# THE TECHNOLOGY OF IMAGE PROCESSING AND ITS APPLICATION IN THE BUSINESS WORLD

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## ABSTRACT

In today's business world, most of the typical offices were flooded with a large amount of papers. Although most of these aged documents were of very poor quality, they could not be disposed because of their importance. This phenomenon led to the research and development of image technology, which made use of the high speed communication and computing power. It offered users instantaneous access to documents and excellent reproduction quality. The invention of this technology caused the redesign of business flow, improved the productivity of workers, and thus brought us to a new stage of the information era. The purpose of this research paper was to explain the basic concepts of image technology, explore the applications in this area, study the imaging products available in the market and come up with recommendations to the users.

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# CHAPTER I

# INTRODUCTION

## Evolution of Image Processing

Today information systems were widely used in a wide variety of industries and enterprises and enjoyed high reputation in its substantial benefits it provided. However, among the numerous information in an enterprise, only 5% of them were captured in the traditional data processing systems. The reason was that data processing only captured coded data while most of the data still existed in non-coded form. Some good examples included insurance claims, contracts and signatures. It thus opened up a new market for one significant computer application areas : _ IMAGE PROCESSING.

As the name implied, image processing directly dealed with the image itself and did not require the tedious data entry. The document or picture could be directly input into the computer and stored. Whenever it was needed, it could be retrieved, displayed or printed. Its convenience and wide application had made it receive significant attention in the information processing industry.

Nevertheless, imaging technology had not been so popular until these several years due to its high cost. Fortunately, several breakthroughs had taken place and they led to the boom in the application of image technology.[1]

- The price and performance of electronic components improved significantly in the past years due to evolution of optical disk.

- Major computer vendors had already endorsed the concept of electronic imaging and actively entered the field.

- There was significant breakthrough in the methods and capabilities of several key areas, including data compression and networking.

- The excitement about imaging had been complemented by numerous success stories in its implementation.

## Scope and Statement of the Problems

Although image processing had been recognized as a significant area of computer application, there were some problems of its implementation in the business society.

- Image processing was a very new concept and there were no documentation which provided a complete discussion on the topic.

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1 Senn, James How Imaging is Changing Business. Business, Jan/Mar 1990, V40 N1 : p.38-42

- There had been success and failure stories in the implementation of image processing. The commercial world needed guidance on how to apply image processing in their business and benefit from it.

- For enterprises which were using information systems, another problem was how to integrate image processing into existing environment.

- There were a wide range of image processing products available in the market. Companies were puzzled on how to select the right equipments which could satisfy their business needs.

This research project attempted to provide advice and guidelines for users to meet the above challenges and problems. First of all, there was a discussion on the concepts of image processing, with the most updated technological advancements in the recent years. A research was then conducted on how to apply image processing and identify the benefits and issues of this technology. Thirdly, the research was performed on how image processing were integrated with other technologies like data processing, microfilm and facsimile. Lastly, a research was conducted of the products in the market. A comparison was made among them in terms of features, compatibility and price. The whole research project was wrapped up with trends and recommendations in image processing.

# Methodology

There were two basic sources of information, namely primary and secondary data. This project did not use any primary data because image processing was relatively new in the information systems area while primary data was practically limited to Hong Kong. There were three methods of securing secondary data, namely questionnaire, personal interview and review on literature. The use of questionnaire was not suitable for the nature of this project due to several reasons. During this research, one should look into a lot of details, such as application background, user requirements and implementation plan. These kinds of in-depth information could hardly be achieved by a general questionnaire.

The secondary data in this research was collected by personal interviews and review on literature. Personal interviews were made with key users of image processing as well as representatives from market leaders in image processing products. However, the names of representatives from product vendors were not quoted based on request by the interviewers. As a result, in the section 'Evaluation of Existing Imaging Systems and Products', no exact reference was made to the information collected from the interviews.

The review on literature was conducted on periodicals, journals and user reports on the latest development of image processing. Regarding the vendor product information, comparison was made among the products based on available brochures, information sheets or manuals. The prices quoted for vendor products only served as a reference for ball park figures and the exact values should be obtained from the corresponding vendors or distributors in Hong Kong.

# CHAPTER II

# TECHNOLOGY OF IMAGE PROCESSING

## Concept of Image

In the simplest sense, image processing meant manipulating an image. One of the first uses of digital images could be dated back to 1920s when a Bartlane Cable Picture Transmission System was introduced. On this system a newspaper was transmitted between London and New York. Since that time there had been a lot of technological breakthroughs which reduced the cost and made things economically feasible. One of the key inventions was the personal computer so that people could get access to fast processing and abundant memory at a relatively low cost.[2]

## What is Image

When an original picture was transformed into an electronic image, the image became a collection of picture elements, which were called pixels or pels (ref fig. 2.1). A digital image could be viewed in the way that it was a page

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[2] McManis, Charles Low Cost Image Processing. Byte, March 1987, V12 N3 : p.191-196

of numbers arranged in a matrix where the value of that number represented the brightness of the particular point.

There were some differences between images and graphics. Images were captured but graphics were created. A good analogy could be drawn to photographs and paintings. Moreover, images were stored electronically in raster lines of pixels while graphics were stored as series of commands.

The term, resolution, refered to the dimensions of the image in pels per line and by the number of lines. The most commonly used unit of measure in resolution was pels per inch (ppi) or pels per centimetre. However, the addressable and discrete resolution should not be confused. In the example of 100 ppi pattern and 50% overlapping pels (ref fig.2.2), the addressable resolution was 100 ppi while the discrete resolution was only 50 ppi. It was because discrete resolution refered to the number of pels per inch as defined by the diameter of the pel. However, in the specification of most image devices, only the addressable resolution was quoted. A device with high addressable but low discrete resolution provided a image with smooth edges on lines but it was difficult to perceive the details from it.

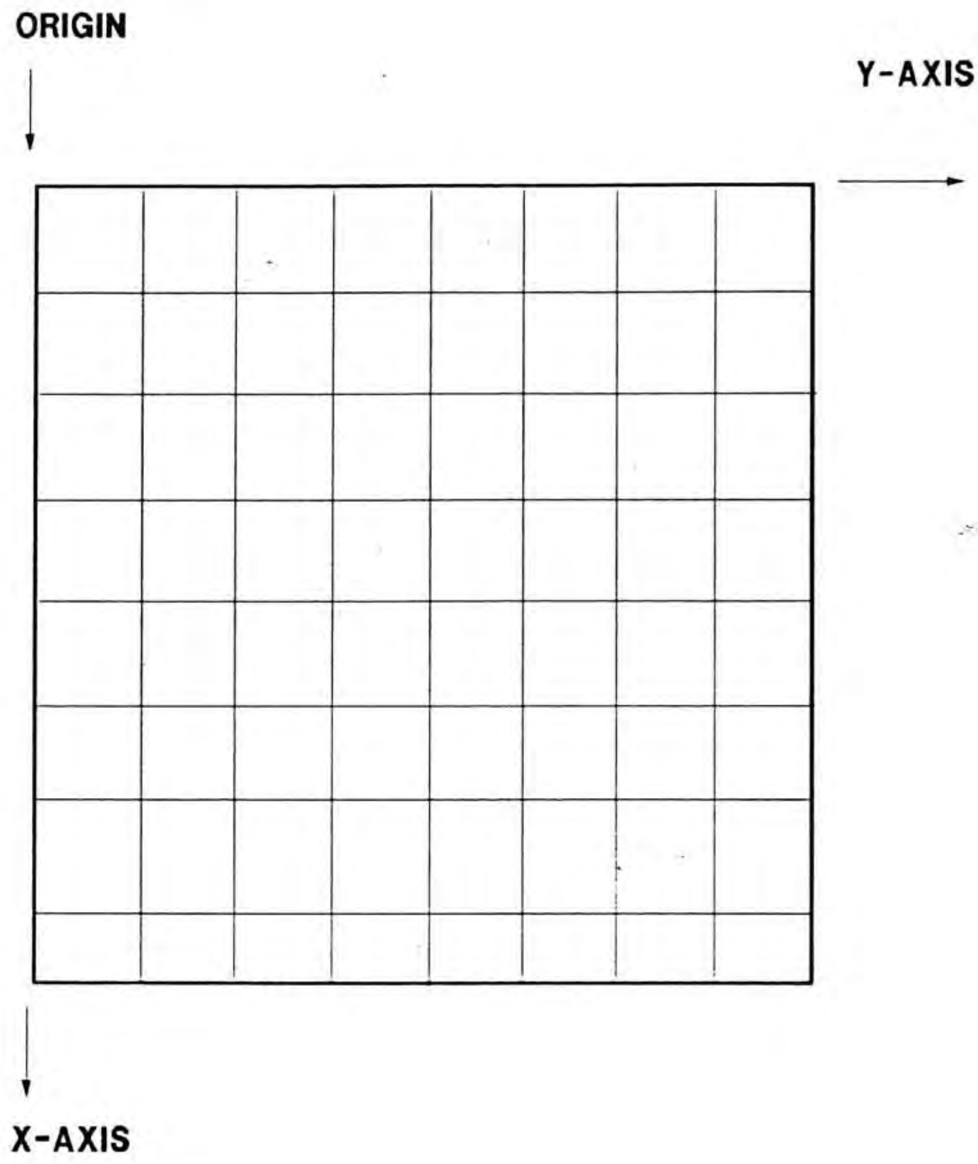


FIG. 2.1 PICTURE ELEMENTS

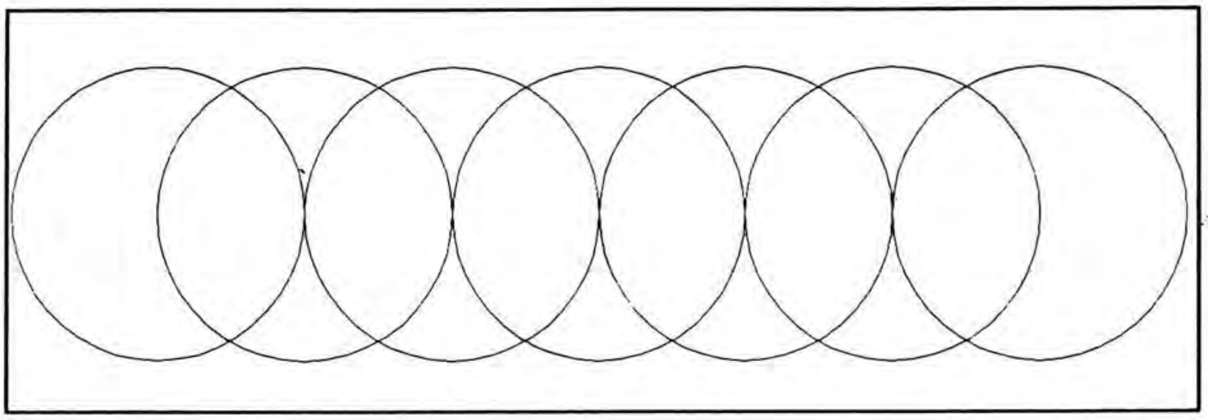

FIG. 2.2 OVERLAPPING PELS

## Image as Non-coded Information

For coded data, each byte or word carried a special meaning. A good example would be the ASCII or EBCDIC system where each specific arrangement of bits in a byte represented a character. In non-coded information, there was just no unit of information and the bytes represented only light levels on an area. Image was one form of non-coded data.

This factor had very important implications in the image technology. Firstly, the storage requirement of an image was about 10 times as great as that for coded information. Secondly, a text editor could not work on image documents since those editors were only built for coded information.

## Types of Image

There were three major types of images, namely bilevel, gray and color image.

- Bilevel image

  Bilevel image refered to the images with only two color combinations and black-and-white image was the most obvious example of a bilevel image. However, those black-and-white images, such as photographs in a newspaper, appeared to be composed of areas of gray and it was due to visual illusion. The picture was just composed of some black and white dots but human eyes could hardly resolve them. The level of gray depended on how packed the dots were and this technique was called halftoning. It could thus create the illusion of gray by means of bilevel pel patterns. A matrix of 10 x 10 pixels was taken as an example. To show dark gray, most of the pixels would be black. To show light gray, most pels would be white.

- Gray image

  Black-and-white television was a typical real life example of gray visual display device. Unlike bilevel image, each pel on the screen was really a shade of gray. In most of the systems 256 shades of gray were used due to the historical use of a byte per pel in showing the shades.

- Color image

  The standard red-green-blue (RGB) process was used for all color imaging applications. Similar to the concept of gray images, there were 256 intensities for each of the red, green and blue dots on a color image picture. These three primary colors were called bands of the images and all color images comprised of the combinations from three of them.[3]

## General Flow of Image Processing

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[3] Helms, R.M. Introduction to Image Technology. IBM System Journal, 1990, V29 N3 : P.313-332

The basic image activities included scanning, compression, filing, decompression, and reproduction (Ref fig. 2.3). Firstly, the original hardcopy document was scanned by a scanner for input into the computer. The resulting information were compressed to save storage and stored into a central image database called 'repository'. In the process of retrieval, the stored image information were decompressed and then displayed or printed.

During the capture of image, scanners were used. However, the main restriction was that the image had to be two-dimensional. The scanner speed varied greatly with the model and the kind of image. A scanner worked much more slowly in gray because there were about ten times of data which needed to be input into the computer. Similarly, a color image required at least three to five times in the scan time when compared to a gray scanner. Another scanner speed limitation was the communication point between the scanner and computer itself. Therefore only the standalone scanner speed was not representative in an integrated imaging system.

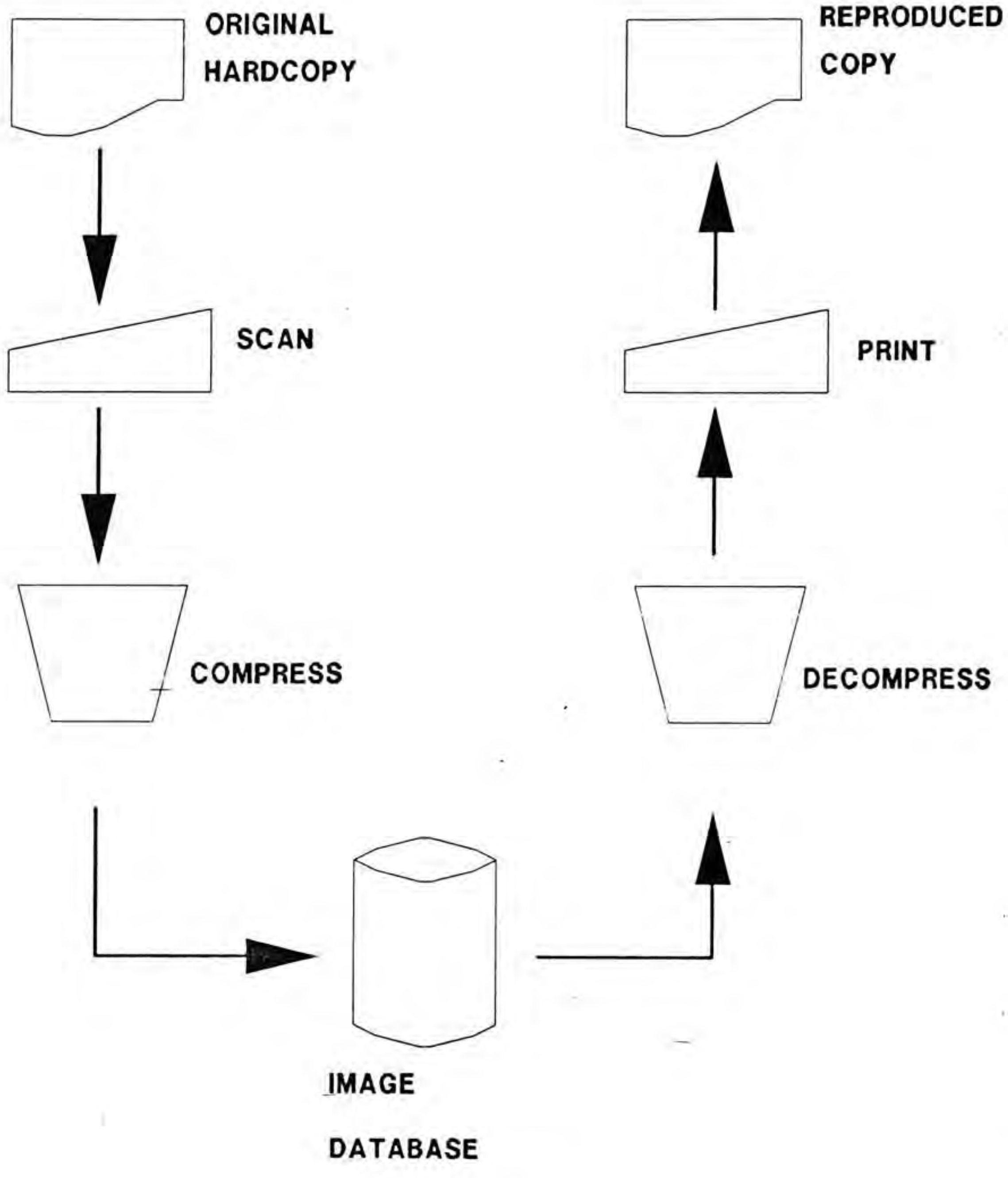


FIG. 2.3 TYPICAL IMAGE SYSTEM FLOW

The objective of compression was to reduce the image data size for storage or communication. Currently there were two classes of compression : lossless and lossy. In lossless compression the decompressed image would be exactly the same as the original image. In lossy compression, the decompressed image was only 'almost' the same as the original one. The objective of lossy compression was to further reduce the amount of data while at the same time visual integrity was maintained at the expense of some unimportant details.

The consideration between lossy and lossless compression was a tradeoff between visual fidelity and transmission efficiency. Generally lossy compression was more commonly used in gray or color images due to the enormous amount of data. Lossy compression could result in at least 10 times of reduction while the restored image difference was beyond human perception.[4]

## Storage of Image Documents

Storage was the most complicated part of image processing due to vast variety of devices involved and methods employed. A research was performed on the different

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[4] Helms, R. M. Introduction to Image Technology IBM System Journal, 1990, V29 N3 : p.313-332

storage devices and how they were used in the image processing applications.

## Electromagnetic Devices

Electromagnetic devices included the direct access storage devices and magnetic tapes. During the interview with Mr. Wilson Yeung of IBM China/Hong Kong Corporation, he commented that electromagnetic devices were still the most common storage for data processing. However, it posed a big problem in image processing due to huge amount of data. The use of direct access storage devices would be too expensive while the access time of magnetic tapes could hardly satisfy the user needs. As a result, electromagnetic devices had become a major obstacle to image processing until the evolution of optical disks.[5]

## Optical Disk and Juke Boxes

The invention of laser optical disk led the information storage into a new era since it offered a storage media which far surpassed the current magnetic media in terms of storage capacity. For example, a single 5.25 inch optical disk could store up to 500 millions of data characters. It was

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[5] Laub, Leonard The Evolution of Mass Storage. Bye, May 1986, V11 N5 : p.158-160

equivalent to the storage capacity of more than 1000 magnetic diskettes or 50 magnetic tapes. Moreover, the access time was only in the range of 50-200 msec and was much more acceptable to end users. It thus made the storage of images economically feasible.

In 1983 write-once optical disk drives emerged as a commercial product and was abbreviated as WORM (Write Once Read Many) disk. The disk was a "write-once" medium i.e. any given region could be written once but not altered. It offered the distinct advantage of massive storage capacity, data permanence and was particularly suitable for storing historical information or non-volatile data. However, the relatively low access speed of approximately 80 msec made it unable to compete with magnetic media which had only 20 msec access time. Since images consumed a large amount of storage and was usually not changed after 'burning', WORM disk was used extensively in computer based imaging systems. Besides, they were well considered as an ideal replacement for microfilm due to its much faster access speed. However, the success stories of write-once disk were still marked by a difficulty of performing "undo" onto it.

Finally, in recent years several vendors had developed the erasable or rewritable optical disk in the market. It used a laser beam to record data on a magnetized surface. As a result, the magnetism gave a polarity which could then be read by another laser. While erasable optical disk combined the advantages of large storage capacity and write-many-times capability, the access time was pushed down to the range of 30-60 msec, comparable to that of direct access storage devices.

The introduction of optical storage implied ever-increasing storage volumes. To deal with a database spanning many disk volumes, some companies launched products called 'library' or 'autochanger', which were more commonly known as 'jukebox'. This machine put many disks into a few drives which were operated by software control. It provided a solution that access could be made possible to hundreds of gigabytes of data while usually only 5 percent of them were mounted.[6]

Optical disk featured a lot of benefits over other storage media.

- Capacity - space and cost of storage media was drastically reduced.

- Reliability - data would not be subject to mechanical drive failure during access.

- Concurrent access

- Immediate retrieval

- Integration with other systems - when both images and coded data were stored in a system, they could be

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[6] Harvey, David State of the Media. Byte, November 1990, V15 N2 : p.275-282

displayed simultaneously with related text via a split screen or display windows.[7]

## Storage Management

In a typical enterprise computer system, there existed more than one types of storage device. To meet the different requirements of access speed, a storage hierarchy was necessary for different applications. Fig.2.4 depicted the costs and access time of magnetic disk, optical disk and magnetic tape storage. Magnetic disk was in the highest level of hierarchy because of its subsecond access time. However, the huge data volume and high cost made it impossible to store all image data on magnetic disks permanently. Therefore optical disk was used to store data which could afford longer access time. It became the second level of the hierarchy. Finally, magnetic tapes were used to store those 'archived' objects for backup purposes.

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[7] Malloy, Rich A Roundup of Optical Disk Drives. Byte, May 1986 , V11 N5 : p.215-227

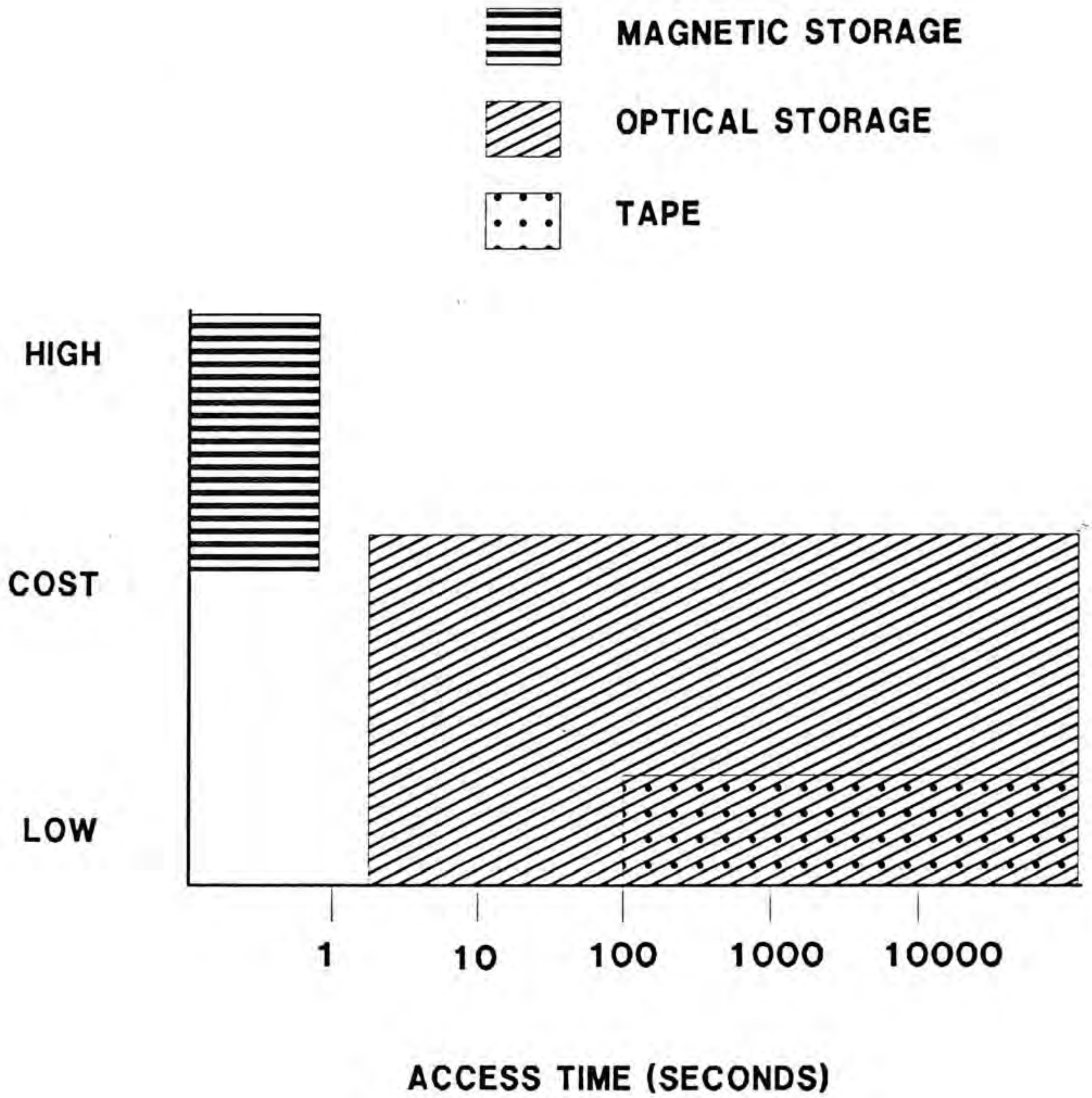


FIG. 2.4 STORAGE MEDIA COST
AND PERFORMANCE COMPARISON

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One of the approaches to manage the storage hierarchy was a primitive manual system. An image data administrator was held responsible for moving the data between the storage so as to satisfy the end users and keep the storage costs low. Another way was to use software program to manage the storage. It should allow the storage administrator to define device-independent performance levels so that the system could optimize the resources. Management classes were also defined for retention, backup and class transition criteria. The retention characteristic of an object was used to determine when an object reached its expiration date. When an object expired, all reference to the object would be deleted. In this way it could be ensured that image objects were stored in the most cost effective way while maintaining a satisfactory service level to the customers.[8]

## Image Management System

After the image pictures were captured and compressed, it would be stored inside a database. However, for an end-user to access it effectively, an automated image system was necessary and should be composed of the following components:

- Repository - the central place for storing the documents

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[8] Harding, W. B. and Others, Object Storage Hierarchy Management. IBM System Journal, 1990, V29 N3 : p.384-297

- Folder management - new documents were indexed before they were scanned into the system. The description of the document should be entered and the user specified how the document would be processed after it was scanned. The indexing information entered thus allowed the workflow management, to monitor and route the work assignments. Folder management also provided security function to safeguard unauthorized access and update of the image documents.

- Workflow management - it assigned documents in need of processing to the appropriate users on the system based on end users' specifications. Work assignments were usually controlled by user profiles and document priority. A profile was created for each user on the system, which described the categories of work each user was supposed to handle. The objective was to distribute the resources on a fair basis so that the most critical work could receive the service at higher priority.

- User applications - the above components only dealt with the storage and getting the image document to the end users. However, there were various types of applications which could make use of these image documents. One of the main streams of development was the office system. The traditional office system confined itself to word processing, text document processing and message distribution. However, in the modern and advanced office system, image was included as one of supported objects and could be distributed among the end users.[9]

## Image Communication

As more and more applications started to use images, there was a strong demand of exchanging and sharing image databases among different applications. Without a standard image communication architecture, it would be impossible for image applications to exchange images without conversion. Mr. Wilson Yeung commented that it would be a serious concern when image applications became more popular.

In the development of an architecture, there were several main objectives :

- application and device independence

- extendibility - the architecture should be designed in such a manner that any changes could be introduced without disrupting its nucleus and existing applications.

- compatibility with different data stream environment

- subsets and supersets - each function set should be defined as a subset or superset of the others so that it

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[9] IBM MVS/ESA Imageplus General Information Manual. p.7-16

could maximize the possibility of interchange among products with different image processing capabilities

In the information systems industry, one of the representative image architectures was the IBM IOCA (Image Object Content Architecture) and IBM basically divided image processing into creation, preprocessing, processing, postprocessing and output. The IOCA was mainly enforced in the 'processing' step since in this step the image was free of all application and device unique features. The base structure used to represent an image was called an image segment. It was the IOCA structure which served as both input to IOCA processor and output from it. The structure of the image segment consisted of image data parameters and image data. The image data parameters would include the following image characteristics :

- Image dimension and resolution - the number of pixels in the image in both horizontal and vertical directions

- Recording sequence

- Compression - usage of IBM Modified CCITT Modified READ algorithm (IBM MMR) or CCITT T.6 Group 4 Facsimile Coding Scheme in addition to the uncompressed data.

- Bits per pixel

- Pixel structure - two methods for color image representation. One was the interpretation of a color of a pixel based on the combination of colors and a typical one was the RGB (Red, green, blue) mode. The second one was described immediately below.

- Look-up table - In the look-up table (LUT) method, the pixel value was interpreted as an index in a table and the data at the indexed position in the table was the color value for the pixel.

The syntax and semantics of each structure were defined by the architecture and it could provide consistency of generation and interpretation by all IOCA supporting products.[10]

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[10] Hakeda, Y. The Image Object Content Architecture. IBM System Journal, 1990, V29 N3 : p.333-342

# CHAPTER III

# APPLICATIONS OF IMAGE PROCESSING

## How to Implement an Image Processing System

### Feasibility Study

An image application was not as simple as ordinary data processing applications. It involved a new set of hardware and software, an analysis of the existing business, a redesign of the workflow and even an impact to the existing information technology infrastructure. As mentioned by Mr. Wilson Yeung, imaging technology would be the company's strategic direction but he agreed that implementation of an image application was a complicated task. In general, it was recommended that one should identify an area for pilot study in the implementation of an image application. The first step was to perform a feasibility study and it should cover the following aspects :

- The existing business and document flow

  It was necessary to first understand the existing business and document flow before one went ahead to plan for an improvement on the current procedures. It should cover the role each party was involved and the documents that flew through the parties. Their purposes of referencing the documents should also be explained.

- Current transaction volume and document characteristics

The transaction volume of documents processed by each party should be counted and the growth of these documents estimated for the next five years. They served as a reference for capacity planning of the imaging system. The document characteristics such as the paper length and width should also be identified in the report.

- User requirements

It was necessary to understand the user requirements. They might have an ideal solution in their mind when their companies moved into image processing. It was their dream of the image solution. However, this was often a blue sky that could not be achieved because of technological and financial issues. It might be necessary to clarify with them and pursue a feasible solution with modifications of their requirements.

- Existing image systems available in the market

The next step was to report on the available product from the market so that users could acquire an understanding of the existing solutions offered and the gap between the reality and the blue sky.

- Capacity sizing of each potential system

  After the product vendors were shortlisted, a capacity sizing should be performed. The purpose was to understand the hardware and software required as well as the costs for the equipments.

- Potential benefits

  The potential benefits that an imaging application could provide should also be documented in this report. It provided users a base for justification on the investments and benefits.

Finally, users should justify the implementation of an image system. Cost was by all means one of the most important aspects. Examples would include one time equipment cost, recurrent equipment costs, operating costs, human resource costs and conversion costs.

## Implementation Stages

1. Gathering and finalization of user requirements

   User requirements may be classified into the following :

- Input requirements - the input devices and methodology expected by users, such as the number of scanners, scanner characteristics, scanning speed and use of other technology, e.g. bar code and optical character recognition (OCR).

- Storage requirements - the storage media such as optical disks, magnetic disks or any types of microforms. The retention period, the need for juke-boxes and any legal concerns should also be mentioned.

- Access requirements - the access methodology required by users such as types of display devices, access frequencies (i.e. retrieval rate) and acceptable response time.

- Output requirements - the output methodology such as use of host or terminal printers, output volume and its estimated growth rate.

2. System design - a redesign of the workflow process

It was necessary to understand that once an image application had been implemented, the existing business flow might be totally different and the system design in fact turned out to be a redesign of the overall workflow process. The input, output or even the handling sequence of a document might be different from before. Only a comprehensive top-down planning would bring to an organization the full benefit of imaging systems.

3. Development of image system

It might be necessary to change the existing data processing application in order to match the imaging application. Moreover, the imaging system itself also required customization and tailoring which was even more complicated.

4. System testing

Image applications required more testing on the operation, and especially the new procedures in scanning and printing.

5. Education and training

Scanning and printing an image from a computer system was new to the users. Only through training and education would the users better understand the new process and learn to operate the system effectively. The education should cover the concepts of imaging, basic knowledge of scanning and printing devices, and possibly some hands-on exercises for the users to acquire skills prior to production.

6. Conversion plan

It was a very complicated task and users always wanted to perform it within a short period. If the conversion could be done prior to full production, it would then be the ideal case. However, the volume of existing documents was usually very high and the conversion could take more than one year, depending on the investment for conversion.

7. Pilot run

The pilot run was to serve as a simulation of the production environment. Only part of the functions and a small volume of data would be used for testing. However, the main idea of the pilot run was to have every part of the system fully executed. If the business had a cycle and repeated itself, e.g. month-end closing on the first of each month, it was recommended to test at least three cycles before the pilot run was accepted.

8. Live production date

It was necessary to select a suitable date for cutover to production in an imaging system. It did not only involve the conversion of a document from hardcopy to image form, but also the change of the entire business flow.

9. Post installation review

After the system had been cutover to production for a certain period, (e.g. six months), a post installation review was recommended. Feedback from users should be reported, defects or problems in the system identified and overall system design reviewed. It would serve as the lessons learnt from this implementation and suggested improvements for the next time.

## Benefits of Image Processing

### Storage

The traditional place for storing a paper document ranged from a paper folder, a file cabinet, to even a warehouse. It was obviously very costly and inconvenient when a particular document was searched.

With image processing, the location for storing the documents would be the optical disks. On average, a 12" optical disk could store an equivalent amount of documents that required four 5' file cabinets. This was a significant improvement because it reduced the cost of renting large storage spaces for these documents. In addition, the durability of a paper was definitely less than optical disks. Paper got worn out and the information might be blurred after five to ten years. The life of an optical disk was considered to be approximately 25 year. However, once the data had been converted into digitized format, they could be backed up and/or reproduced easily without loss of quality.

## Document Organization

Documents were usually organized in a folder concept and related papers were grouped under the same category, e.g. by customer numbers, by companies, by part numbers. Normally a folder contained different types of documents, such as hand-written letters, invoices, receipts and forms, and these documents were often of different sizes, shapes, and quality. In order to organize them properly, they would be further separated by separators, thus making the folder unnecessarily larger.

In image processing, these problems were simply eliminated by folder management concept handled by indexes or tabs. With the presence of these tabs, it would be easier to locate and organize any of the documents without difficulty. These logical separators did not incur any significant storage overhead and could be maintained easily.

## Data Security

When documents were saved, there was a need to retain them for future reference. They were usually stored in file cabinets, shelves or a warehouse. From the security point of view, they were not well protected at all. They might be damaged by accidentally spilling a cup of coffee, deliberately modified by an unauthorized staff, or even totally destroyed by fire. Moreover, these documents were seldom backed up. Even though they were replicated, the result was disastrous and it was not easy to recover from the damages.

In image processing, data could be protected in two levels - hardware and software. Hardware was the physical protection of the CPUs, I/O devices and communication devices. Software was the logical protection of data according to the types of users, nature of documents and degrees of access. These were the standard security measures adopted by most computer installations regardless of whether there was any image application. Needless to say, information protected in such a way was much more secure than those left on the shelves.

## Data Integrity

It was impossible to ensure no error in handling papers, especially when the volume got large. The invoice was not inserted in the right customer folder, the folder was placed in the wrong cabinet, or the invoice should actually not be inserted into the folder. These errors were likely to happen everyday and it was extremely difficult to locate the right document once the mistake had been made.

In image processing, these would not happen. It was the software that controlled the updating and management of the filing.

## Document Retrieval and Workflow Management

It was time consuming to search a document from a warehouse unless there was a good filing system. When the transaction volume became high, it required a group of staff dedicated for searching documents. After the document was found, there was an overhead of routing before the requestor could finally obtain the copy. The elapsed time could range from a few hours to a few days.

There was absolutely no such problem in handling images. The electronic retrieval of data from optical disk only ranged from a few seconds to a few minutes. Some products contained a workflow management feature that could assist users to forward the necessary documents to the right person and save them in a logical input tray. Since the image was only logically retrieved from the disk without physical erasure, there was no need to replace it back. Processing would be faster, less error prone and more productive.

## Concurrency

For instance, Accounting department might need a customer folder to find out the accounts receivable information while the administrative department might need the same customer folder to check some orders at the same time. Examples like this happened everyday. When documents were filed together, it could hardly be shared by more than one user. Practically, paper filing system was limited to single user access.

One of the advantages of implementing an image processing system was it could facilitate multiple user access. There was no need to wait for the current user to finish processing before the next requestor could obtain the document. Many users could simultaneously read the same document without any delay.

## Issues of Image Processing

Unlike data processing, image processing was a very new concept. There were many operational and financial problems when it came to implementing such a system. This section attempted to identify some of these problems and discuss the impact to the organization.

### Cost Justification

A set of image processing system consisted of scanners, display devices, printers, optical disks and image processing software. Depending on the requirement, the initial cost could vary from hundreds of thousands to millions of U.S. dollars, not to mention the recurrent cost. If the organization was a new computer user, the initial cost would be even higher. If one used the cost benefit approach, the only major financial benefit would be the savings from the storage space and clerical staff. The productivity improvement and user satisfaction gained could hardly be converted into monetary terms for evaluation.

In this scenario, Thornton May proposed five justification strategies in a paper called 'Justifying the Image'. They were :

- Return On Investment (ROI) Strategy - it was basically the traditional cost-containment approach which employed the accounting principles of payback from capital asset investment and savings from payable. This method did not take into consideration any gain from non-financial benefits such as satisfaction and did not involve end users or technical people.

- Wing It Strategy - the strategy was to identify the ideal computerization environment that the end users were dreaming for and then simply went ahead to implement according to the their proposal. It did not involve the technical people and they would likely have problems in the implementation.

- Cooked Books ROI - this was the other end of the Wing It Strategy. It was the formulation of the computerization environment that the technical people were looking forward to. The evaluation was based on the cost benefit figures using the ROI principles.

- Quantify Intangibles Strategy - since it was difficult to identify the intangible benefits, this strategy was to gather the technical people, end users and financial staff together to convert these benefits into numerical terms. However, it was not easy to come to agreement when these people were brought to work together.

- Select and Populate Strategy - this was the joint effort of senior management in the end user and technical departments where they worked together to identify the strategic approach for the company and implement it once the technology had been selected.

As quoted from the article,

> 'The companies that continue to speak the language of cost containment operate with a metric mentality that fails to reflect the increasing importance of intangible assets....Such organizations will be economically mute in a world where intangible assets are the true determinants of market success....Organizations we interviewed that are successfully using imaging technology to their competitive advantage are already at work redesigning skills and incentives, and revamping the IT infrastructure for the future....They realize that the way to differentiate themselves is by proactively creating and then empowering compelling visions of the future with information technology, visions that are focused throughout their organizations'.[11]

Paper Storage Elimination

If the document was scanned into the system, it could be reproduced easily and there was no need to retain the original copy. However, if it was mandatory to use the

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[11] May, Thornton. Justifying the Image. Datamation, 15 April 1990

original copy, the document had to be kept. If the document produced from optical disks had not yet been accepted for use in court during litigation, the original document could not be destroyed. In this case, implementation of an image processing system would not eliminate the storage cost, but could benefit the other productivity gains. Therefore it was necessary to understand the nature of each document and identify the need of referencing the original hardcopy before destroying any of them.

## Data Conversion

Once it was decided to implement an image application, one of the question was how long it would take to convert all the existing data into images. Naturally, user preferred the duration to be as short as possible. However, this was not feasible in reality and the following example showed why.

Assuming two pages could be scanned in one minute, 840 pages would take a full 7-hour day. Assuming 25 working days in a month, only 21,000 pages could be scanned by one workstation. If there were five workstations dedicated for conversion, approximately 100,000 pages could be converted in a month. Adding the set up time and contingency, one million pages would require almost one year elapsed time.

As one could tell from this example, the conversion was a very long and tedious process, which could not be completed within a quarter of a year normally. A couple of ways were recommended to solve the conversion problem :

- To increase the investment in the conversion : for example the number of workstations was increased from five to twenty. This would reduce the conversion period by four times, and a one year conversion would only take three months. Apparently, it solved the conversion problem, but it raised the question of how to justify the equipments which were only needed during the conversion period.

- To allow the image system to cutover to production before the completion of data conversion : this would allow the organization to realize the benefits of the image system earlier. However, a very careful and detailed procedure would be required when the organization tried to manipulate the data which existed in two entirely different formats, i.e. image and hardcopy.

## Legal acceptance of Image Document

The legality of documents reproduced from image was a very controversial issue after the birth of this technology. In a survey of electronic image management, 27% of 726 samples perceived 'output possibly not admissible in court' as a serious drawback. 'Although the biggest perceived disadvantages of electronic image management are cost and unseasoned technology, legality of output is also a major worry'.[12]

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[12] Skupsky, Donald. Avoiding Legal Gray Areas. Computerworld, 5 November, 1990, p. 83-88

It was necessary to be aware that if reproduction of documents from optical disk was not legally accepted, it meant that the original documents could not be destroyed after they were scanned. When these documents were required, manual searching had to be performed.

## Environment suitable for Image Processing

Image processing was considered as the next office automation frontier in today's business world. Whether it could really achieve 'paperless' or simply 'less paper' was still unknown. However it definitely represented high productivity, fast retrieval and enhanced data security. In order to have a better understanding of how image processing benefited the business sector, three areas had been studied and were discussed below.

### Banks

According to Dexter Holt, program manager of check processing system development at the Federal Reserve Bank in Boston, U.S.A, 'Imaging really changes the way you do business, because you stop moving paper the way you've done in the past, and you start moving data'.[13] This was exactly

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[13] Booker, Ellis. Not as new and strange as it seems. Computerworld, 5 November 1990, p. 67-75

the concept of imaging. Banking business was characterized by high volume of transactions every day. The number of checks handled could be measured in terms of millions and also because of legal requirements, a lot of documents had to be kept for a number of years before they could be disposed. To efficiently and effectively handle the huge amount of documents and to meet the stringent requirement in the banking business, image processing was definitely the strategic directions for a bank. Some areas for image applications were check processing, signature verification, customer service in credit cards department and general records management. Image applications could provide fast retrieval of images, reduce storage space and indirectly lead to improved customer services and increased productivity. It was not surprising to find that Jean Perret, the vice-president at Citibank's Latin America and Canada Division said that, 'Image will be the breakthrough of the 1990s'.[14]

## Hospitals

Patient's record was undoubtedly one of the most important information in a hospital. 'An average of eight

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[14] Cortese, Amy. <u>Image yields interest at banks.</u> Computerworld, 19 March 1990

people need to review a patient's medical record per day'.[15] To allow the information to be easily and quickly accessed by hospital personnel, an imaging system would be the best candidate to manage the documents. The patient record could be scanned, stored and retrieved. Different people at different locations could access the same piece of information by pressing a few buttons, such as the doctors, pharmacists or cashiers. They could then spend more time on meaningful tasks and decisions making. However, the interview with Dr. Peter Lo of Grantham Hospital gave us some additional insights. He agreed that imaging applications could definitely help the hospital's operation but he believed that there were a lot of technical hurdles in front and it was not easy for a hospital like them to justify the image technology at this time.

Insurance Companies

Another type of organization that would most likely consider image processing was insurance companies. Similar to banks, they needed to handle a very large volume of transactions, enquires, and documents. Data processing could only help them to streamline part of their business. However, their business nature often required them to access documents that were not stored in computer systems, such as letters

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[15] Molloy, Maureen. Hospital improves services through electronic imaging. Network World, 29 October 1990, V7 N44 : P.21-24

from customers claim forms filled in by applicants. In these cases, image technology would definitely be the best way to address the problem. By means of storing these documents onto optical disks, they could be protected safely, retrieved quickly and reproduced easily. The success story of an American insurance company was discussed below in order to better understand how image technology helped the insurance industry.

## USAA Image Processing Case Study

United Services Automobile Association (USAA) was one of the largest insurers in United States, serving two million members. Back in 1970s, they already realized that they have serious problems in handling the large volumes of paper and documents. The huge amount of phone calls and mails had made the situation even worse. The chief executive officer, Robert McDermott, decided to consider advanced technology as their strategic direction in order to maintain their competitive advantage in the market. They finally adopted the image technology and implemented IBM's MVS/ESA ImagePlus system.

> 'The company had now fully implemented with an imaging system to process the company's files and get rid of 99% of its original paper documents. An estimated 160 employees once involved in file handling are being retrained for other positions, according to Donald R. Lasher, president of USAA Information Services'.[16]

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[16] Sullivan-Trainor, Michael. <u>USAA's CEO cited for systems role.</u> Computerworld, 10 April, 1989, P. 15

Areas of applications

- Document Entry

  This was the process where the clerk in the mail room opened the letters and scanned them into the system. The system had the ability to route the image of the letter to the appropriate staff.

- Processing

  A user could retrieve a mail pending in his logical in-tray and there was no need to search and wait for the paper. The user could file the document, route it to the next user or suspend it for a while, and the operation was very simple.

- File Reference

  When it was necessary to view a document, the user could simply select one or several related documents from an indexing screen, and the system would be able to retrieve the images from the storage manager to the front end image workstations.

Benefits

By implementing imaging systems, USAA had gained the following benefits :

- Reduced costs

  The Property and Casualty policy service file took about 39,000 square feet but the same amount of optical disk required only 100 square feet. More than hundred of people were reassigned to other tasks and the total savings from reduced costs added up to $5 million per year.

- Improved productivity

  The productivity of the professionals improved in USAA because of the ability to access documents online, as their work was mainly driven by the customer calls.

- Improved service

  Because of the higher responsiveness to customer enquiries, customers satisfaction increased in USAA.

- Improved security

  After the implementation in USAA, there was no need to retain the hardcopy documents which were usually stored in the warehouse. The images were protected by hardware devices and software control. Encryption could be implemented if necessary. This reduced the risk of exposing the documents to unauthorized personnel and hence led to better data integrity and security.

USAA had realized that it was not possible to effectively manage the two million customer files and therefore they decided to implement an image system to automate the processing of documents. They justified the system from the savings acquired and they were further evaluating the next area for imaging applications within USAA, such as their Real Estate Department. 'Therefore, the outlook is great for the users of the system, for the customers and for the "bottom line" of the business'.[17]

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17 Plesums, Charles. Image Processing at USAA. Mainframe Journal, June 1990, P. 8-15

# CHAPTER IV

# INTEGRATION OF IMAGE PROCESSING WITH OTHER TECHNOLOGY

## Interface with Data Processing

It was not possible to have image applications running alone, without the support of data processing. The concept of image processing was an electronic file cabinet run by an automated document flow management system. It could not serve the daily operations of an organization because its purpose was to process images and not the data.

There was close relationship between data processing and image processing :

- If the document contained bar code information, one of the requirements was to convert it to coded information and then transfer to the host applications. In this way, operators would save the effort of entering the bar code data and hence improved productivity and minimized error.

- It was highly desirable to have a single screen to handle both image applications and data processing applications. In some displays, the screen could show both images and host simultaneously, or the users could swap to another screen by simply pressing a hot key.

* Once an image application had been implemented, there were a lot of new information that might be added to the host database, such as date of scanning, optical disk numbers.

Interface with Microfilm

Basically, the application of microfilm in image processing was very similar to optical storage concepts. The major difference was the storage media. Instead of optical disks, microfilm was used. They had the similar capabilities of capturing, searching, retrieving and printing the original documents, with excellent image quality. Before further evaluating the advantages and disadvantages of microfilm, the system components in a microfilm image system would be reviewed.

Input

The input in a microfilm image system was usually a camera device, which would capture the image of the document into the microfilm. Some manufacturers called it a 'recorder', a 'filmer' or just a camera. These cameras usually had the following characteristics:

* Automatic document feeder was provided to minimize the manual operation and increase the productivity of document handling. Some of these camera devices could

also handle computer printouts in continuous form. Therefore the huge output generated by computer could easily be converted into microfilm and stored for a very long time.

- They had high picturing speed of approximately 40 to 50 pictures per minute. The 6600 Mixed Document Camera produced by 3M could even handle 90 pictures per minute.

- Three level blip control : this was an indexing methodology commonly adopted by the manufacturers and it provided an identification of each film. The terms generally used were called 'item', 'batch' and 'block'. They served as different levels of indexes, e.g. date, customer number, and sequences etc. These indexes would become part of the film and would be used subsequently for searching.

- Various size of documents could be handled and the maximum size was 11" x 17".

## Storage Media

As explained above, microfilm was used as the storage media in this image processing technology. It was similar to the films that we used for taking pictures by a camera. The standard film size was very handy and only a few inches in length and width. However, its could house as many as 3000 to 4000 pictures. It subsequently required a development process just as the ordinary films and usually took less than an hour.

## Output

Most of the manufacturers called the output device a 'reader-printer'. As the name implied, it had the capability to read the films stored in a microfilm, and reproduce a copy of the image onto paper. It was basically a combination of a display device and a printer, which were combined into one single equipment. The functions and characteristics were :

- There was a carrier for housing the microfilm. It was where the user inserted the microfilm into the machine for reading the pictures.

- There was a screen for displaying the image retrieved from the microfilm. The input was usually the keyboard, where the user could key in the indexes, such as the three levels of blip control mentioned above.

- These devices usually had a very high searching speed. The time required to locate the last picture starting from the first one took less than 15 seconds. The film moved at a very high speed and slowed down when it approached the required one. These devices could search in the reverse direction and also moved the pictures by using the keyboard.

- Common functions, such as zoom, magnification and rotation, could be performed by most models.

- The printer was usually located right below the display, and could produce a copy of the image retrieved from the microfilm onto a paper. Most of the models had the paper cassette located in front of the unit for the convenience of paper replacement. A very common feature was the masking function. By moving the control keys around, the user could select to print a portion of the image so that the sensitive information might be protected from disclosure. The common print speed was approximately ten copies per minute.

- More sophisticated search could be performed by connecting the reader-printer to a personal computer (PC). Most reader-printers could interface with a PC and accepted command from it. A software program would be required to run under the PC.

## Software

When a reader-printer was connected to a personal computer for retrieval purposes, a software was required to run under the PC. A common term was adopted by the manufacturers to denote such a software - Computer Assisted Retrieval (CAR) System. The functions and characteristics of a CAR system were :

- The operation was menu driven. It could improve the productivity and minimize errors.

- Statistical report could be provided by the software, depending on the sophistication of the product.

- Indexing and retrieval would be made easier with less keystrokes. Related information, such as customer information and microfilm information, could also be stored and displayed upon request.

- The PC could emulate as a terminal of a mainframe data processing system. This could benefit the users to work with the host application and manipulate the microfilm system without operating on two displays.

## Comparison between Microfilm and Optical Disk

- Input and development process

  Although both the microfilm and optical disk was a write-once-read-many (WORM) technology, microfilm was less convenient in the input stage. A film could not be developed unless all the frames had been captured. If the transaction volume was low, it would take a long time before the film would finish. It might cause inconvenience when a user wanted to locate an image only to find out that it was still inside the microfilm which had not been developed yet. Furthermore, there was a turnaround time which was needed for development before it could be placed into a reader-printer for retrieval. All these problems would require manual procedures to resolve until the end of the development when the microfilm was ready for retrieval. In the optical disk case, it did not require any development process. As soon as the data was stored onto the disk, it could be retrieved immediately for display or printing. There was virtually no lead time between the document scanning and retrieval.

- Conversion effort

The speed of a camera could be as high as 90 frames per minute. However, only three to five pages could be scanned per minute. This was because the operator had to adjust the quality and verify the document every time. If we took conservative comparison of 50 frames per minute in microfilm and five pages per minute in scanning, the difference was ten times, i.e. a two month conversion period done by microfilm was equivalent to 1.7 years in scanning. The latter was definitely a disadvantage when large volume of conversion had to be done initially.

- Data sharing and workflow management

A reader-printer configuration actually operated in a single user environment. If another user wanted to access the data on the same microfilm which was used by the another one, the requestor had to wait until the current user finished and released it before he/she could use it. This was obviously different from optical disk where the image was digitized and therefore could be shared among many users concurrently. This led to the possibility of workflow management in optical disks technology where the images could be forwarded according to the desire of the user and the flow of the business process.

- Storage capacity

Assuming a page of document required 100K of storage after compression, and one side of an 12" optical disk could store up to 1GB of data, one optical disk could store a total of 20,000 pages. If a cartridge of microfilm could store a total 4000 pages, one optical disk storage capacity was equivalent to five cartridges of microfilm. In terms of managing these storage media, optical disk would be simpler and easier.

- Physical characteristics

A microfilm cartridge was small and handy in size when compared to optical disk. It was relatively easier to handle. Moreover, microfilm claimed to have a storage life of over 100 years, while optical disk could last for quarter of a decade only.

- Access mechanisms

The minimum requirement for retrieving images from microfilm was simply a reader-printer, which did not need special set-up or software execution, although a CAR system could simplify the operation. However, optical disks required a disk drive as well as sophisticated software to communicate between different system components. It was more complicated in terms of configuration and required special skills to operate and maintain the system. Moreover, optical disks was accessed directly by mechanical arm movement and microfilm was accessed sequentially. As a result optical disk had a much faster access time than microfilm.

- Costs

The costs required to implement a solution using microfilm was much less than the cost required for a similar one using optical disk technology. Both the hardware and software costs in optical disk technology were very large and it might be very difficult to justify.

- Legality of image documents

This was a very important issue when the management decided which type of technology to choose from. In many countries of the world, documents produced from the image of optical disks were still not accepted legally and could not be used in the court during litigation. Therefore if a company had selected an image processing system using optical disks, they would face the problem of producing a legal copy unless they retained all the original copies scanned before. On the other hand, microfilm was a direct capturing mechanism of the original copy and involved no digitizing in any means. Thus reproduction of a document from microfilm was more likely to be accepted by court and in this case microfilm was better than optical disks. As quoted by Marsha Fisher,

> 'Given the immense asset value of the documents being managed with imaging systems and the novelty of the optical media used to store them, many users who are thinking of buying these systems are questioning whether a digital copy of the paper is as legally sound as microfilm'.[18]

— Integration of Microfilm with Optical Disk

As one could tell from the concept of microfilm and optical disk, they were two totally different types of technology. It would be best if one could combine the benefits of both of them into a single product. 'Kodak has just launched a family of products...Imagelink, is based on microfilm but gives users the option of simultaneously writing to optical disk'.[19] Fuji also had a Micro-image/optical disk file systems where it integrated micro-image and optical disks into a single system. These products provided the benefits that could address the problems identified above.

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[18] Fisher, Marsha. The legality of digitized documents : A red herring? Datamation, 15 April 1989, P. 20

[19] Weldon, Susie. Science ends paper storage. Computerworld, 6 September 1990

## Interface with Facsimile

Facsimile machine (FAX) was probably the most common image product that one could find in today's offices. In simple terms, it was just like a photocopying machine with the camera in one place and the output tray in another place, connected by telephone lines. Most fax machines conformed to the Group III standard of International Telegraph and Telephone Consultative Committee (CCITT), so that they were compatible to each other and the machines could talk easily. That was why fax machines were so common and convenient to use.

In the imaging technology using scanners as input devices and optical disks as storage media, the capture process had already converted the information into bit maps and digitized the data. Therefore an imaging system could talk to a fax machine in the way the user could have the choice of sending the data to screen or directly writing it out to a fax machine. On the other hand, people from remote locations might send a document to your system via fax. The receiving fax machine could thus receive it and send back to your imaging system.

Another type of image was created by microforms. Some reader-printers available in the market nowadays had the ability to digitize the image and forward the signal to communication lines and local area network (LAN). They could also be connected to fax machines so that the signal could be sent to different locations.

Although the benefits could easily be realized for an imaging system to connect to a fax machine, there was an issue on the architecture of images and compression methodology used by different manufacturers. Different compression algorithms were used and there was no standard in the interface with fax machines. It remained a major problem of imaging technology until there was a control on the standards of image architectures.

# CHAPTER V

# EVALUATION OF EXISTING IMAGING SYSTEMS AND PRODUCTS

At present a lot of image system products were commercially available in the market. The objective of this section was to explore into features, compatibility and prices of some products offered in the market. The prices given here served only as a reference so that users could have the feeling of the ball park figures. The exact values should be obtained from the corresponding vendors or distributors.

## Image Management Systems

There were two main types of image management system products. Some of them ran on the host e.g. IBM S/390 and AS/400, Wang VS machines, DEC VAX machines while the others ran on a microcomputer based server e.g. Philips Megadoc. Each of the configuration had its own merits and drawbacks. A host based system usually offered better functionality but the price was also much higher. In a PC server based system, the functions provided were relatively not so rich. Nevertheless, the price was lower. It was more economical and suitable for entry level users. The market leaders in this area were respectively Wang, IBM and Philips.

## Wang Integrated Image Systems

Wang Integrated Image System (WIIS) was an integrated office information system based on the Wang VS machines. The information captured in image form included typed text, handwritten forms, printed documents annotated with text and drawing, line drawings and photographs. WIIS could work with Wang's own workstation, optical disk and printers. It only served as the platform of image processing applications and there were at least 50 third-party software vendors which had developed applications based on WIIS. WIIS could be integrated with other systems of Wang Laboratories, including Wang OFFICE automation system, VS/WP Plus and VS/IIS word processing applications.

WIIS used the PACE relational database management system and WIIS software for image database management. It was composed of the following components :

- one image system database as central store of all image documents

- one or more document locator databases for image document retrieval based on selection criteria specified by end users

- Basic Image Support Package (BISP) as an entry level packaged solution

- WIIS Primer Applications (WIISPA) as PACE databases which provided scan, index, print, and display image capabilities for applications

The price of a configuration varied according to the size of the system and specific user requirements. For a typical intermediate systems based on VS 8000 series and support of 20 workstations, it cost around US$300,000. However, for high end systems connected with many I/O devices the basic cost was US$500,000 or more.[20, 21]

IBM Imageplus

IBM Imageplus could run on two different IBM platforms, AS/400 or MVS/ESA on S/390 mainframes. Although there were some minor differences in the functionality of the two versions, they were basically the same.

The folder application facility was a panel-based front-end application and could automate the filing, retrieving and processing of documents. It maintained information about each document and provided an indexing function for images. Users created their own identification

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20 Wang Wang Integrated Image Systems (WIIS). 1991 : p.1-16

21 Wang WIIS Basic Image Support Package. 1991 : p.1-5

scheme for storing scanned documents e.g. date, department name, account number. The workflow management feature could automatically assign work to system based on the document's processing requirement and priority.

The price for both the hardware and software was roughly US$600,000 for a AS/400 based Imageplus system which could support 5-10 workstations. A MVS/ESA host based Imageplus system cost roughly US$1,500,000 and could support around 20 workstations.[22, 23]

Philips Megadoc

The Philips Megadoc image filing system was designed to run on Philips server and connect to a variety of devices from different manufacturers. The configuration was based on a server connected to a number of workstations and the server could be a Philips P4000 or Philip 320X. For a typical configuration with 10 workstations, it cost around US$500,000.

Megadoc Input/Output was a set of application programs for data capture, validation and archiving plus document output and display. ARF (Archive Retrieval Facility) was used to index documents. A department could customize its

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[22] IBM MVS/ESA ImagePlus General Information Manual. 1991 : p.1-17

[23] IBM AS/400 ImagePlus General Information Manual. 1991 : p.1-34

own filing system. Keywords and references could be either assigned or automatically generated. ISR (Information Storage and Retrieval) facilitated image document retrieval by keywords or references.[24]

## Scanners

In the procurement of scanners, the following points should be considered :

- Input capabilities - most desktop scanners could only scan one side of a A4 paper while some could scan both sides

- Feed mechanism - there were in general several methods used for feeding the scanned material and it could in turn impact the input capabilities of a particular device.

  - edgefeed and flatbed models : most scanners were of this type. Edgefeed types automatically rolled one page at a time while flatbed models required the user to manually place the document on a flat glass surface for scanning

  - hand-held models : this type of scanners required the users to manually roll the surface of the document across the device

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[24] Philips Philips Megadoc Image Filing System. 1991 : p.1-12

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- Compatibility - most scanners could work on Apple Macintosh and IBM PCs but they required separate interface card on each computer.

- Resolution - the most common resolution was 200-400 dpi (dots per inch)

- Speed - most scanners worked at a speed of three to five pages per minute

Currently in the industry there were around 50 vendors competing in the scanner market and the number of different scanning devices available was close to 200.

Wang Laboratories

- DS-4200

  DS-4200 was a floor console image scanner to be used on Wang VS machines. The price was relatively high at US$100,000. The maximum document size was 9.5 x 14.5 inches and it employed the sophisticated vacuum technique for paper feed. The maximum resolution was 200 dpi and it could work double-sided at rate of 50 documents/minute with data compression.

- SC300

  SC300 was a desktop image scanner for use on IBM compatible personal computers and the price was US$1500.

The maximum document size was 8.5 x 14 inches and the scan speed was around four pages per minute. It employed the most popular flatbed or friction mechanism for paper feed and the resolution was from 100-300 dpi. Data compression was also provided.[25]

Ricoh

- FS1

FS1 was a desktop color image scanner for desktop publishing. It also employed a flatbed mechanism and worked on both IBM PC and Macintosh. The maximum document size was 8.5 x 11 inches. The resolution could be from 120 to 400 dpi and the scan speed was about four pages per second at 400 dpi. There could be 256 different intensities and compression was done during scanning.

- IS400

IS400 was a bilevel dithering image scanner and worked with both flatbed or friction mechanism. It could work on the IBM personal computers and a wide range of minicomputers. The resolution was 400 dpi and the maximum document size was 11 x 17 inches. The scan speed was as

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25 Wang Wang Integrated Image Systems (WIIS). 1991 : p.14-15

high as 20 pages per second and compression was also performed.

## Optical Disks

There were around 30 vendors selling more than 100 different optical disk products. Erasable disk was already very popular and provided by a lot of vendors. Moreover, the price was close to the traditional WORM disk. The following was a comparison among the market products.

- Capacity - the range of storage capacity was around 500MB to 1000MB for an optical disk. Most of the 5-inch optical disks carried a data capacity of 800 MB.

- Access time - although long access time was one of the key disadvantages of optical disk, some vendors had already launched products which claimed to have access time as low as 28 msec. However, the typical access time was still around 100 msec.

- Diameter - most of the erasable or WORM optical disks were either 5-inch or 12-inch in diameter. Usually the 5-inch optical disk were used with microcomputers while 12-inch ones worked on mainframes or minicomputers.

- Compatibility - there was a wide variation on the disk compatibilities. Some optical disks could only be used on one single platform while some independent disk vendors manufactured optical disk which were compatible with more than five brands of computers. Apple Macintosh and IBM PCs were the most commonly supported computer models.

## Storage Dimensions

- LNE1-1000 (erasable)

  The LNE1-1000 optical disk was a 5-inch erasable optical disk system for use with Novell operating system on a 80286/386 based microcomputers. The maximum storage capacity was 876M and the storage life could be up to 25 years. The average access time was about 50 msec.

- MCE8880-HC1 (erasable)

  The MCE8880-HC1 was a 5-inch erasable optical disk for use on an Apple Macintosh computer. The maximum capacity was 876 MB. The characteristic was quite similar to LNE1-1000 with the same storage life and average access time.

- LS800 (WORM)

  The LS800 was a 5-inch WORM disk for use with DOS based 80286/386 based microcomputers. It was mounted in an external box with a separated power supply. The maximum capacity was 786M and the average access time was 180 msec. The storage life was around 10 years and the maximum number of drives was two.

## Wang Laboratories

- 2278V-1 and 2278V-7 (WORM)

Both were 12-inch standalone WORM optical disk drives for use on Wang VS computers and connected to Wang Integrated Image Systems (WIIS). 2278V-7 cost US$5,000 and the maximum capacity was 940M with an average access time of 90 msec. 2278V-1 could store up to two gigabytes of data and cost around US$30,000.

- 2278V-J2 and 2278V-J7 (WORM)

Both products were 5-inch WORM optical disk juke boxes which could accommodate a number of optical disk drives. 2278V-J2 cost US$180,000 and could house up to five optical disk drives and 87 platters. 2278V-J7 cost much lower at US$50,000 but it could only hold up to 50 5-inch media.[26]

## Limitation of Optical Disk Systems

While optical disks enjoyed a significant boom in the industry, there were a lot of limitations with this technology.

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[26] Wang WIIS Optical Disk Drives. 1991 : p.1-4

- System costs

Optical disk storage systems were considerably more expensive than microfilm or hard-disk storage system. The cost differential was due to the new optical disk media, sophisticated manufacturing techniques and powerful laser-based equipment.

- Industry standards

In optical disk there had not been an industry standard and it was crucial to the success of optical disk technology. As a starting point, Sony, Philips and Dupont Optical developed an ISO standard for the drives and media but it had not yet been widely accepted in the industry.

## Printers

The printers used for image processing ware either laser or thermal printers attached to the workstations. There were two reasons for this connection. Firstly, image was by itself a very high resolution picture and in turn required a printer which could reproduce high resolution pictures. Secondly, the workstations were dispersed around the organization and, therefore, it was much more convenient to have each workstation have its own printer.

Laser or thermal printers varied by their speed and memory. The printer memory could have a very significant effect on the printing speed since the images had to be loaded into the buffers before they were printed. Small buffer memory would result in longer time of loading, less parallelism during printing and thus reduction in printer speed.

Wang Laboratories

- LIS-24 laser printer

  The laser printer printed at a high speed of 24 pages per minute and worked with the Wang workstations. The price was around US$25,000. It came with 2MB of memory but did not perform duplex printing.

- LCS-14 laser printer

  The laser printer printed at a speed of four pages per minute for image documents and worked with the Wang workstations. The price was roughly US10,000. It came with 3MB of memory and did not support duplex printing either.

- PIC-PM04 thermal printer

  It was a high-resolution image thermal printer and output hear-sensitive paper at 200pi. The speed was around one page per minute.[27]

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[27] Wang Wang Integrated Image Systems (WIIS). 1991 : p.14-15

- 3812-002 pageprinter

The 3812-002 pageprinter could print at a speed of ten pages per minute and worked with the IBM Imageplus workstations. The price was roughly US$15,000 including the adapter cards. It came with 1MB of memory but did not support duplex printing.[28]

- 4216-20 pageprinter

The 4216-20 pageprinter could print at a speed of four pages per minute and worked with the IBM imageplus workstations. The price was roughly US$5,000 including the adapter cards. Duplex printing was not supported and only a single input cassette was featured.[29]

## Workstations

A typical imaging workstation was basically a personal computer with attachment capability to the image server or host. However, there would be minor difference from a general personal computer in terms of communication capability and user interface and one of the differences was

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[28] IBM IBM 3812 Page Printer. 1991 : p.1-2

[29] IBM MVS/ESA ImagePlus General Information Manual. 1991 : p.26

the display terminal. Due to stringent requirements of image processing, the resolution of the display would be very high of around 100-200 dpi. It usually required a special-purpose image adapter card on the personal computer to support imaging.

In the purchase of an image workstation, the users should pay attention to :

- windowing capabilities
- real and disk storage
- functionalities during standalone or host mode
- viewing of image e.g. rotation, enlargement, reduction
- manipulation of image e.g. insertion, deletion

### Wang PC 200/300 Series Image Workstation

The Wang Professional Computer (PC) 200/300 Series Imaging Workstations were designed for use on WIIS. The workstation provided users with image manipulation functions in a multiwindow environment. Users could display up to four application windows and up to three image windows for concurrent viewing of image pages and data base records.

Basically it was a high resolution workstation connected to a 80286 based system unit. A typical configuration was one with 1M RAM, a 1.2 MB diskette drive, a 20 MB hard disk drive and a 16-inch 200 dpi monitor. For ease of packaging, Wang preconfigured two models called 425-IMG-2A and 4250-IMG-2B.

The workstation could work in a standalone mode or VS WIIS mode. In VS WIIS mode, the workstation enabled users to view a variety of documents. As a standalone unit, the workstation was an AT-compatible desktop computer.

Image manipulation allowed users to rotate, flip, enlarge and reduce the image. Both portrait and landscape image documents could be viewed directly without rotation. For the 4250-IMG-2A workstation, the price was around US$8000 and it cost $1000 more for the 425-IMG-2B workstations.[30]

## IBM PS/2 Imageplus Workstation

The IBM image workstation was built around the IBM PS/2 processor with micro channel architecture. A typical configuration cost around US$10,000 per workstation. Imageplus Workstation Program was the intelligent software component of the user workstations and supported the following tasks:

- Scanning a document - the image was scanned, compressed and stored in both 100 and 200 ppi format

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[30] Wang Wang PC 200/300 Series Imaging Workstations. 1991 : p.1-4

- Displaying a document - the image was converted to 100 ppi for display

- Viewing an image object - the program allowed users to view displayed image with functions such as jumping to specific page, scrolling up or down, panning to left or right and rotation

- Manipulating an image object - the request was made from the host session to manipulate image documents like rearrangement, deletion, addition or replacement

- Printing a document

The workstation program also provided online help function for several key areas. It included configuring facility, installation facility, user tasks and messages. Two large-screen, high resolution monochrome display, namely 8506 and 8508, were designed for use with ImagePlus systems. They supported programmable selection of screen resolution and up to 16 shades of gray.[31]

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[31] IBM MVS/ESA Imageplus General Information Manaual. 1991 : p.23-25

# CHAPTER VI

# CONCLUSION

Image applications could help an organization to change the way they run the business. According to a study conducted by the Association for Information and Image Management (AIIM), the electronic image industry would grow four times to $12 billion by 1993 in United States. The growth was even more prominent in Canada where the annual rate was estimated to be at least 50% and the market could exceed C$100 million by 1992. While imaging was still considered an expensive technology due to its high costs, those companies using it said it could pay for itself in the hard and soft savings and benefits.[32]

One of the most representative industry was banking, which had a long tradition of making good use of computer technology to improve its operation. In the 1990 US National Operations and Automation Conference, the technology of image processing became a prominent topic. Big companies, like Bank of New England, Northern Trust Co. and First Interstate Bank of California, all made very encouraging comments on their plans to implement image processing. According to 1990 Image Technology Survey completed by the US Bank

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[32] Bunka, Lawrence Image Systems : The Next Wave. ComputerData (Canada), Apr 1990, V15 N4 : p.24-25

Administration Institute, one out of five respondents reported they were using some form of image technology today. Two out of three said that they expected to be using it by end of 1991. The study had well shown that the bankers were absolutely aware of how imaging could help to cut costs and improve service to customers. The bankers also agreed that imaging could automate a variety of paper intensive functions and there would be substantial benefits in application areas like loan services and loan application processing.[33]

Although image applications had been prominent in traditional document based industries such as insurance, finance and engineering, new areas had already opened up for new applications in real estate, art and architecture. According to the Yankee Group, the annual growth rate of digital document storage would be as high as 75% for the US State Government in the next four years. It was expected that there would be a matching growth rate in other countries, including the Asia Pacific region.[34]

One of the very well-known examples of successful image implementation was the Jockey Club in Hong Kong. Back in 1988 the Club invested US$600,000 on a Wang Integrated Image System for signature verification and bet tracking. The top management of the company commented that the cost had paid for itself in labor savings, reduced storage and improved security. Another well-known example was the deregulated

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[33] Anonymous <u>Image Processing : The Good, the Bad, the Uncertain.</u> ABA Banking Journal, Aug 1990, V82 N8 : p.54-57

[34] Rasch, Ted <u>Imaging in the Big Easy.</u> Inform, Nov/Dec 1990, V4 N10 : p.14-16

telecommunication industry in Japan. In mid 1989 Japan Telecom Co. purchased an image processing system from Eastman Kodak Co. at US$1.7 million to manage its two million accounts all over Japan. The examples showed that these significant investments would continue and grow at a drastic rate in the coming years.[35]

The imaging revolution would continue and it would make communication and information management much more efficient. To provide stability within the information and electronic image management industry, AIIM would spend its resources developing technical reports and standards for electronic imaging systems. This strong commitment complemented the evidence there would be a boom in the electronic imaging industry within very short future.[36]

Although the benefits acquired from image applications were attractive, very few companies were willing to invest in it. They believed that the technology was too new and some even did not believe that the advantages could be fully realized. In fact, there were a lot of improvements over the last few years, and more were likely to come. Storage capacity of optical disks would increase. WORM technology would be phased out gradually, and replaced by read/write optical disks. Compression algorithms would improve significantly and it thus reduced the need of high storage

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[35] McCann, Stenfanie and others Image Processing Systmes : Other Places, Other Uses. Computerworld, Nov 1990, V24 N45 : p.94

[36] Courtnot, Marilyn Impact of Optical Storage Standards on the Image and Information Industry. Optical Information System, Mar/Apr 1990, V10 N2 : p.70-74

requirement. Although the jukebox concept could host many optical disk, there was always an I/O contention when multiple users were accessing the disks concurrently. There might not be one read/write head per optical disk in future, but at least the ratio of optical disks to number of drives should be reduced significantly to ensure better response time. Moreover, the access speed was expected to improve by a few folds. In scanning, the speed of current scanners varied from one or two seconds to more than 20 seconds. It was expected that all scanners would be able to complete a scan in less than two seconds in the future. The ability of reading barcode information and optical character recognition (OCR) would become a definite requirement in scanning as it could reduce the need of input data substantially. Finally, interface of image with other technologies, such as microfilm, CAD/CAM, CASE (Computer-aided software engineering), would be more common and become a standard function in most products.

In the application side, imaging would no longer be just an electronic file cabinet. End users would be able to realize the workflow concepts and take advantage of it. More software on imaging would emerge and most of them would build around the workflow concept. Scanning and retrieving would become the basic functions in image applications and serve as the infrastructure for developing more sophisticated software. However, cost remained as the most formidable barrier for an organization in considering image applications. It was hoped that there would be some improvement in technology and it could reduce the cost of hardware and software so that more companies could afford this technology. However, until then justification would be the most difficult task in proposing image applications.

In summary, technology was expected to change rapidly in the coming years and users would find that the technical life of their equipments purchased would be shorter. However, at the same time they would find that the high cost would be well justified by the benefits. Imaging would be a standard application area, just like online or graphics systems nowadays. Users should not hesitate otherwise they would suffer from the loss of competitive advantages which their rivals had achieved by adopting this technology. Imaging would definitely help in numerous applications and reshape the business world tomorrow.

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