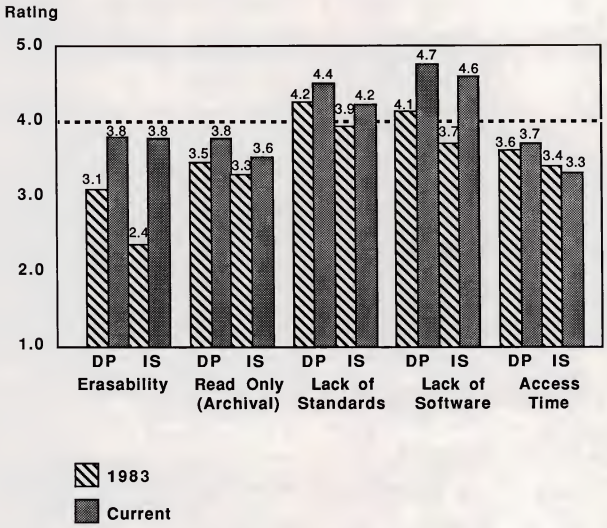
  . Lack of software.

- The research for Impact of Upcoming Optical Memories which was done in 1983 asked for a similar set of ratings on the limitations of optical disk. The IS managers interviewed in 1983 were selected based on familiarity with optical storage developments whereas those in the current study were selected randomly. Where the limitations rated were the same, there is reasonably good correspondence in the ratings (see Exhibit IV-4).

  - The significant limitations of standards and software were both rated over 4.0 for data processing applications in both studies. For information processing, the 1983 ratings slipped out of the significant category. This can be explained primarily because "information processing" was more clearly defined as being associated with image

EXHIBIT IV-4

COMPARISON OF RATINGS (1983 AND CURRENT)



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processing and document storage in the 1983 research (it was not restricted to CD ROM).

- Both studies also identified a third significant category which was not included in the other study. Expensive file conversion was rated over 4.0 on the current study, and "error rates" were rated at 4.6 for data processing applications in the 1983 study. (It is idle to speculate, but it is probable that if the categories had been included in both questionnaires their ratings would have been similar.)

- The ratings for access time (as a limitation) fall within the neutral range on both studies.

- The lower ratings for erasability on the 1983 study are deemed to be significant even though the ratings for data processing fall within the 3.0 to 3.9 range on both studies. (The analysis of these disparities and their importance will be presented a little later.)

- Of course, the fact that particular items fall within the neutral range does not mean they are not important and should not be analyzed. Asking respondents to rate "limitations" means that ratings which fall within the neutral range are considered limitations by the respondents. Those falling out of the neutral range indicate either that the respondents do not consider the particular attribute to be a limitation or they consider it to be a serious limitation.

- While it seems obvious to us that the current lack of active interest in CD ROM applications is related to the perceived limitations which have been identified, it appears doubtful that the respondents related their rejection of applications to specific limitations. Everything points to a general rejection of (or disinterest in) not only CD ROM but optical technology, and the important question raised in the previous section is "why?"

- When we asked the respondents why they did not have any plans for CD ROM (before the limitations were suggested in a later question), the answers clearly established the general nature of the technological rejection (see Exhibit IV-5).

  - Thirteen stated the technology was "not right."

  - Nine stated they had no knowledge of the technology.

  - Six stated there was "no need" for it.

  - Sixteen did not answer or merely stated they did not have any reason. (Six of these respondents either had applications installed or had plans, as shown in Exhibit III-1.)

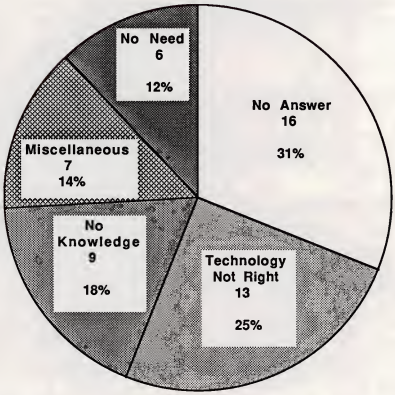
  - Among the miscellaneous responses, one mentioned lack of standards, and another mentioned that no applications of interest were "currently in use." Other answers were extremely vague (such as being novices in information processing) and could be just as easily included under the no knowledge or no need categories.

  - Among the technology "not right" and "no need" categories, five respondents qualified their responses by specifically mentioning "read only" as being the problem.

- Therefore, it was only after limitations of CD ROM technology were suggested that the respondents' perceived reasons began to emerge. It is practically as if they welcomed the suggested limitations as excuses for their lack of action and/or knowledge. However, there is a curious and significant anomaly in the ratings. IBM's failure to endorse CD ROM technology is the lowest rated limitation (see Exhibit IV-2), despite the following:

EXHIBIT IV-5

REASONS FOR NO CD ROM PLANS



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- IBM's failure to endorse the technology is the primary reason standards and software are not available, and these current limitations have been consistently rated among the most serious deficiencies of optical storage technologies.

- When asked at the end of the interview for general thoughts on the technology, the following comments were received:

  . Will be interested when I see IBM involvement.

  . When IBM comes out with a product.

  . When IBM gives its blessing.

  . Like with any computer technology, have to see what IBM is going to do.

- The general tone of the responses received from the interviews (concerning technology and timing) follow closely the comments IBM is currently making in public meetings when asked about potential impact of optical technology.

- It would appear that most people are doing what IBM would prefer to have them do regardless of whether they acknowledge the influence or not. This will be analyzed in more detail later in this report.

C. THE RATING CYCLE

- Over ten years ago, a leading computer consulting firm informed its customers that by 1985 magnetic storage would not be used because optical storage would make magnetic media obsolete. Since that time, optical

storage seems to have always been "just around the corner," and a cult of optical storage gurus, armed with newsletters, have tried to keep the optical drive alive. However, if our recent research is any indication, there has been a sharp decline in end-user interest or even willingness to consider major applications of optical storage technology.

- This phenomenon, which INPUT refers to as the Rating Cycle, is not new. It was first identified by Ada Augusta when interpreting the work of Charles Babbage on the analytical engine. She stated:

  - It is good to be wary of exaggerating the ideas that arise from the process of the analytical engine. There is often a tendency, in considering any new topic, to initially overrate the technology by emphasizing the interesting or amazing aspects of it. Then, when we realize it doesn't meet our expectations, we tend to undervalue the true condition of the technology.

  - The (device) does not pretend to originate anything. It can perform only what it is ordered to perform. It can follow analysis but cannot foresee any analytical relations or truths. The purpose and capacity of the device is to help make available what we are aware of already.

- It is difficult to think of any major hardware/software development in the computer industry which has not gone through the Rating Cycle of being first overrated and then undervalued. Optical storage is a major hardware development which has gone through the overrated phase of the cycle and is now in the undervalued trough.

- The second observation is not gratuitious. It was originally included in an INPUT report on artificial intelligence (Artificial Intelligence and Expert Systems, 1985) and applies equally to CD ROM applications. The ability to have enormous quantities of data and knowledge (as recorded in books and paper publications) available on CD ROMs attached to personal computers

does not necessarily improve the performance of the individual operator at the keyboard (whether file clerk or corporate executive).

- It appears that most IS management is unaware and unprepared for the fundamental change in media which is occurring and which will accelerate exponentially because of optical storage.

D. THE MCLUHAN MASSAGE

- Marshall McLuhan was scarcely understood in his own time and now is seldom referenced in the works of information science. Without pretending to be able to explain the works of McLuhan within the scope of this or any other study, it is important to credit him with the following insight: the means by which humans communicate determine our thoughts, our actions, and our life; and, the ascendancy of electronic media will have as far-reaching impacts as did the invention of the printing press.

- Since McLuhan did not specifically anticipate developments in microelectronics and optical storage, it is our opinion that the revolution in electronic media will have even more severe, and more rapid, impacts than were imagined. It is INPUT's belief that these impacts will be especially severe on traditional, paper-based business systems, and that it is necessary to be aware of, and sensitive to, these impacts in applying these new technologies.

- About 20 years ago, McLuhan published The Medium is the Massage which was billed as "an inventory of effects." It is not difficult to imagine what McLuhan might think about the situation today. McLuhan himself would find he can prepare finished publications using his Macintosh, and a major publisher might like to turn out a CD ROM version of The Medium is the Massage with its many photographs and illustrations.

- The personal computer is where "linear or sequential" communications and thought has begun to give way to a narrowing of the gap between thought and action. "What if. . ." questions are being answered a lot more readily today than ever before, and end users are no longer satisfied with long lead times to develop or change simple applications. More information is being generated in a much less structured manner--just as McLuhan predicted. The only problem is that there is little assurance that the quality of essential information can be maintained under the onslaught of the hot media.

- A well known company slogan circulated around the world used to be THINK. Ironically, the shift to electronic media leaves little time for thinking, and the emphasis of the tools of white collar productivity are on reaction time and the production of paper documents. The greatest challenge to IS management in this environment is the management of the flow of data and information and the assurance of their quality.

- Most office systems remain paper-oriented, and the tools of office automation have permitted and encouraged an enormous increase in the volume of paper documents being distributed within and among public and private enterprises and organizations. DP management over the years has tended to ignore conventional paper systems and procedures while concentrating on the computer room. IS management (despite fancy new titles) has been disinclined to become involved in such mundane things as records management while concentrating on computer networking.

- It appears that paper-oriented information sources, whether libraries or routine office paper handling, hold little interest for IS management. Since the early applications of optical storage (CD ROM and others) will address these problems, it is little wonder that most of the respondents had little interest in the proposed general applications of CD ROM. They are not familiar with, nor do they feel responsible for, the paper handling and storage problems which have been created primarily by computerized data processing and current efforts in office automation.

E. SHOW BIZ AND SOFTWARE

- INPUT has defined a software hierarchy it uses for purposes of classification and analysis (see Exhibit IV-6). IS management tends to have the following attitudes concerning this hierarchy:

  - SNA and operating systems are generally considered to be delivered from on high and are hardly subject to question. Humility is the most charitable term which can be applied to the patience and thankfulness for small favors which users demonstrate as they wait for software support of hardware they have already purchased and pay to have its poor performance improved.

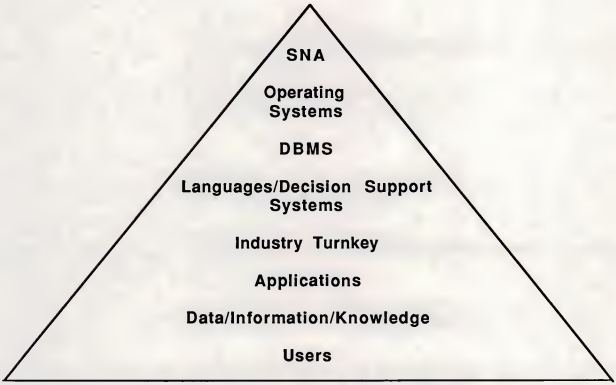
  - DBMSs, while central to the thinking of many IS managers, imply a lot of nitty-gritty work in order to assure data base integrity, data independence, control of access, etc. The data base administration function which is responsible for the quality of the data base is viewed as being routine and dull compared to DBMS software itself. There is every reason to believe that most IS management would view librarians as falling into the same category as data base administrators.

  - Languages (4GLs and above) and decision support systems are considered "quick and dirty" alternatives to professional systems development. They are necessary to keep end users quiet while the major systems are being developed. Install tools in the information center, hope for the best, but expect the worst.

  - Industry turnkey systems (or applications packages) are viewed as potentially being cost-effective ways to be more responsive to the demands for new and more complex application systems. However, even while more IS managers now express willingness to consider packaged applications or even systems, there remains a strong element

EXHIBIT IV-6

SOFTWARE HIERARCHY



of suspicion about the effectiveness of packaged solutions to "their problems."

- Applications development employing the latest hardware and systems software are considered the responsibility of the IS function and the challenge is considered enormous. Hardware and software are changing so rapidly it is nearly impossible to get a new system installed before it is obsolete. Integration of PCs, LANs, micro-mainframe links, relational data bases, and connectivity are all happening now; who needs optical storage?

- Data/information/knowledge as software is a foreign concept to most IS managers. Aside from constant reminders that "information is a corporate asset" and a lot of current talk about expert systems, most IS managers are not accustomed to thinking of buying data or information--much less knowledge. IS management thinks in terms of processing data and producing information (reports), but at this point they do not seem to be terribly concerned about the management of information and knowledge within their companies once it leaves the data center.

- Users are considered as part of the "software" because they interface with all of the above and are currently the primary storage facilities for knowledge. IS managers believe that users do not know what they want, do not understand the complexity of what they are asking for, and are generally antagonistic to the information systems department.

- Early personal computers were considered "toys" primarily because the early applications were games. It was not recognized that the players were interacting with complex systems and the software tools (graphics, menus, icons, etc.) were determining the user interfaces of the future. The action-oriented, non-linear, "McLuhanish" environment of electronic rather than paper media was being created.

- IBM, which was well aware of the potential of microprocessor technology, certainly did nothing to dispel the view of personal computers as toys. It was only after they began to appear in offices that IBM reacted to the obvious impacts on word processing equipment and intelligent terminals and announced the PC. The toys became business machines over night.

- The user acceptance of the early personal computers created enormous pressures on the central IS department. This rinky-dink piece of junk armed with a simple-minded spreadsheet package was suddenly giving some users information they had not been able to get from the enormous mainframe data base systems supported by decision support software. The users took the paper reports produced from the data center, entered the data, played games with the numbers to their hearts content, and then generated their own information (reports). The cycle between thought and action had been shortened because of the change from paper to electronic media, and users would never again be satisfied with the responsiveness of the central IS department.

- There is every indication that optical storage is on a course which will be very similar to that of personal computers.

  - This time the early impetus is coming from the entertainment business. Early videodisk development directed toward the home market failed because VCRs provide erasable media, but the CD ROM for superior audio reproduction appears to be a winner partially because the media is more difficult to clone.

  - Software and programming mean different things in the entertainment business and in the computer business. The early "productions" in multimedia products include the coordination of many creative types--audio-visual technicians and specialists, educators, and script writers all under the direction of a resident "genius." Oh, yes, and maybe some guy who can program a computer might be added as an afterthought.

- The electronic publishing of data and information bases tied into computer services companies refer to "titles" just as if they were publishing books. IS management runs data centers, not libraries.

- It is obviously difficult for IS management to get excited about what is going on with CD ROM; what does this have to do with the complex systems required to run their business? Even the use of CD ROM for archival storage of paper documents does not seem to excite them too much; after all, most computer-oriented analysts have ignored COM and other micrographics systems for years. And, there is a natural tendency to identify all optical storage with CD ROM (ignoring the availablity of WORM (write once - read many) and DRAW (direct read after write) optical media which was available before the term CD ROM came into popular use.

- It is difficult for IS management to see how optical storage (as exemplified by CD ROM) can have any impact on their major hardware-software systems in the foreseeable future, especially since the highest elements in the software hierarchy (SNA, operating systems, and current DBMSs) do not support optical storage. None of the current or potential vendors of CD ROM products can possibly provide the necessary leadership and direction to integrate optical storage at this level.

- That is IS management's assessment of the technology. It is the same position as was taken with personal computers, and the answer is expected to be the same--wait until IBM announces and sets the direction (and standard) before doing much of anything. IBM must be gratified that most IS departments have made this assessment of optical storage.

F. BIG BIZ AND SAN JOSE

- IBM has been the clear leader in the development of magnetic storage technologies; practically all current rigid and flexible disk technologies were originally developed in IBM laboratories. IBM takes great pride in its leadership in this area, and that pride is warranted. However, there is more than pride involved.

  - IBM's dominance of the large-scale magnetic disk (3380) market borders on monopoly, and the storage market is growing faster than the market for processors.

  - IBM revenues from magnetic disks exceed those from large-scale processors, and profit margins are substantially higher than on other product lines. Magnetic disk storage is the key factor in IBM's plan for the remainder of the 1980s.

  - At the present time, sale of magnetic disk products is holding up better than any other part of IBM's strategic plan.

  - It is difficult to overvalue the importance of magnetic storage to IBM's strategic plan.

- IBM's position on magnetic storage is very clear. At major customer briefings this year, the following points have been emphasized:

  - The cost of magnetic storage has been coming down by 17% per year. A megabyte of storage costing $300 in 1973 costs $30 today and will cost $3 in 1997.

  - Magnetic storage will "be around for the next 20 years."

- When asked about the potential impact of optical storage, IBM always makes the following points:

  - Research has been conducted on optical storage for years in IBM, and product development is currently the responsibility of the Tucson facility. (This makes it clear that IBM is aware of the technology and has continued to work on it despite the abortive joint venture with MCA on DiscoVision and lends credance to IBM's other observations concerning optical technology.)

  - IBM then states that optical storage will "probably appear at the low end first."

  - In addition, IBM emphasizes that they consider optical storage systems "very effective for mass storage replacing microfilm and for image processing."

- Therefore, IBM can be expected to introduce optical storage products in the following general application areas:

  - PC-based systems to support education and training (electronic publishing).

  - Archival storage of paper documents (micrographics replacement).

  - On-line storage of paper documents (electronic filing systems).

- Not surprisingly, IBM does not mention any potential for the archival or on-line storage of encoded data. Replacement of magnetic storage may not be unthinkable, but it will continue to be unmentionable until some sign of potential impact appears. At that point, IBM will make maximum use of the real and imagined limitations of optical storage to assure that its customer base remains with proven, magnetic storage for storing "vital corporate information."

- IBM may encourage a revolution aimed at publishing, micrographics systems, and paper-based systems, but you can be sure it will emphasize evolution in any shift from magnetic to optical storage. And, IBM has awesome tools to put down any revolution being fomented among its customer base. However, if this study is any indication, that population currently seems unmoved by what is going on in the technological streets and back alleys of optical storage.

- It is INPUT's opinion that the current flurry of interest in CD ROM applications is a diversion from the more important systems ramifications of optical storage. Unless these systems ramifications are understood, it is impossible for vendors to plan useful products and for users to make intelligent plans to take advantage of optical storage technology.

V SYSTEMS RAMIFICATIONS

SECTION 2

E.P. 23
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V SYSTEMS RAMIFICATIONS

- When INPUT published Impact of Upcoming Optical Memory Systems in 1983, seven systems categories were defined in an attempt to bring optical storage applications and technology together in proper perspective. These categories will be used as they were originally defined in the earlier report (although two categories have been renamed) to provide some basis for analyzing the following:

  - How CD ROM fits into various categories.
  - The impact of current optical storage limitations on the implementation of applications falling into those categories.
  - Which systems categories are most likely to be addressed by IBM product announcements.
  - The additional (or peripheral) hardware/software requirements necessary for successful application systems implementation.

A. "PUBLISHING" SYSTEMS (CATEGORY I)

- The original name of this category was "Standalone Videodisk Systems," and it presented the potential applications for commercially available videodisk

players equipped with a conventional TV monitor (or high-resolution display). CD ROM is the current "commercially available" implementation of optical storage, and it can be substituted for videodisk without any change in the applications which can be provided. The name of the category has been changed to "Publishing" Systems to more accurately reflect the technology and the fact that the media employed will be prerecorded (published).

- Exhibit V-1 presents a simple schematic of the system. It could be enhanced by adding a full personal computer, but the fundamental applications remain the same as long as the recording technology remains CD ROM. This simple system will accommodate most of the applications being mentioned today, such as:

  - Education and training.

  - Reference materials and proprietary data bases.

  - Manuals and catalogs (such as auto and aircraft maintenance, library catalogs, etc.).

  - Archival storage of paper documents (assuming the availablity of service bureaus for document entry).

  - Subscription services to data and information (there is no reason the published information cannot be supplemented with on-line retrieval from the information source).

- The computer hardware/software technology to implement such applications is available today and has been available for some time. The reason such systems have not been developed are as follows:

  - The published material (data/information/knowledge software) has not been available. This is true for several reasons:

EXHIBIT V-1

"PUBLISHING" SYSTEM

Display

TV Set

or

High-Resolution Display

Keyboard (Microprocessor)

Internal Storage

for

Indices, Simple Programs

Videodisk Player

"Processed" Disks

for

Images, Graphics, Documents

Applications:

- Education and Training
- Reference Materials
- Archival Document Storage
- Point-of-sale (with optional reader)

- Publishers are paper-oriented, and many either do not understand or fear the new technology.

- Taking advantage of the capabilities of the optical media is a significant creative challenge for many diverse professions.

- There is some fear that electronic publishing will cut into sales of conventional books and reference sources.

- There is little understanding of how to charge for such information.

- Proprietary data bases provided from computer services companies suffer from most of the same problems as publishers except the bias is for conventional computer systems.

- Micrographics systems vendors are very much aware of the technology, and they are hesitant to pursue it actively for fear of opening up "high tech" competition.

- Then, of course, there is the general lack of understanding and/or acceptance of the technology which has been, and continues to be, demonstrated in the marketplace.

- However, this is precisely the market IBM will target for initial product announcement. It is anticipated that a PC-based CD ROM system targeted at the education and training market will be announced in the near future (within six months). This would certainly encourage publishers to develop software titles just as software programs were developed for the PC. IBM cannot afford to concede the education market to Apple and has to establish a presence soon.

- IBM also has an exceptional opportunity (and an enormous built-in market) in electronic publishing. The need for technical documentation and training in the use of its products makes IBM one of the largest publishers in the world. Providing such documentation and training on optical media (rather than paper and microfiche) would represent the best possible endorsement of the technology and open up a new market that is now occupied by micrographic systems for IBM.

B. STANDALONE IMAGE SYSTEMS (CATEGORY 2)

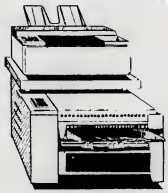
- However, it is probable that IBM will announce more than CD ROM. WORM opens up the whole micrographics systems market. Remember that IBM has publically stated that optical storage is "very effective for mass storage replacing microfilm and for image processing." By announcing a WORM optical drive and adding a scanner/camera, a Standalone Image System (see Exhibit V-2) capable of "replacing microfilm" (and CAR micrographics systems), IBM can open up a new market without concern for the potential impact on magnetic storage.

- This modest step forward in optical technology has significant advantages over "Publishing" Systems in that it permits updating of existing information bases without waiting for new reference works, catalogs, manuals, etc. to be published. In addition, the Standalone Image System permits the flexibility of entering new material to supplement and complement the published works without going through an outside service bureau. Articles from journals, clippings from periodicals, handwritten notes, etc., all can be entered, classified, and managed without resorting to maintaining paper files.

- This level of system would originally be directed toward libraries or central file facilities where it would facilitate information base management and permit users to search or browse through information and extract hard copies

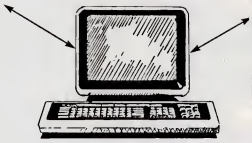
EXHIBIT V-2

STANDALONE IMAGE SYSTEM



Camera/Scanner
Laser/Printer

Document Input
Hard Copy Output



Intelligent Workstation

Optical Disk Storage

WORM

Applications:

- Archival Storage
- Electronic Filing and Retrieval System

as required. However, it also has the potential to be used on a convenience basis like a copier where individuals could update their own personal information bases. (For example, considering the enormous amount of information being published on optical storage, the author of this report would have benefited substantially if such information could have been placed on a single disk rather than being distributed in various books, periodicals, and file folders.)

- The flexiblity of being able to add documents to the information base expands the potential applications enormously. The difference between CD ROM and WORM systems is equivalent to duplicating systems before and after xerography. If INPUT is correct and IBM announces WORM optical drives early, it is doubtful whether the CD ROM "publishing"-oriented systems will ever penetrate the general document storage market.

- The next two systems which will be described will demonstrate how significant simple "write once" capablity can be.

C. ELECTRONIC FILING AND RETRIEVAL SYSTEMS (CATEGORY 3)

- Once a paper document of any kind is captured on CD ROM (or any suitable optical media), it no longer exhibits the "linear or sequential thought, separating thought from action" which McLuhan described as the consequence of printed media. Electronic media facilitates rapid and flexible communications, and the Standalone Image Systems described earlier can obviously be connected to networks. Thus, the archival documents can be retrieved by individuals or broadcast to distribution lists. Problems of "checked out" paper documents, whether medical records, insurance files, legal records, or books, disappear once conversion from paper to electronic media takes place.

- The potential advantages of optical storage for the storage of archival information are well known, but there seems to be less awareness of the significance of the media for day-to-day office operations. With the CD ROM and WORM optical systems described earlier, it is also possible to build operational Electronic Filing and Retrieval Systems (on LANs) which can substantially reduce the flow of paper documents in the office (see Exhibit V-3).

- The reduction of paper in the office environment was determined to be the most promising target for office automation in Impact of Office Automation on Productivity, INPUT, 1983. This conclusion was reached for the following reasons:

  - The physical handling of paper documents (distributing, filing, retrieving) represents 14.6% of total white collar personnel expense in offices. This represented approximately $170 billion in 1981, and by now must be substantially over $200 billon; personal computers and desktop publishing only compound the problem.

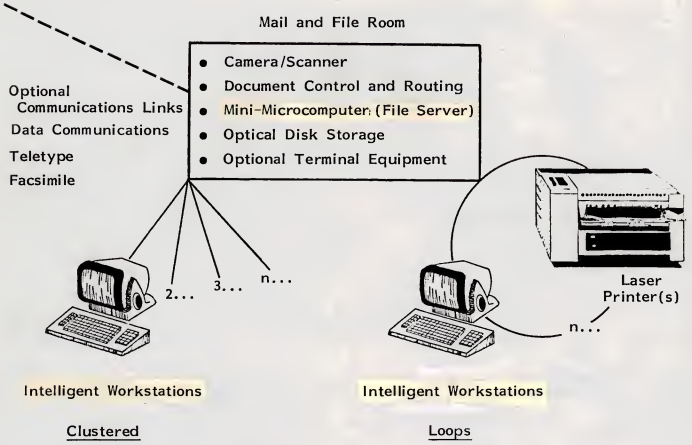
  - Contrasted with this is the fact that typing and data entry represent only 3.8% of white collar expense, and that is where most of the office automation effort has been expended.

  - The physical handling of the paper documents is only part of the expense, copying is not a cost-effective means of information entry. Copies are made of copies, and multiple copies circulate to the same people. All of these multiple copies must not only be handled, they must be analyzed by the recipient (even if it is only to discard the piece of paper in the waste basket).

- The Electronic Filing and Retrieval System depicted in Exhibit V-3 would go a long way toward reducing the flow of paper in the office. The document and publications control center can be viewed as a combination mail room, file

EXHIBIT V-3

ELECTRONIC FILING AND RETRIEVAL SYSTEM
(Local Area Networks)



Applications:

- Archival Storage
- Document Filing and Retrieval System
- Information Flow Control :

room, and library. All paper documents and publications from either external or internal sources are originally routed through this facility. Here they are received, logged, classified, indexed, stored (on optical disk), and routed to appropriate individuals (either automatically on receipt or on request).

- This process could result in the truncation of a high percentage of paper documents and publications, and it most certainly will speed the flow of information within the organization. However, to this point the systems presented deal only with images of paper documents. This has both positive and negative implications:

  - The positive side is that such systems pose little threat to IBM's magnetic storage market and are, therefore, likely to receive early endorsement from IBM. ($200 billion a year spent on paper handling can cost-justify a lot of computer and communications equipment.)

  - The negative side of Electronic Filing and Retrieval Systems is that they are only loosely coupled with centralized data bases. (Early vendors such as Filenet provide a gateway from the LAN.) If permitted to evolve separately (from libraries, central file facilities, or administrative services) without attention from the IS department (a likely possibility if our research is any indication), considerable conflict could develop at the points of interface between the systems. In addition, later integration problems could be horrendous.

D. INTEGRATED IMAGE PROCESSING SYSTEMS (CATEGORY 4)

- If IS management continues to ignore optical storage (including CD ROM), a situation comparable to the experience with PCs will develop rapidly. Standalone PCs proliferated without effective IS control (or interest) until data were required from central data bases. At that point, the question of

micro-mainframe links and "connectivity" became the paramount systems concern. The problems created by early benign neglect of PCs have yet to be solved by most users. (As a significant aside, the "demand" for access to host data bases is associated primarily with media conversion. PC users recognized they were keying in data from paper documents which had been produced from processable data, and it does not take much imagination to improve that type of systems design.)

- Media conversion--from paper to optical to magetic--will also be the primary integration problem which will result from the installation of the first three categories of optical storage systems. More specifically, how are images on optical media integrated with encoded data on magnetic storage devices? Exhibit V-4 depicts an Integrated Image Processing System which is currently possible with existing hardware (and substantial systems design and programming effort). A working model of such a system, using video tape rather than optical disk, was actually developed over five years ago.

  - The integrated image processing system is installed in the central mail/file/library facility described in the previous section. However, it has significantly more ability than an electronic filing and retrieval system.

  - The camera/scanner digitizes the paper images.

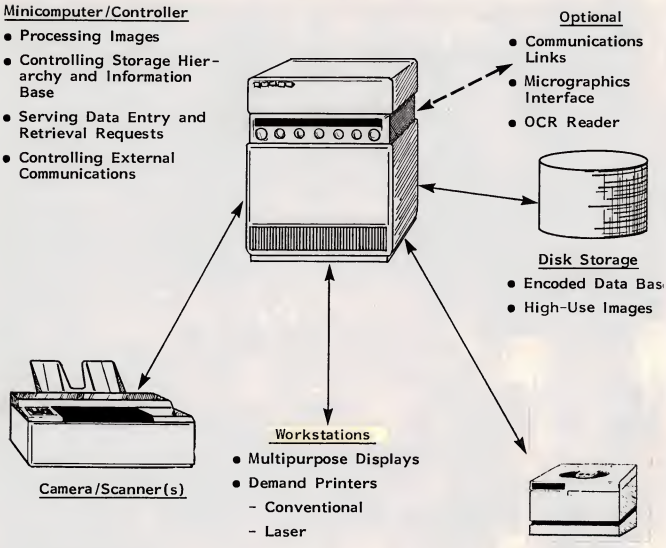
  - The minicomputer/controller performs the following functions:

    . It compresses the digitized images in order to make more effective use of the storage hierarchy.

    . Using pattern recognition, it identifies a set of specified patterns (any font, symbol, or graphics) and updates encoded data bases directly from the source document.

EXHIBIT V-4

INTEGRATED IMAGE PROCESSING SYSTEM



Applications:

- Document Storage
- Data and Information Base Management
- Document Control, Routing, and Processing
- Integrated Word Processing, Data Processing, and Electronic Filing

. It manages the conventional encoded data base on magnetic disk and the image storage on optical disk, integrating requests for information which draw on both encoded data and image information from either of the storage systems.

- Recognizing that current data capture and image storage systems will remain in use, provision is also made for optional OCR (optical character recognition) equipment and micrographics interfaces.

- This type of integrated system is directed toward operational information flow within an organization, truncating the flow of paper documents from outside sources and directing the flow of data and information within the organization. It is the point of interface (integration) between existing paper-based, data processing, word processing, and data entry systems and emerging image processing systems. IS management either becomes involved in solving this integration problem or data processing becomes a secondary appendage on the major operational systems of the organization.

- IBM recognizes the importance of such integrated image processing systems. However, unlike the earlier systems which were described, at this level IBM starts to run into some conflicts with its strategic plan.

  - The storage of images on magnetic disk will assure the type of growth for DASD which has been projected by IBM out into the 1990s.

  - While the system described above does not necessarily replace magnetic storage, once installed it will become readily apparent that many low-use files can be more cost-effectively stored on optical disks. This will cause conscientious IS management to look at the update patterns of their large data bases and discover that many are never (or infrequently) updated.

- At this point, it will be discovered that erasability is not as severe a limitation as it has been projected to be by most users, and there will be the threat of immediate impact on the market for magnetic storage. This IBM wants to avoid at all costs.

- IBM is not likely to fully endorse (support with either hardware or systems software) integrated image processing systems in the near future. This level of system is critical for IBM to control because IBM's growth will depend on such systems in the 1990s. In the meantime, IBM's growth depends on the sale of magnetic storage, and it is a delicate problem to phase in optical storage to replace paper and to manage the impact on magnetic storage at the same time.

E. MAINFRAME OPTICAL STORAGE SYSTEMS (CATEGORY FIVE)

- Nonerasable optical disks (whether CD ROM or WORM) have the potential to cost-effectively supplement and complement mainframe magnetic storage (see Exhibit V-5), and this conclusion is usually substantiated when a detailed analysis of large data bases is conducted. It is also a fact that where mainframe products have appeared (such as STC's optical system), they have not met with success.

  - The usual reason given for rejecting the drives is that erasability is required, and this usually comes from those who have not done detailed analysis of access against on-line files.

  - In addition, this study clearly demonstrates that substantially higher cost justifications are required for optical storage than for most new products and services.

EXHIBIT V-5

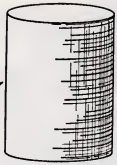
MAINFRAME OPTICAL STORAGE SYSTEM

Optical Disk or Storage System

- Encoded Data
- Images
- Initially "Read-only"

Storage Controller

Storage Controller



Magnetic Disk Storage System

- Encoded Data

Advanced or Modified Systems Software

Conventional Mainframe

Communications

- Satellite
- Coax
- Fiber Optics
- Conventional

Work Stations

- Conventional Displays
- Conventional Printers
- High-Resolution Displays
- Window Displays (Split-Screen)
- Graphic Devices
- Laser Printers

Applications:

- Supplement and Complement Disk Storage
- Backup
- Very Large Data Bases
- Information Bases
- Network Management
- Integrated Data/Information Storage

- However, INPUT believes that even with erasability and lower costs for optical disk systems, significant penetration of the mainframe market will require IBM's endorsement. And, IBM will not endorse optical storage for mainframes until it is forced to do so. A 80386-based microprocessor system with gigabytes of optical storage is going to raise some serious questions among users accustomed to paying for central host storage and access. Traditional economies of scale for processors are going to have to be reexamined; they obviously do not apply to such systems. The time when both IBM and IS management must take a serious look at the processing and storage hierarchy is approaching rapidly.

- IBM has considerable ability to control both the hardware/software interfaces of mainframe processors and user acceptance of new mainframe peripheral products regardless of price-performance. In addition, IBM has demonstrated the ability to control the distribution of processing and data from host mainframes for the last 15 years despite the relative price-performance of minicomputers. The replacement of mainframe magnetic disk storage with optical media is going to be a war which will rage well into the 1990s.

F. DISTRIBUTED INFORMATION MANAGEMENT SYSTEMS (CATEGORY 6)

- The potential for distributing processing from mainframes on either a geographic or architectural basis has been a constant INPUT theme for over ten years. While IBM has been successful to this point in resisting distribution of processing to minicomputers (geographic) and to data base machines (architectural), the advance of microprocessor technology has threatened to turn mainframes themselves into enormous "data base machines" whose primary function is to provide data for distributed nodes (LANs) and intelligent workstations (micro-mainframe links).

- Since various data models (hierarchical, network, and relational) are destined to coexist into the next century, some means of integration is necessary even for conventional systems. (Data flow between production systems (IMS) and information centers (DB2) is a horrible hodgepodge.) With image processing systems and electronic filing systems, new concepts for information management are going to be required. Optical storage presents an ideal opportunity to build integrated data/information management facilities into hardware systems rather than add an additional software burden to already overloaded mainframes (see Exhibit V-6). Indeed, optical storage may force such distributed architectures.

- This level of integration goes far beyond that demonstrated in Category 4. INPUT has stated that IBM's host-oriented networking strategy is more justified now than it has ever been, primarily because of considerations of data and information quality, including security and privacy. The uncontrolled distribution of data and information raises many problems, and optical storage only exacerbates these problems because of its cost, capacity, and portability, and the fact that it may contain information (images of documents, etc.) rather than raw data. This central facility permits the following:

  - The orderly integration of magnetic storage with optical storage.

  - The establishment of audit trails between documents and the data on which they are based.

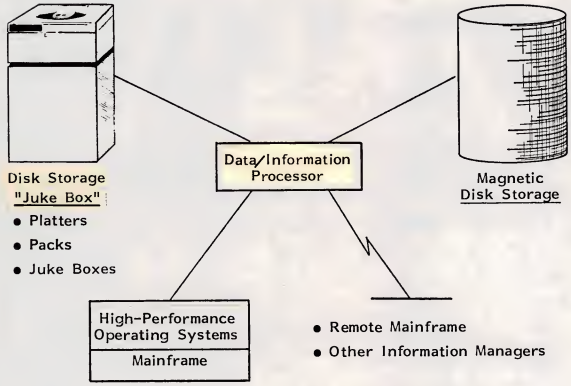
  - The orderly integration of the different types of optical media which will become available (CD ROM, WORM, erasable, etc.).

  - The ability to take advantage of the unique properties of these media. For example:

    . For published works (including programs), CD ROMs have the advantage of not being modifiable, and centralized management

EXHIBIT V-6

DISTRIBUTED INFORMATION MANAGEMENT SYSTEM



Architectural Information Systems Distribution

Geographic Information Systems Distribution

Application:

- Integrated Data and Image Processing
- Information Management
- Information Interchange
- "Libraries"

of such published works creates many alternatives for distribution and cost recovery.

. Nonerasability can also be considered an advantage for many documents, data bases, and programs; security is enhanced when hackers cannot destroy data bases and correspondence cannot be altered or removed from the "file cabinet."

- Improved performance and control for the problems of file conversion and backup which are going to be enormous as media conversion proceeds. Incidentally, these problems already exist with distributed data bases regardless of media, and it is important to recognize that optical media should contribute to the solution rather than the problem.

- When asked a direct question concerning data base machines, IBM's public answer has consistently been that hardware assists for DBMS performance will occur under the covers of the mainframe and not be distributed to a backend machine. However, as this report was being prepared, it has been reported that IBM may be prepared to announce an intelligent controller for DB2, but it should be understood that this would be virtually under the covers and not constitute a full-function data base machine. Either way, there is additional support to INPUT's opinion that large mainframes are, in fact, becoming data base machines. Coupled with the fact that DEC is stressing that mainframes should be viewed as "peripherals" on distributed processing networks, a Category 6 system could be viewed as a replacement for those peripherals.

- Regardless of what tactics are employed, IBM's objective is going to be to prolong the central role of large host mainframes and to minimize the impact of optical storage on magnetic storage revenues.

G. NETWORK STORE AND FORWARD RESERVOIR SYSTEMS (CATEGORY 7)

- Distributed Information Management Systems (Category 6) represent the architectural distribution of processing to backend file processors. The Network Store and Forward Reservoir distributes processing to communications processors on the front end of large mainframes (see Exhibit V-7). The use of optical storage media on the communications network would serve primarily as buffers for mainframe (or supercomputer) processors, and optical storage systems might be either optical disk or laser/optical tape.

- While information bases on the backend can be readily identified with conventional data base management systems, the analogy of network store and forward reservoirs with conventional spooling is somewhat misleading. A few specific application examples may be of assistance:

  - One obvious example of the need for a network reservoir is for storing data from space probes, where the volume of data being returned requires days, weeks, and even months of data reduction before it can be analyzed by even the largest computers.

  - With satellite and fiber optics communications between and among computer systems, and the higher bit rates required for the transmission of images, there will be increased need for buffering between the network and processors. In fact, even with a personal computer tied to an information services network, it is possible to accumulate enormous quantities of information for possible future analysis and use.

  - While it is currently not recognized (or accepted), micro-mainframe links and the distribution of data bases is going to require a return to sequential batch processing on mainframes. Imagine 50 requests, from 10 different nodes, for extracts against a large sequential file to build DB2 tables which are to be transmitted, and it is easy to understand

EXHIBIT V-7

NETWORK STORE AND FORWARD RESERVOIR SYSTEM

Optical Storage "Juke Box"

- Encoded Data
- Images
- Digitized Voice Messages
- Video "Messages"

Magnetic Storage

- Accounting Data
- Network Management Data

Communications Processor

- Communication Front End
- LAN Communication Control
- Earth Station
- Public or Private Switching System

Applications

- Data Collection
- Information Store and Forward
- Network Archiving

why batching will be desirable. Then the question becomes what do you do with these 50 files (data bases), and the answer is apparent--you get them off the mainframe as soon as possible. That means you push them out on the network which must have the ability to store and forward because the node and/or the requesting workstation is not ready to receive. Enormous storage capacity is required for this environment, and mainframe magnetic storage just will not be able to handle it. The network management philosophy will have to be to get the information as close to the requestor as soon as possible, but queues (bottlenecks) will be inevitable at some level. Optical storage is going to be necessary to satisfy this environment.

- Then, of course, once we get beyond encoded data (such as ASCII), images, digitized voice, and all those wonderful things we are talking about require enormous amounts of bits. Moving them around on networks will require storage capacity and costs which cannot be provided by either current or projected magnetic storage devices.

- It is possible that IBM will endorse optical storage for network store and forward reservoirs before it does Category 5 (Mainframe Optical Storage). In many ways it makes both good technical and business sense for IBM to do so. However, SNA is still trying to catch up with rudimentary network management functions which were requested by some users over ten years ago, and those venerable 37XX communications front ends are not designed to take much burden off the big boxes. However, times are changing and many obsolete products and systems are going to be swept away by the types of systems which will be developed around optical storage.

VI PROJECTED TECHNOLOGICAL IMPACTS

VI PROJECTED TECHNOLOGICAL IMPACTS

A. OPTICAL MEDIA ON SYSTEMS CATEGORIES

- Exhibit VI-1 presents the impacts of CD ROM, WORM, and Erasable optical media on the various systems categories which were described above. The impacts of the media are rated on a scale of 1 to 5 based on how much impetus they give to the development of a specific type of system. Generally, the ratings can be construed as follows:

  - A rating of 1 means the particular media will be the driving force behind the development of such systems. Products incorporating that particular media should be seriously considered for the types of applications facilitated by that particular systems category.

  - A rating of 2 means the such media makes a strong contribution to the particular systems category regardless of the primary media which will be employed. This means that products incorporating the media can be considered for implementing such systems prior to the time the primary media becomes available, or may be superior for specific applications even though the primary media is used for most applications.

  - A rating of 3 means the particular media neither contributes significantly to nor detracts significantly from the implementation of most

EXHIBIT VI-1

IMPACT OF OPTICAL STORAGE ON APPLICATION CATEGORIES

APPLICATION CATEGORY	CD ROM	WORM	ERASABLE
Publishing	1	3	5
Image	4	1	3
Filing	4	2	1
Integrated	5	2	1
Mainframe	5	3	1
Distributed	4	2	1
Network	5	3	1

Rating: 1 = High Positive Impact, 5 = No Positive Impact

applications for that systems category. This means that such media can be considered for prototyping of many applications prior to the time the primary media is employed (either because of availablity or cost). The rated media could coexist with the primary media for a significant portion of the application's life.

- A rating of 4 means that while the media may be appropriate for a limited implementation of certain applications within the systems category, it probably would be advisable to implement with another media even if this would mean that implementation would have to be postponed.

- A rating of 5 means that the particular media is unsuited for the particular systems category either because of its characteristics or its cost.

- For Category I systems (Publishing Systems), CD ROM is an appropriate media providing security for copyrighted materials (books, training courses, programs, etc.) and protection for vital archival records. WORM media does not add sufficiently to most of the applications to justify it, and erasable media would be considered a disadvantage for many possible applications (for example, medical records, letters of credit, accounting records, etc.).

- Once beyond Category I, CD ROM does not have attributes which give impetus to the development of other systems categories, and it is probably just as well that users do not seem to be terribly enthusiastic about the technology at this level. However, INPUT research and most published reaction to optical storage indicate that the negative reaction is on the "ROM" portion of CD ROM. When this negative reaction carries over to WORM media it is very badly misplaced.

- WORM technology should encourage immediate implementation of four of the remaining Systems Categories: Image (2), Filing (3), Integrated (4), and

Distributed (6). Fundamentally, this says that there is no reason to wait for erasable storage of information (images) which has previously been stored on paper. Paper itself is not erasable and extremely expensive to manage since it is labor intensive.

- Erasable optical media has the advantage of adding substantial flexibility to the storage hierarchy, and the direct cost comparisons with magnetic media will literally force IS management to consider optical products. Unfortunately, once erasable optical media becomes available, attention will be focused on mainframe applications, and the important office applications which will reduce paper flow may continue to be neglected. IS management seems focused narrowly on processing of encoded data and not on information processing.

B. IBM ON SYSTEMS CATEGORIES

- Exhibit VI-2 presents IBM's perceived attitude toward the optical storage systems categories, its ability to control those categories, and the probable data on optical storage products which will address some of the applications facilited by those system categories. The ratings of IBM's attitude and ability to control are on a scale of 1 to 5. (For attitude, 1 = very positive and 5 = very negative; for control, 1 = great ability to control and 5 = virtually none.)

- IBM's attitude toward the various systems categories is obviously based on the potential impact on magnetic storage products. The ability to control is based on systems software (SNA, operating systems, and DBMS) and the lemming-like loyalty of some IBM customers (IBM calls it account control). INPUT believes IBM will be able to control the impact of optical storage on mainframe magnetic storage until the 1990s, and even after IBM announces directly competitive (erasable) optical media products, they will probably be positioned at another level in the storage hierarchy rather than as a direct replacement.

EXHIBIT VI-2

IMPACT OF IBM ON APPLICATION CATEGORIES

APPLICATION CATEGORY	IBM TACTICS	IBM IMPACT	AVAILABLE FROM IBM
Publishing	1	(5)	1987
Image	1	(4)	1987
Filing	2	(4)	1988
Integrated	3	(2)	1989
Mainframe	5	(1)	1990
Distributed	4	(2)	1991
Network	4	(3)	1989

Rating: 1 = Low IBM Concern, 5 = High IBM Concern

Rating: (1) = Low Probability of IBM Endorsement, (5) = High Probability of IBM Endorsement

- Several years ago, when conducting research for Market Impacts of IBM Software Strategies, INPUT, 1984, it was reported that someone from IBM research informed the then IBM vice president of technology and programming that optical storage could start impacting IBM revenues from magnetic storage by 1988. The reply of the vice president was reported to be: "I'll believe it when I see it, and when I see it we'll take it away from them." It is probable that this was (and remains) an accurate assessment of the situation.

C. SYSTEMS CATEGORIES ON NETWORK HIERARCHY

- INPUT has propounded a "proper" network hierarchy of very large mainframe-, minicomputer-, and microcomputer-based workstations for over ten years, and it is beyond the scope of this study to repeat our arguments that functions fall naturally at appropriate levels in the hierarchy (based on hardware/software price-performance) and that IBM's strategy has consistently been to control the distribution of processing in order to maintain demand for large mainframes. (For those interested in details of our continuing analysis of distributed processing, it is suggested that the Large-Scale Systems Directions series of reports be reviewed, starting with 1984.)

- Optical storage will substantially enhance the economics of the proper hierarchical network and clearly demonstrate how functions (applications) should be distributed over the network.

  - Categories 1 and 2 (Publishing and Image S stems) are most economically built around microprocessor-based systems. Just as we have all become aware that it is more economical to do word processing on a PC, we shall also find that it is more economical to browse through "books," images of paper files, and large archival data bases at the workstation.

- Catetgories 3 and 4 (Filing and Integrated Systems) will be driven by minicomputers because it will be found that it is more economical to control the flow of data and information within the work unit (office) with specialized hardware/software configurations. Mainframes with general purpose hardware/software will be too expensive, and the systems software to maintain complex data/information bases on optical storage will prove to be too much of an event for the most powerful desktop.

- Categories 5 and 6 (Mainframe and Distributed Systems) will require the power of large, general purpose hardware/software systems to maintain data/information/knowledge quality on the institutional network. The ability to distribute enormous data bases only exacerbates quality problems (data base synchronization, integrity, security, etc.) for which there are no known solutions.

- Category 7 (Network Reservoirs) will be the IS on-premises implementation of switching systems. The environment which will evolve is not only going to be something like ISDN; it is also going to have attributes which are like the U.S. Post Office and your mail room. Priority mail and junk mail do not move at the same speed through networks and some provision has to be made for accumulation of garbage, otherwise the internal operational networks will be overwhelmed with sorting and classification problems.

- Undue focus on any particular level of the network will result in serious discontinuities at other levels. For example, if optical storage does start at the "low end" as IBM has predicted, users with a gigabyte of storage at their workstation are likely to consider mainframe magnetic storage costs excessive, and what do they do about backup? Just as "power users" of PCs get addicted, so will those who become accustomed to dealing with large quantities of data and information.

D. SYSTEMS CATEGORIES ON COMPETING MEDIA

- Exhibit VI-3 presents the potential impact of the various systems categories on competing media. The ratings are on the basis of 1 to 5, with 1 being the most severe impact and 5 being minimal. In addition, the ratings are cumulative in the sense that the ratings for each system assume the availability of previous systems on the projected time table in Exhibit VI-2. In other words, it is only after all of the optical storage systems are available that the potential impacts on competing media are maximized.

- It should also be pointed out that we are projecting the potential impact of the system, and that the impacts (advantages) associated with optical storage require a considerable implementation effort. Therefore, the ratings can best be interpreted as follows:

  - The impact of Systems Categories 1, 2, and 3 (Publishing, Image, and Filing Systems) on paper media are rated at 3 and 4 which means that there is the potential for impact on the growth rate of paper products (fanfold paper, books, Xerox copies, etc.), perhaps even to the point of leveling off. Systems Categories 4, 5, and 6 being rated at 2 means there is the potential to actually reduce the paper flow withing specific work units and organizations. Once networks can accommodate the volumes of interorganizational information flow (and storage), the potential for reduction in all forms of paper communications could be quite high.

  - Micrographics systems have never had outstanding growth characteristics despite significant cost justification; therefore, CD ROM, as the harbinger of better things to come, will start to reduce the demand for such media even with the rating of 3 which has been assigned to Systems Category 1. The impact will rapidly become severe, and while micrographics systems are not going to disappear overnight, the

EXHIBIT VI-3

IMPACT ON COMPETING MEDIA BY APPLICATION CATEGORY

APPLICATION CATEGORY	PAPER	MICRO-GRAPHICS	MAGNETIC
Publishing	4	3	5
Image	3	2	5
Filing	3	2	4
Integrated	2	2	3
Mainframe	2	1	2
Distributed	2	1	2
Network	1	1	1

Rating: 1 = High Impact, 5 = Low Impact

number of applications for which they are appropriate will diminish rapidly as optical technology becomes available in other systems categories.

- The growth in demand for magnetic media (specifically disk) will not be impacted by Systems Categories 1 and 2, and only minimal impact on the growth rate will be possible with System Category 3. System Category 4 (Integrated Systems) will make possible some significant leveling in demand for magnetic storage (that is the reason System Category 4 is pivotal for IBM). Significant impact on demand for magnetic storage will not be possible until Systems Categories 5, 6, and 7 become available.

E. SYSTEMS CATEGORIES ON SOFTWARE

- Exhibit VI-4 presents the impact of the Systems Categories on software. (Data/information/knowledge, which INPUT also considers to be software, is considered important enough to warrant a separate section and will be presented in the next section.) The impacts are rated on a scale of 1 to 5 where 1 means substantial software work must be done in order to take full advantage of the potential of the particular systems category and 5 indicates no significant work is required. It is beyond the scope of this study to present detailed justification for the ratings INPUT has assigned to the various cells of the matrix (although some of the reasoning will become clear when we describe systems requirements in a later section). However, the ratings clearly indicate the following:

  - Systems Category 1 does not require any substantial software development effort on the part of either the user or vendor. Therefore, most of the currently proposed applications of CD ROM can be readily installed as soon as it is determined which "titles" will sell. A little bit

EXHIBIT VI-4

OFFICE STORAGE SOFTWARE REQUIREMENTS BY APPLICATION CATEGORY

APPLICATION CATEGORY	SNA	Operating System	DBMS	Language/ DSS	Industry	Applica-tions
Publishing	5	4	5	4	5	5
Image	4	3	4	3	5	3
Filing	3	2	3	2	3	2
Integrated	2	1	1	1	1	1
Mainframe	3	1	1	1	4	2
Distributed	1	1	3	4	5	4
Network	1	2	5	5	5	2

Rating: 1 = Critical Software Requirements, 5 = Negligible Software Requirements

of work on the operating system (if the system is developed around a general purpose microprocessor) and minimal work at the user interface is all that is required. (As pointed out previously, the actual production of the published material may be extremely complex, but software in the usual sense will be relatively straightforward.)

- Systems Categories 2 and 3 (Image and Filing Systems) require increasing work on the part of both the vendor and the user if effective use is to be made of the systems. Dealing with large volumes of images requires interfacing with existing systems and applications software on an entirely new basis. The "automation" of the office no longer stops with the printed report. There will be a lot of software work to do if the hardware systems are to be used effectively.

- Systems Category 4 (Integrated Systems) is the challenge of the 1990s in terms of both vendor and user software effort, and that challenge is clearly reflected in the ratings. The requirement for such a system will be required in somewhat more detail later in the report. However, an extensive feasiblity study which was conducted jointly by IBM and a major insurance company in the late 1970s spelled out the complexity of such systems. In rejecting potential cumulative cost savings of 10% during the 1980s, the insurance company offered the following reasons for rejecting a proposed image processing system:

  . New hardware would be required (scanners, image display stations, and some data storage hardware) and would have to be introduced into the work environment.

  . New and more complex systems software would be necessary in order to handle both interactive terminals as well as the image display stations.

  . New applications software was necessary.

- Since the savings would be achieved by reducing the number of clerical workstations, significanty new workflows would be required.

- New jobs and job descriptions would be necessary.

- An entirely new organizational structure would be required.

- Despite the PC "revolution," much talk about departmental systems, LANs, and the office of the future, not much has really changed out there in the real (paper-pushing) world. There remains a lot of systems work to be done, and it is little wonder major users are waiting for IBM.

- Systems Categories 5, 6, and 7 (Mainframe, Distributed, and Network) begin to require extensive work on SNA and operating systems if the effective integration of optical storage in the overall network is to be achieved. This naturally depends on IBM, and IBM's entire theme for both hardware and software is "evolution rather than revolution." Unfortunately, while waiting for IBM, the detailed systems analysis required of users for implementation at lower systems categories, and particularly Systems Category 4 is not proceeding.

- While most of the categories in the software hierarchy are self-explanatory, two require comment:

  - INPUT includes emerging "Expert Systems" under the category of Languages/Decision Support Systems. This has been done for the following reasons:

    - Expert Systems are a logical extension of the category representing another level of human interface (natural language) and

a narrowing of "decision-making" into narrower and more manageable domains.

. Progress on the actual implementation of such systems to date does not warrant a separate classification. (The hardware/software tools being marketed are not applications or "solutions" despite the current trend to label such tools in this manner.)

. The distinction between conventional decision support and expert systems is more appropriately described by defining the differences between data, information, and knowledge.

- Industry turnkey systems become especially important when addressing Systems Category 4. The problems associated with reducing paper flow in an office environment (which were described above) are peculiar to particular industries (check processing, insurance claims processing, handling market research surveys, etc.). In fact, even individual management styles within companies can become serious factors in implementing systems which change paper-based systems and procedures. Therefore, general purpose "solutions" are becoming substantially less viable.

F. SYSTEMS CATEGORIES ON DATA/INFORMATION/KNOWLEDGE

- Optical storage systems, because of their cost/capactity characteristics, have the obvious impact of making data/information/knowledge (D/I/K) more readily available on-line and of facilitating the management of D/I/K which were formerly stored on paper. It is also true that in order to use and manage D/I/K effectively, it becomes increasingly important to understand and distinguish between and among them. What has previously been a rather arcane academic discipline suddenly begins to have a great deal of importance

in assuring that the quality of D/I/K is maintained as we plunge fearlessly into the "information age."

- INPUT has endeavored to come up with a set of practical definitions:

  - Data (as in data entry, data storage, data retrieval, data processing, data services, etc.) refer simply to bit patterns fed into a computer. These patterns, once captured, are data from the point of view of the programmers, operators, and users of the computer.

  - Information and knowledge have a firm link, and the best way to define them is by distinguishing between them. The commonly accepted distinctions are as follows: (1) information is piecemeal, fragmented, particular, whereas knowledge is structured, coherent, and often universal; (2) information is timely, transitory, perhaps even ephemeral, whereas knowledge is of enduring significance; (3) information is a flow of messages, whereas knowledge is a stock, largely resulting from the flow, in the sense that the "input" of information may affect the stock of knowledge by adding to it, restructuring it, or changing it in any way (though, conceivably, information may leave knowledge unchanged). An additional fundamental distinction is that information is acquired by being told, whereas knowledge can be acquired by thinking (without new information being received).

- Despite all the efforts of office automation, it can still be stated that:

  - Data, by definition, are stored in computer systems. Data of institutional significance remain on host mainframes (for any but the smallest organizations), departmental processors are used primarily to concentrate data for specific work units, and personal computers are used to generate paper documents (correspondence, reports, etc.).

- Information is transferred by voice (being told) or by paper documents. While the transfer of information by voice represents a substantially higher percentage of total office costs, the official communication of information remains on paper. If information of significance is generated in meetings or telephone conversations, it must normally be documented for purposes of validation, distribution, and storage. Paper remains the primary information media of organized human activity (business).

- Human minds remain the primary processors of information, and the brain remains the primary storage device of knowledge (a very small percentage of individual human knowledge is ever documented). The best research efforts in artificial intelligence have resulted in precious little information as to how either the mind or the brain works.

- The significance of optical storage is that it will permit the storage of all recorded information (paper documents) and knowledge (books, technical papers, diagrams, etc.) in easily accessible form on computer/communications networks. This has ramifications which go far beyond vague statements about the value of timely information and the potential cost advantages of reducing or at least controlling the enormous quantities of paper our current office automation efforts are generating. Consider the following:

  - Starting at the simplest level, the storage of archival data and information on magnetic tape and/or microfilm practically dictates that it is lost except for high-priority or mandatory access (otherwise it is too expensive). The availability of such data and information in readily accessible form increases its value for future research and analysis by extending its useful life (purging files always destroys some valuable information).

  - The potential ability to assemble all information pertaining to a specific situation, topic, or decision has far-reaching ramifications in

terms of organization, information flow, quality of information, and human factors. A few examples will suffice to illustrate that the true impact of such availablity is difficult to predict.

- How will middle management react if it becomes possible for higher executives to have ready access to all of the information (correspondence, memos, reports, etc.) which is made available to him by his subordinates?

- What will happen to forecasters (both public and private) when their published prognostications can be readily retrieved and compared with other forecasts and actuals?

- How will professional workers react when they leave a permanent, easily followed trail of all of their opinions, thoughts, and actions? (For that matter, how will anyone react when there is a good possiblity that everything you ever "say" may be later recalled, reviewed, analyzed, and used against them?)

- How will decision makers react if they have all of this current and historical information available to them?

- How will all of the above impact the quality of information and the decision-making process?

- Accepting that what is now information (voice and paper documents) becomes data once it is stored in a computer, information then clearly becomes the flow of electronic information between and among computers and humans. The concept of the orderly data bank from which information can be controlled gives way to a network on which even the flow of messages (information) becomes part of the data base. Current concepts of both data base and network management are

not adequate to manage this type of environment. It is INPUT's opinion that there is high potential for chaos in such an environment (information entropy is high), and substantially more energy (both processing power and human) must be expended merely to maintain current data and information quality.

- Then there is the question of what the impact of ready access to vast amounts of information will have on knowledge. Will human beings dependent on electronic information have either the time or the desire to think (and potentially become more knowledgeable), or will they be caught up in a "McLuhanish" type of tactile interaction with the network? Will the mere volume of information make the identification of knowledge more difficult?

- INPUT believes the primary responsibility of IS management will be to distinguish between information and knowledge. Based on our earlier distinction between information and knowledge, this responsibility involves:

  - Distinguishing what is piecemeal, fragmented, and particular (information) from what is structured, coherent, and often universal (knowledge).

  - Determining what is timely, transitory, and perhaps even ephemeral (information) from what is of enduring significance (knowledge).

  - Filtering and routing the flow of messages (information) to update the stock (knowledge base).

- All of the above considerations require careful systems design as the fundamental change from paper to electronic media takes place and the structure of data, information, and knowledge undergo significant and unpredicatable changes.

VII SYSTEMS REQUIREMENTS

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- The real payoff from optical storage will only come with the reduction of paper use in the office. While it is all very nice to say that timely information has value, the major systems effort required to shift from paper to optical media in most offices will require specific personnel savings in order to be cost justified. A quick review of the systems categories defined earlier reveals the following:

  - Publishing Systems (Category 1) may be justified by distributing large data bases on optical disk to intelligent workstations where they can be used more economically than accessing the same data on large mainframes (either internal host processors or outside services companies). However, they will have little impact on the flow of paper documents in the office. In fact, unless carefully managed they may contribute to the problem as it becomes "cheaper" to generate even more paper documents from information and data on CD ROM.

  - Image and Electronic Filing Systems (Categories 2 and 3) may help stem the flow of some paper, but the loose coupling with current data processing systems will usually truncate the flow of paper at the time it would normally go to the file cabinet (after the initial information has been distributed, processed, and acted on--in other words, archival storage for computer output).

- Categories 5, 6, and 7 (Mainframe, Distributed Information Managers, and Network Reservoirs) may be justified on the basis of lower hardware and communications costs, but they really do not directly address the cost of paper handling in the office.

- That leaves Integrated Image Processing Systems (Category 4) which is pivotal between the simple automation of paper files (after the fact) and the computers which produce the paper in the first place. In other words, Category 4 systems force attention to the use, processing, and control of paper-based information. This requires substantial investment in analysis and systems development effort, but the payoff can be tremendous.

- Therefore, in the firm belief that the most important application of optical storage will be to eliminate as much paper as possible from the office environment, the requirements for an Integrated Image Processing System will be analyzed in more detail.

A. PERIPHERALS

- Since INPUT published Image Processing Systems - Concepts and Status in April 1980, substantial progress has been made in the area of peripherals. Most of this is directly attributable to the rapid development of microprocessor technology. Personal computers have provided the necessary processing power to have vastly improved graphics which in turn has encouraged the development of a variety of exciting new peripherals which facilitate the display and printing of images.

  - Display resolution is increasing dramatically along with the microprocessor power necessary to drive the graphics for such applications as CAD/CAM. Costs are coming down, and the early electronic imaging systems are boasting up to four million pixel resolution.

- Laser printers are becoming available and are the fastest growing segment of the printer market. (Even though the objective of the system is the elimination of as much paper as possible, the need to conveniently print copies of images will remain indefinitely.)

- Scanners with increased performance (currently one page per second is about the top speed) and lower cost are also becoming available, and even IBM has announced the Scanmaster I (which hopefully indicates there will be additional models).

- Arrays of microprocessors hold great promise of improving the performance and cost of both character and pattern recognition capability.

- Fiber optics can move the bits among the various peripherals associated with the system at speeds which encourage the transfer of enormous quantities of information.

- Peripheral hardware advances have been significant, and optical disk seems to be slower in being accepted than some of the other components which already have clear applications with or without optical disk.

- However, there is no question that optical storage is required for image processing. The capture of information in image form requires enormous amounts of storage (the exact amount being heavily dependent on compression ratios) which can easily get into the 100 gigabyte range, and terabyte data image bases would not be at all uncommon. Projected magnetic storage costs cannot economically accommodate such volumes. Optical storage is essential if such information is not to be lost.

- Even with the improvement in peripherals and assuming high compression ratios, the conversion of many existing archival files seems unlikely. A popular example has been cited where a 768 million image base currently on microfilm would take over 100 machine years to convert (at one page per second). It is doubtful that conversion of such large files will ever prove cost justified. Careful analysis is required to determine the physical and economic limits of merely filling hundreds of gigabytes and terabytes of storage. "Mixed media" systems will be a practical reality in the foreseeable future.

B. INTELLIGENT SOFTWARE

- One solution to the problem of handling enormous files of images is obviously not to produce the paper documents in the first place. That is one of the reasons INPUT feels strongly that it is important to plan for Integrated Image Systems from the beginning. A high percentage of business documents have been generated from computer systems, and a high percentage of paper documents in file cabinets are copies of copies. It is important to exercise control before the paper comes into existence, or at least capture it as soon as possible.

- The other answer is intelligent software at the point of information entry into the system. This takes several forms:

  - Compression ratios for images range between 10:1 and 200:1, and much of that depends on how smart the software is in recording only the information contained on the page and in eliminating the boiler plate.

  - Advance pattern recognition software can extract information from paper documents (including some which is handwritten) and update encoded data bases. Arrays of microprocessors make the performance of such intelligent scanning increasingly cost-effective.

- The classification and indexing of images becomes increasingly important as data which are updated must be tied back to the source images. In addition, the "filing" of images themselves require cross-referencing which goes far beyond the capabilities of normal filing or library systems. To a certain degree, it is necessary (or at least desirable) to decompose printed documents into more accessible information. Here, however, balance must be reached because the indexing and structuring of the information may require as much storage space as the information itself.

- The additional complexity of identifying what is "new" information and knowledge will require expert systems in order to be truly effective. It should be pointed out that one of the oldest measures of information content stresses what is not already known. The ability to weed out the essence of what is new in correspondence and technical documents and to screen information which is significant enough to change a knowledge base may be one of the more practical applications of expert systems. Careful systems analysis is required when building knowledge bases; indeed, the enforced discipline of careful analysis may be one of the main benefits of knowledge bases.

- The point is that the value of information is not uniform and some means of screening and classification according to importance is necessary. It is our belief that careful systems analysis and intelligent human programming will be required. If the tools of AI and expert systems can be of help, they should be employed; building enormous data/information/knowledge bases and failing to distinguish what is important will increase volume and decrease usefulness. Vendors and users must work together on intelligent software which will enhance the value of D/I/K stored on optical media.

- A simple, personal example of an expert system which would screen published information for buzz words and take appropriate action is not too difficult to visualize. Consider the following scenario:

  - Expert system: I have noticed that when you read an article which exceeds 5% reference to CD ROM and contains less than 2% reference to other optical storage you normally "trash it." Would you like me to stop sending them to you?

  - Expert: Yes.

  - Expert system: Do you want to be notified that they have been received?

  - Expert: Yes.

C. PROCESS CONTROL

- As electronic information flow replaces paper in the office, it is probable that the tools of industrial engineering will be employed. In fact, it is important to recognize that, unlike the assembly line which moves physical objects from one workstation to another, once electronic information replaces paper it will be possible to process information in parallel. This can lead to levels of work simplification never dreamed of by the industrial engineers who descended on factories with stopwatches to count "therbligs."

- In addition, the capability for conducting "time and motion studies" is inherent in systems which control information flow. (At this point, it is appropriate to mention that one of the pioneering firms in Electronic Filing Systems (Category 3) has revealed that only 25% of its customers use the system for archival storage; the remaining 75% install the system to control information

flow.) It is also necessary to mention that not only clerical workers but professionals could be subject to such scrutiny. While work simplification of office work may improve office productivity, the payoff only comes from the reduction in personnel costs. This fact is frequently ignored when discussing office productivity, but the same problems which arose for blue collar workers may occur for white collar workers unless the shift from paper to electronic media is handled with care and sensitivity.

- Clerical workers in routine clerical processing functions will see clear evidence that work simplification and performance improvement can mean fewer, less interesting jobs. (Remember the insurance company's feasability study which stated cost justification was based on the elimination of workstations.) The result will probably be some kind of collective bargaining either through unions or through informal confrontations within the work unit.

- The impact and reaction among professional and managerial employees will be more subtle but equally unfortunate for both the employees and the company. Because certain metrics of white collar performance become available does not mean that they are appropriate. For example, financial analysts should not be evaluated on how fast they can type or use a spreadsheet, and managers should not be measured based on the time it takes to prepare a report or turn around a piece of correspondence. However, if such measurements are available, it is possible they will be used with unfortunate consequences.

    . The employees may assume that is the way to get ahead and turn out superficial work rapidly and in volume. (To a certain extent this is already occurring even with today's rudimentary tools.)

    . The ready access to all information by superiors, which was alluded to earlier in this report, may discourage employees from considering unpopular or creative solutions to problems.

- The old joke about "wild ducks" in IBM comes to mind. It states that, of course, IBM likes wild ducks, as long as they fly in formation.

- It is INPUT's belief that the true challenge and opportunity of optical storage lies in developing systems which assure the ready availablity of high quality data, information, and knowledge within an organization in the face of increased entropy in the information processing environment. This cannot be done without control of the total information process, and it cannot be done with controls which are counterproductive.

D. QUALITY CONTROL

- All of the above requirements address general areas of D/I/K quality assurance. However, it is necessary to understand that even if all data stored in computer systems were qualified carefully before time of entry, there is no assurance that the information generated from that data base will be of similar high quality or that the knowledge base will be enhanced. Mistakes in computer programs, errors of human analysis and judgement, or misunderstanding of data can all contribute to the continuing problems of quality. And, the natural tendency toward chaos accelerates as more information becomes available. To the degree that optical storage systems facilitate the distribution of information (and we believe they do), they can become part of the problem unless issues of quality are understood and addressed early in the development cycle.

- In New Opportunities for Software Productivity Improvement, INPUT, 1984, some proposed quality assurance systems for current development environments were outlined. Those systems become of increasing importance as optical storage appears to be arriving on schedule with our earlier predic-

tions. While it is beyond the scope of this study go into any detail concerning the proposed systems, they will be mentioned:

- An Information Base Management System (IBMS) was described which would serve as a central locator of information sources (including knowledgable individuals). Essentially, IBMS would serve as supervisory systems for other data/information dictionaries and directories. The intelligent indexing and cataloging systems described earlier would fit under IBMS.

- A Document Control System (DOCS) which could be used to manage the distribution of paper reports which will continue to be circulated before, in parallel with, and after advanced optical storage systems have been installed. The system provides for classification for security and information quality purposes and for the tracking of distribution of the documents. Quality classifications would identify the document with its source. For example:

  . Produced from certified central data base by production programs.

  . Produced from certified central data bases by protype system.

  . Produced from personal or organizational data base by XYX spreadsheet package.

  . Produced from published CD ROM data base from XYZ company, supplemented by current data from ABC service company using special programs.

  . The possiblities are practically endless, but they serve to demonstrate the complexity of the problem.

- A Data Flow Monitor (DFM) which would be used primarily for network management and performance monitoring. The purpose would be to track the flow of data among systems and anticipate performance problems on both the network and the processors to which a request is addressed. For example, a request for a join and select on archival relational tables stored on an optical storage juke box would be intercepted, as would a request for transferring enormous files over the network rather than on mailed optical disk. (There is always someone who will not understand that megabytes, gigabytes, terabytes do not work very well with 1,200 baud modems and floppy disks.)

- The general requirements for a Security, Protection, and Privacy (SPP) program were described with emphasis on the problems of distributed and large data bases. There are security problems associated with information flow which go far beyond access control and separate and centralized control of security codes and keys. While these problems do not currently have solutions, it is important to be aware of them in designing systems for the new environment.

- Tools for quality assurance of data, information, and knowledge are essential as the fundamental change from paper to electronic media occurs. It does not appear that they will be available from external sources unless IBM becomes involved. It is possible that IBM will address (not solve) some of the issues as it continues to recommend an evolutionary approach to both distributed processing and the acceptance of optical storage. There is reason to go slow if the potential quality problems cannot be solved through the careful design of applications systems or vendors of optical storage systems do not incorporate such systems with their products.

E. HUMAN COMPONENTS

- Finally, there is the question of the human components which are integral parts of the information network. The information systems function has been accused of trying to keep computer power and now data from end users. Personal computers destroyed much of the control which the IS department once exercised over computer processing power. Optical storage is going to break down some of the barriers on data. The paper-based systems and archival storage activities have normally remained outside IS control. The development of systems which replace traditional paper in the office will require cooperation at all levels both within the user and IS departments. This time there will be no room for fingerpointing if things do not go well--both credit and responsibilty will be shared equally.

- Regardless of when a company is planning to install optical storage, the identification of specific applications associated with the various optical storage systems categories should be identified now, and preliminary analysis should start at the earliest possible time. Any tendency to automate offices as if they were factories should be examined carefully. Performance in an office cannot be measured in the number of widgets produced per hour. The purpose of office systems is to improve the quality of information and knowledge available to run the company. It is not anticipated that machines are going to replace people in this regard despite all of the talk about knowledge-based and expert systems.

- Human beings should be considered the primary source of quality information and knowledge, and systems should be designed with the system being an extension of the human being rather than the user being an appendage of an artificial system. Personal computers started with that design philosophy, and it is time that even the most complex computer/communications networks be viewed in the same fashion. This requires a considerable change in the design philosophy of most large-scale data processing applications and on the part of many IS personnel.