# Strategies for Automating Office Information
# A Comparison

Perhaps the humble conveyor belt bets exemplifies the original breakthrough inherent in the idea of automation: bring the work to the operator rather than having the operator continually going to the work.

Galitz distinguishes four types of work that take place in modern office environments (Walter, 1982):

- Cognitive (data analysis, planning, decision making)
- Social (telephone calls, presentations, conferences)
- Procedural (compiling forms, checking documents)
- Physical (filing, mail handling, reproducing, typing)

In all of these activities the material that is worked upon is knowledge and information. The office has been compared to an exchange node which takes raw information as input and synthesises it into refined information and decisions (Walker, 1982). The function of automation equipment in these environments is precisely the same as that of the conveyor belt—to bring information to people rather than having people go to information.

Perhaps the most difficult problem in doing this is compatibility. Different disciplines and technologies have flooded the business marketplace with an array of informational media, forms and formats. A typical report, for example, can require any combination of the following items as source documentation:

- Correspondence files
- Histories (financial, performance)
- Directories
- Computer output from management information or support systems
- Graphic libraries such as product catalogues
- Manuals, specifications, instruction guides
- Engineering drawings, graphs, tables
- Pictures, photos, advertising copy
- Newspaper articles, periodicals

Moreover, these source documents may be stored in paper files, libraries, word processors, computers, memory-writers, microfiche, floppy discs, transparencies, or aperture cards. In all probability, the report itself will utilise a similar variety of formats and media in its production.

What kind of a ‘conveyor belt’ can efficiently bring such a diverse set of materials to an operator, and allow him or her to produce an equally diverse array of outputs? Digital technology has been the obvious choice for achieving this kind of versatility, but its applications have been limited by important shortcomings of input and storage devices. Three major processes have been employed for data input.

## Translations (Text Representations)

The traditional way to create computer-readable information is to translate it into strings of symbols that are computer recognisable, using a standard code such as ASCII-2. This can only be done with information that is expressed in some standard symbol system such as English or mathematics. Symbols must be separately encoded, character by character, using some sort of key entry device such as a keypunch or terminal keypad.

The advantage of this method, as with any translation, is that recognition occurs simultaneously with data input. That is, the computer 'knows' the content of what it has been given, and this content can be indexed, altered and operated on with great speed and sophistication. In addition, form is differentiated from content so that information is stored in the most efficient and inexpensive manner possible. One alphanumeric character can be stored with one byte of memory, independent of its size, brightness, position on the page, or typeface—all of which take additional memory to store.

The disadvantages are the severe limitation on the forms of information that can be encoded, and the enormous amounts of time required to perform encoding. In this regard, the everyday 'typo' and its cousins have become a well-known and serious problem in digital technology. When perhaps thousands of pages of information, or megabytes of numerical data, are encoded through a device called 'the secretary' or 'the research assistant,' human variability quickly becomes a significant impediment to cost effectiveness and reliability. For this reason data input has been the least efficient process in computer technology.

Also for this reason, translating techniques are best suited for relatively small databases which must be manipulated in elaborate ways. Office information, on the other hand, tends to present the opposite picture: enormous amounts of data must be rapidly and reliably encoded, retrieved and transmitted. They usually do not require elaborate, content-specific manipulation. By far, the most frequent operation performed is merely 'looking' at specific information, on demand.

**Copies**

Until recently, the approach used to satisfy the previous requirements has been to make copies of original documents. All micrographics systems are essentially based on the same idea as carbon paper with the additional concept of miniaturisation. A copy is a 'dumb' image of original information in that what is copied is not the meaning or content of a document, but its visual appearance.

Copying technologies sacrifice recognition and content-specific manipulating activity. In return, they gain the ability to store and retrieve all kinds of information in a uniform format, regardless of content. Copying can be done with great speed and small cost, and miniaturisation allows large amounts of data to be stored in small amounts of space.

In the early days of micrographics storage, fiche, roll film and the like were treated simply as 'better' pieces of paper. They were filed, duplicated and mailed in much the same way as paper, with the added conveniences supplied by small size. Modern automated micrographics systems employ fiche or roll film as mass storage devices. Images stored in this way can be scanned and digitised for purposes of viewing and transmission.

Methods for copying documents have had a long and honoured history. In one sense, they were the first major step in automating the management of information. The beginnings of the modern college lecture system, in fact, were instituted in Britain because there was no method of effectively duplicating books. Lectures were no more than extended sessions where each student, quill in hand, created his own copy of materials in a text possessed by the instructor.

Most of the major drawbacks of copies—both then and now—stem from the fact that they are physical objects with many of the same characteristics of the originals they were designed to replace. Such media as fiche, roll film, or aperture cards contain images which deteriorate with age and frequent use, and are sensitive to a variety of environmental conditions (dust, temperature, etc.). Because of this, copies usually must be made of copies, creating an unfortunate cycle of successively degraded images. Degraded images result, as any copy produces an image which is inherently inferior to the original.

As copying in an analogue 'what you see is what you get' process, it is difficult to eliminate or compensate for defects in an original when making its duplicate; nor can a copy—once made—be easily altered. Finally, it takes fairly complex mechanical equipment to store and retrieve physical objects such as fiche or microfilm. Mechanical operations are slower than electronic ones, and mechanical equipment is prone to wear and breakdown with frequent use. What can be said of mechanical equipment can also be said of the objects they manipulate. Film grain, media quality and variations in photographic processes all create significant variations in the quality of images that can be stored.

Many of these 'complaints' can be summarised with a generalisation: mechanical, chemical and electronic processes form a hierarchy with respect to quality control. The more processes of the first two types that are present, the greater the likelihood of problems with reliability and image quality.

## The Binary Raster Image

The problem of multiple document formats is really a special case of a more general issue faced by almost every scientific and artistic discipline: how does one depict a large, even infinite, variety of objects and events in a uniform and yet accurate way?[1] In the case of document information this problem has been solved for quite some time. The binary raster image is really a general descriptive system which can describe any document, regardless of its content. A page of 'anything' is treated as an enormous 0 – 1 matrix. Each cell is coded as '1' or

[1] The solution to this problem in music is credited with making western, classical music an internationally successful art form. The lack of a general descriptive system for depicting dance is considered the principal impediment to its acceptance as a major discipline. Its problems in this regard have exactly paralleled our discussion of copies *versus* translations. Films of a choreographer's work, for example, do not differentiate form from content, *i.e.*, what is part of the 'dance' and what is part of a particular performance. They fail in this because they are content-independent duplications which do not 'recognise' similar and different elements. On the other hand, notation systems, such as Labanotation, require pages of time-consuming labour to accurately describe the mere raising of a hand (Hutchinson, 1971).

‘0,’ depending on whether the part of the document corresponding to it is dark or light. The resolution of the picture corresponds to the size of the matrix, that is, the number of black or white dots used to represent the document’s image.

Such a system provides a truly electronic, digital description of any document. As with copies, a binary raster image is a ‘dumb’ one. It encodes information only as patches of light and darkness. Recognition and content-specific manipulation are again sacrificed. However, a digital, electronic description of an image has a number of advantages over copies. Electronic information can be processed, stored, transmitted and retrieved endlessly with almost no deterioration of, or variations in, image quality. Electronics are orders of magnitude more reliable than mechanical or chemical processes, and human error is mitigated, as there are no physical objects to handle or transport.

Charge-coupled device (CCD) cameras have been available for some time which can scan a document and convert it to a digital image. The problem has been what to do with the image after it has been converted.

Consider, for example, this sentence which contains 121 characters (counting the spaces which delimit words and sentences). It can be stored in text mode as 121 bytes of information. However, the sentence occupies a display area of $6.2 \times 1$ inches on a typewritten page. If this area were scanned at 100 scan lines per inch and 200 pixels per inch along the scan line, the total number of pixels required is:

$$6.2 \times 1 \times 100 \times 200 = 124{,}000$$

Formatting these pixels into 8-bit bytes, it would require 124,000/8 or 15,500 bytes of computer memory to store this same sentence as a raster image. Compared to key entry, this is a ratio of 128 to 1.

A second problem concerns the descriptive system itself. Continuous spatial relations containing continuously varying shades of brightness must be mapped into sets of tiny, discrete rectangles, each of which is either black or white. This must be done in such a way that desired features of the original document are preserved, while undesired features are reduced or eliminated.

For these reasons, practical use of the binary raster image has awaited three major developments:

- A mass storage medium that could accurately and cheaply store huge amounts of raster image data.
- Data compression techniques which could abbreviate a large volume of digital data into a smaller volume containing the same information.
- Image processing and enhancement algorithms which preserve desired document features and eliminate unwanted ones.

## Optical Disc-Based Information Management

All these developments have now taken place. The storage medium is provided by the optical disc which is capable of storing up to two Gigabytes or 40,000 8½ × 11-inch pages on one disc. The life of these document images is estimated at a minimum of ten years, with no deterioration of image quality. The actual life may be very much more than this. Data compression techniques such ass those implemented in facsimile transmission satisfy the second requirement. Average abbreviation (compression) ratios of 1 to 8 are commonplace for a large variety of information formats. Finally, sophisticated image processing techniques are now available which differentiate pictorial content from text and preserve the most important features of each while a document is being captured.

As a result of these developments, it is now possible to convert any document, of any content, on any medium, directly to raster image form and to store the image directly in this form. For all practical purposes, this eliminates the problems of image quality and mechanical reliability present in micrographics systems. Further, these images can be transmitted anywhere in the world, and printed in almost any output medium (fiche, vector images facsimile, paper, film, etc.), as they are digital data.

The problem of recognising and manipulating content still remains, although it is mitigated by optical character recognition devices and revision workstations which can alter image data.

Until recently, image management systems of the type we have been discussing have been implemented only in large-scale, expensive applications. However, several smaller-scale systems have currently appeared on the horizon. As the price of mass storage continues to go down, small, lower-cost image management systems should become increasingly available.

**Social Considerations**

Image technology has been thought of as another welcome step toward elimination of that villain of efficient office management—paper. Yet employees on all levels have shown a propensity for maintaining their own personal files. To do so, they often print out hardcopies of electronic information ‘just for their records.’ Paper has also proved the medium of choice for aeroplanes, internal mailboxes and other contexts where groups of people meet and work together on common projects. The result has often been more, rather than less, paper as an accompaniment to office automation.

Paper is also a syntax-independent device that can be ‘fiddled with’ far easier, in many cases, than terminal screens. This is true because of the precision with which one must know what one is doing when working with electronic information. This precision runs counter to the varieties of *ad hoc*ing, improvising and vagueness that characterise how real people digest and compose informational documents (as found in social scientific studies).

The effects of image technology on office organisation will depend critically on the distribution of information and skills concerning image software. For example, it may be that middle and lower-level personnel are the ones who will learn to operate these systems efficiently, whereas managers and supervisors will be responsible for reviewing and composing final documents. In this case, the efficiency of image systems may be gobbled up by the inefficiencies of interfacing with many people on several levels of authority so as to get a common task done.

Finally, the explosion of information that image technology makes available to business people may prove more of a curse than a blessing, as it has in some of the sciences. In these sciences, small networks of trusted friends were the idiom that guided one toward relevant and trustworthy information. When the amount of available information surpassed the ability of these networks to know about information sources firsthand, scientists became swallowed in a sea of studies and data that became all but impossible to adequately review.

## Conclusion

Image technology is a dramatic application of an increasingly prevalent metaphor in the business community: treat information as a commodity. As with any commodity, it is assumed that things will be better if it can be produced, stored and used more quickly, in larger quantities and at less cost. However, many social scientists and linguists insist that information is not a commodity in terms of how it functions within interaction in human groups.

Leaving this debate aside, objectifying information in office environments will produce dramatic changes in the way work and interaction are organised in modern offices. The exact nature of these changes will depend on the interaction of these new image technologies with human interactional systems.

## References

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