

# Towards a Better Understanding of Electronic Document Management

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## Abstract

*Documents are central to the functioning of an organization. Among other roles, they are critically important as a means of communication, as organizational memory, and in business processes. In addition, office workers spend as much as 60 percent of their time handling documents. For these reasons, many organizations have tried to improve document handling and use through the application of information technology, but progress in this area has been slow. However, recent technological advances, such as new storage technologies, higher computation speeds, and system integration, are lifting many of the traditional restrictions on the conversion of paper to electronic systems, and on the media richness of these electronic documents. As a result, many of the envisioned benefits of electronic document management (EDM) are within reach. Successful exploitation of these benefits requires managers to address specific issues in system design, system implementation, and organizational support.*

## 1. Introduction

Most organizations, especially large corporations, produce enormous amounts of paper. A study by records managers in the U.S. estimates that there are 318 billion pages of paper documents on file, with 92 billion new pages added each year. Computers print 775 billion pages each year. In 1990, these new documents required 3.1 million tons of paper (Allerding, 1992). Business forms are a large portion of this paperwork. U.S. companies spend more than \$6 billion every year on preprinted forms, and they spend from \$94 to \$120 billion per year to distribute, store, and process forms (Skapinker, 1991). Filing space is a major problem and expense and handling paper is one of the main tasks of the so-called "information worker." In fact, 90% of all communication continues to exist on paper despite the massive application of computer technology to modern office operations and the widespread discussion in the popular press and elsewhere of "the paperless office" (Lukanen, 1988).

This should not be so surprising, given the diversity of documents and their "media richness", i.e., the variety of communication media used in documents: not merely text, but tables, graphs, and pictures in all colors and formats. Traditional computer databases have been largely unable to

handle this richness. Information technology in the form of word processors and application-specific programs has been used mainly to create paper documents to support the traditional paper-based document management process. Not surprisingly, when using information technology to transmit documents one relies much more on faxing than electronic mail. The dream of the paperless organization has so far proved to be rather elusive. Yet, with office workers spending 40 to 60 percent of their time working with documents (Frappalo, 1992), organizations are looking to advances in storage technologies, computation speeds, and integration of technologies for better ways of handling documents.

In this paper we argue that technological advances may fundamentally change the way we view and handle documents. We describe these advances in terms of their effect on media richness and the structural constraints of information representation. This leads to a notion of electronic document management (EDM) and an expanded view of information management which integrates traditional documents into electronic document management.

To reap the potential benefits of EDM, however, a better understanding of opportunities and limits posed by this technology is essential. Although many of the technologies needed for EDM are available today, successful electronic handling of documents has so far been limited. This is often because advances in EDM tend to be product-driven and lack an encompassing conceptual and theoretic foundation.

## 2. The functions of documents in organizations

Documents serve many functions in an organization, everything from providing simple communication through memos, recording agreements in contracts, to adding value to a product through complex instruction manuals and even to creating a corporate image through brochures and annual reports. In the era of electronic communication, however, the definition of document has been widened to include such things as voice mail, presentations, even video clips. In order to assess the limits and opportunities posed by the implementation of electronic document management, we must first establish a clearer definition of just what a

document is, and then derive a workable classification of the functions that documents serve in an organization.

## 2.1. Definition

A document can be described simply as recorded information structured for human consumption (Levien, 1989). Or a document can be defined as an information set pertaining to a topic, represented by a variety of symbols, stored and handled as a unit (Sprague, 1993).

A more detailed definition accommodates technology somewhat more. "A document is a snapshot of some information set that can

- incorporate many complex information types;
- exist in multiple places across a network;
- depend on other documents for information;
- change on the fly (as subordinate documents are updated);
- have an intricate structure, or complex data types such as full-motion video and voice annotations; and
- be accessed and modified by many people simultaneously (if they have permission to do so)" (Michalski, 1991).

Documents which fit these definitions can exist in many forms in an organization. Examples include:

- Contracts and Agreements
- Reports
- Manuals and Handbooks
- Business Forms
- Correspondence
- Memos
- News Items and Articles
- Drawings, Blueprints, Photographs
- Electronic mail and Voice mail Messages
- Video Clips
- Presentations
- Computer Printouts

Clearly these definitions include both traditional paper documents as well as electronic documents, even though the two have until now been managed in completely different ways. This broad definition of documents is an important first step in developing an integrated approach to document management. The next step is to classify the functions that documents serve in organizations.

## 2.2. Functions

Documents play a variety of roles in organizations. In fact, it is hard to identify anything more fundamental and pervasive in organizations than documents. We need to develop a generic classification scheme for document roles to use in structuring our analysis of EDM.

Our classification scheme is anchored in Galbraith's notion of organizations as information processing systems (Galbraith, 1979). By viewing organizations as consisting of information processing units that need to interact,

communication becomes an essential element in the functioning of an organization. Documents form a constituent element of organizational communication in addition to oral forms of interpersonal and intergroup interaction. Structured communication processes then become the sequence of events that convey sets of information among the organizational units. These structured processes form the essence of most business processes, such as purchasing supplies, hiring employees, reporting to managers and external constituencies, etc. Finally, stores of documents form the organizational memory to communicate among organizational units over time. The time transcending characteristic of documents is the most important difference between oral and document-based communication.

**2.2.1. Communication mechanism.** Documents as a means of communication are an important aspect of organizational activity. Examples include memos, newsletters, proceedings, or bulletin-board announcements. This role of representing and communicating concepts also allows documents to become a product or revenue source. Examples are the operating manuals that support a durable goods product, or reports sold by think tanks, consulting firms and similar institutions.

**2.2.2. Business Process Vehicles.** Another generic role of the document is as a process vehicle. Many key business processes consist of document flows that enable different information processing units in an organization to collaborate. Examples are forms driving workflows, file folders circulating between departments, or data records being manipulated along a business process.

**2.2.3. Organizational memory.** Documents constitute a major part of organizational memory. Examples include individual notes, manuals, contracts, correspondence, reports, and of course, databases. Some kinds of organizational memory cannot be captured in documents, such as technical expertise. But documents and databases are the primary mechanism for storing and communicating information within an organization over time.

These categories are not mutually exclusive; the same document may serve different purposes at different times in its life cycle. For example, correspondence and reports serve as a communication mechanism at first, but then are stored as organizational memory. The three part classification scheme does, however, help organize the analysis of the limits of traditional documents, new technology, and the benefits of EDM.

## 3. Limits of traditional documents

To get a good grasp of the opportunities and limits of electronic document management, it is important to analyze traditional document management in more detail first. Once the limits are understood, the potential of new

technologies to overcome them can be clearly analyzed. Our analysis is based on the three generic document functions described above.

### 3.1. Limits on communication

In order to understand the limits on communication imposed by traditional document management, it is helpful to draw on communication theory. A contextual model of communication involves a message being sent from a source or sender through a channel to a destination or receiver where contextual aspects are included that shape communication (Lewis, 1987). According to this model, information conveyance using traditional documents can be analyzed either through a message or receiver orientation.

**3.1.1. Message orientation.** The limits of traditional documents as a means of information conveyance are related to the transmission of contextual and emotive clues. These limits become especially important in interpersonal tasks. Although well-designed traditional documents can go beyond the purely referential function of communication by using aesthetic and social codes, such as metaphors or allegories, to provide contextual and connotative meaning, this ability is usually found in poets rather than in writers of business documents. The popularity of desktop publishing has raised awareness of this situation and generated some guidance in the business literature (Martin, 1989). Yet, relying on print media imposes limits on the ability of documents to communicate social cues. When ranking different media, print media, which form the basis of most traditional documents, have the lowest degree of social presence. One analysis of the social presence of media ranked face-to-face at the top, followed by video-conferencing, telephone, e-mail and finally print (Fulk, Steinfield, Schmitz, & Power, 1987). Note that this ranking corresponds to a ranking of media richness.

**3.1.2. Receiver orientation.** For practical reasons, many kinds of traditional documents tend not to take the receiver's personal requirements into account. For example, the personalization of traditional documents aimed at a multitude of readers is usually limited to the insertion of a reader's name and address. No detailed reader profiles can be accommodated unless each reader receives a document personally written for him or her.

### 3.2. Limits as a process vehicle

In business processes, the use of traditional documents is characterized by repeated media breaks and one-person-at-a-time access to documents.

**3.2.1. Media Breaks.** Media breaks are the repeated conversion of a document from one form to another. Examples include copying a paper document, printing a text file prepared by a word processing program, copying a fax to avoid the thermal paper, keying in the information

on a paper form into a data record, pasting a picture onto a paper document, etc. This document manipulation is labor intensive, since human agents have to buffer these media breaks in most cases. Media breaks also lead to transmission errors that can range from illegible paper copies to misspelling and data entry mistakes. The results are potentially dangerous inconsistencies of a document across a business process.

**3.2.2. One-person-at-a-time.** One-person-at-a-time access to documents also has severe impacts on document throughput time in a business process. It forces a linearity of access to information that may not reflect the needs of the business process. Ford reduced the head count in the Accounts Payable department by 75% with a new system that allows simultaneous access to documents by several departments, instead of requiring the physical flow of paper documents (Hammer, 1990). Since simultaneous modifications to different components of a traditional document is physically impossible they often circulate repeatedly through various departments with minor modifications at each stage, resulting in fragmented workflows and, ultimately, fragmented understanding in complex organizations:

"In a long chain of paperwork stretched over time, people, and geography, no single individual may have a complete picture of the system ... (with the result that) documents can easily take over the work process they are intended to support, controlling rather than being controlled by the people who must rely on them" (Keen, 1991, p. 97). Moreover, with time being a major focus of competition, low document throughput time results in "information float," the time gap between the occurrence of an event and the information about the event becoming available. Like check float, which represents unavailable funds, information float represents wasted time. Just-in-time business needs just-in-time information" (Keen, 1991, p. 101).

### 3.3 Limits on organizational memory

Before the era of computers and data processing, all business information was stored and conveyed on paper documents and business forms. After the advent of computers, some of this information was converted into databases. Fields in data records were predefined, information was compressed with the help of codes, and information access became equivalent to executing simple search algorithms. In short, traditional automation required information to be highly structured in format and content.

However, since few documents meet these criteria, most organizations have only a small percentage of their organizational memory in this highly structured, highly coded form. Instead, they store millions of pages of free text, graphs, tables and pictures mostly on paper or microfilm. Huge filing spaces tend to fill most

organizations' basements. Access may be computer-aided through automated indexes and library catalogues, yet access remains basically constrained by physical limitations, i.e., a physical document can be in only one place at a time and new versions of a document require reprinting and redistribution.

This imposes two important limits on organizational memory. The first is a limit to the number of people with access to most of the documents, such as corporate librarians who, by being the only person capable of retrieving most of the stored information, pose an access bottleneck. The second limit is in the accuracy and scope of documents stored. This is illustrated by the machine designer who must leaf through large parts catalogues which are often not up to date. No wonder that many designers choose to design a new part rather than go through the complex and often futile document access procedure necessary to find an existing part. If the new part isn't added immediately to the catalogue, then the document becomes even more outdated. The result is an increasingly inaccurate catalogue and a tremendous increase in complexity in the manufacturing and logistics process.

### **3.4. Summary of Limits**

In summary, the limits of traditional documents affect all three of their generic functions, limiting organizational efficiency and effectiveness. In the next section we explore the potential opportunities and benefits offered by electronic documents.

## **4. Opportunities for electronic document management**

In this section we argue that the application of electronic document management allows us to transcend the limitations of traditional document usage. We first define the notion of electronic documents in the context of technological evolution. Based on this notion we then analyze the opportunities by looking at each of the generic document roles.

### **4.1. Electronic documents and the technological evolution**

The multi-media nature of electronic documents allows us to draw on multimedia research as well as traditional document management literature as the basis for an analysis of new opportunities associated with electronic document management.

First, however, it is helpful to take a closer look at three technological trends that are particularly relevant for electronic document management: Increasing media richness in IT, more powerful computing, and increasing integration of technologies.

The ability of IT systems to handle different kinds of media, or even to create new media, is increasing rapidly. With electronic storage becoming ever-cheaper, graphic images, sound, and even animated image sequences or videos can be stored digitally and eventually manipulated with IT. Optical storage technology, such as CD-ROMs and WORMs, plays a major role in this context. High-resolution scanners and display technology allow for input and output of media-rich electronic documents. High bandwidth LAN and WAN allow for transmission of media-rich electronic documents. Thus, technology advances allow us to increase the media richness of electronic documents when entering, storing and transmitting them. This increases the variety of formats in traditional paper documents which can be converted into electronic documents and adds some media and formatting that have not been feasible on paper.

More powerful computing has opened up more elaborate ways of manipulating electronic documents. There is also less need to omit details from electronic documents in order to make them computationally accessible. This leads to fewer structural constraints on the representational form of information. The ability to search full-text databases is a good example of this trend. High-speed computing enhances the power of automated pattern recognition, which is key to searching the content of documents rather than just keywords.

Thanks to increased digitalization and standardization, technological integration is increasing, across both media breaks and between representational formats. Standardization pertains to all levels of the IT architecture, covering telecommunications, hardware, and system and application software. At the same time, the IT architecture is becoming the organizing paradigm for areas traditionally independent of IT, such as photography and video.

These ideas are represented in Figure 1. It defines the two major attributes or dimensions of a document: the richness of media used to represent the content or meaning of the document, and the amount of constraint imposed by the need for structure. We noted earlier that a data record met the definition of a document as a unit of information, but was highly structured, and limited in the nature of the symbols used to represent the information. Data records thus occupy the lower left corner of the matrix, because they contain only letters and numbers, and they must fit a strictly defined structure. Documents that include pictures, graphic elements, voice, and video are not easily handled by traditional computing technology. Nor are documents with a free-form, complex and unrestrained structure.

The best example of all three of the advances described above is probably hypertext, the non-sequential access to information (Conklin, 1987; Halasz, 1988). Although the idea has been around for decades, it is only thanks to recent technological advances that hypertext tools have become commercially available and widely used. In our framework,

the advent of hypertext signals a lessening of the computer's structural constraints on representing textual information. Many hypertext tools now incorporate graphics capabilities or even interfaces to video technology (Carlson & Sudah, 1990).

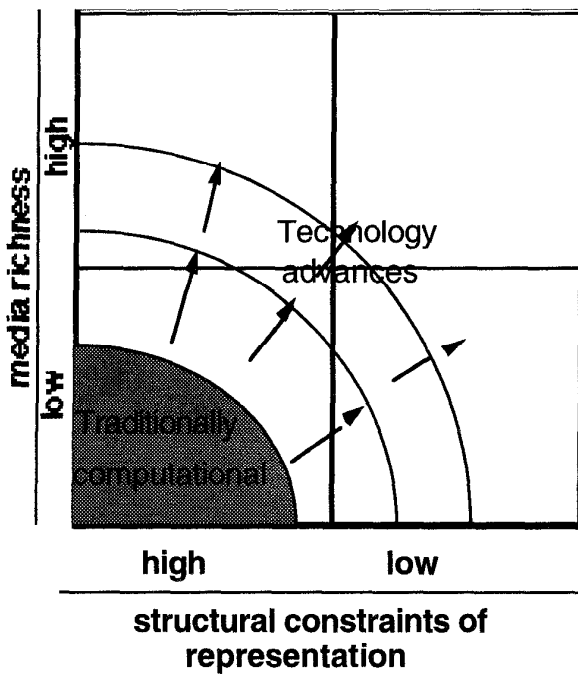


Figure 1: The expanding domain of electronic document management

#### 4.2. Opportunities and benefits of electronic document management

Given the technological developments described above, it becomes clear that EDM offers significant opportunities to improve document management and the performance of documents within each of the three functional categories outlined in Section 2.

##### 4.2.1. Communication mechanism

Electronic document management can support internal and external communication by employing media richness that focuses on the recipients' needs.

¶ Increased media richness can supply more social cues when communicating with employees. Many studies have found that the message in corporate communication programs often does not get through and that corporate

management is seen as remote (Keen, 1991). Electronic documents can enhance the emotive content of communication by making use of the richness and denseness of video and audio. For instance, research has shown that color can significantly increase the communication power of documents (Shank & LaTarge, 1990; Vienzenu, 1988).

Communication is also enhanced by the speed and timing of electronic transmission. Electronic documents can be sent out quickly and timed to reach all recipients at the same time. Communication which is timely encourages a quicker response. As a result, electronic documents are more relevant, have higher impact, and improve coordination. This converts communication time from a constraint into a resource.

Research on computer-mediated communication suggests that rich communication mechanisms, such as videotex newsletters, open up avenues for increased employee motivation by addressing employees more in a more timely and personalized fashion (Kiesler, J. Siegel, & McGuire, 1984; Kusekoski, 1989; Sproull & Kiesler, 1991). Moreover, electronic document management can combine documents with user profiles to tailor the message to the receiver's needs. The ability of electronic documents to carry embedded contextual information, such as reader profiles, and to act on that information leads to "active" or "intelligent" documents (Weinberger, 1991). Computer-based training (CBT) uses multimedia documents with receiver-tailored content. Faster learning is the result, as evidenced by extensive experience with hypertext at Brown University (Yankelovich, Haan, Meyerowitz, & Drucker, 1988).

Another opportunity for better internal communication can be found in the area of management decision making. Information systems that are integrated with electronic document storage can provide "drill-down" capability along different levels of aggregation of information, where hypertext-type links combined with visual signals can alert managers to the need for action.

In external communication, electronic documents have major potential for increasing emotive content. While most organizations use paper to communicate with their customers, there are highly effective electronic-based Point-of-Sale (POS) and Point-of-Information (POI) systems. Moreover, as the capacity global telecommunications increases, reaching the customer with personalized electronic documents at home is becoming more feasible.

##### 4.2.2. Business process vehicle

Probably the most immediate benefits from electronic document management stem from the opportunities to reengineer business processes. By expanding access to documents beyond the traditional sequential approach,

workflows that used to be split between functional departments can be integrated into a "point-of-work" workstation. For example, insurance companies, in order to capture a transaction at the point of origin and then manage it electronically, have developed seamless integration of electronic document management, from individual desktop workstations to large mainframe processors. This allows them to provide more value to the customer and develop more responsive product and distribution strategies (Wilson, 1989).

Reengineering business processes with the help of electronic document management makes it possible to avoid duplication of labor and reduce errors; intermediary clerical functions are reduced and significant improvements are achieved in staff productivity (Skinner, 1989). This can be illustrated by an example from the commercial and mortgage loan industry where an electronic folder management system in support of the loan documentation process led to major time and quality improvements. The labor intensive process of encoding dollar amounts and proofing and repairing misread or damaged checks became a fast electronic manipulation at a high resolution graphical display terminal (Meier, 1990).

#### **4.2.3. Organizational memory**

Electronic document management can lead to an expanded organizational memory with better access. Storing documents on optical disk allows much more information to be stored in much less space with better access. Lasher et al. report that, at USAA Insurance, storage space for active files required 39,000 square feet and inactive files required 80,000 boxes in a warehouse. Total storage requirements for the equivalent on optical disks were reduced to about 100 square feet (Lasher, Ives, & Jarvenpaa, 1991). Airplane and automobile manufacturers are moving their manuals and parts catalogues to optical storage to make them more accessible to designers and service employees. "An F-18 fighter plane weighs 13 tons. The manuals that come with it weigh about 13 tons as well. The manuals one company provides on CD-ROM for a commercial airliner weigh about 8 ounces" (Keen, 1991, p. 7). Electronic document management which leads to better access to organizational memory will result in higher productivity and major bottom-line impact especially in paper-intensive industries such as the mortgage and loan industry, or health care and pharmaceuticals (Lasher, et al., 1991; Mattox, 1990; Vacca, 1992).

In summary, electronic document management can substantially improve the efficiency and effectiveness of documents in each of the three functions described. The management challenges which must be met to harness these benefits are discussed in the next section.

## **5. Management challenges**

In order to harness the benefits of electronic document management, major challenges have to be met in the areas of EDM system design, organizational support, and implementation.

### **5.1. Design challenges**

The goal of electronic document management should be multimedia document integration rather than merely multimedia combination. A major design challenge for an EDM system is to provide an architecture that ensures modularity and allows computability of document components. Modularity of electronic document components allows the free combination of components into an electronic document. It should be noted that there may be different levels of modularity (Bullinger, Fröschle, & Hofmann, 1992). Databases, which can accommodate Binary Large Objects (BLOBs), provide modularity on an elementary binary data representational level (Shetler, 1990). Yet the challenge is to achieve higher levels of modularity where components can be searched for and combined according to meaning. This requires computability of components so that the contents of electronic documents can be structured so that they can be retrieved, classified, combined, destroyed, etc., by a computer.

This design challenge goes beyond the typical database architecture approach. In a traditional text document, all occurrences of a person can be easily found using a sequential text traversal and a simple pattern matching for the person's name. In a data record environment, a database management system can do the search even more efficiently. In an electronic document containing multimedia components, finding all references to a person is much more complex. In addition to searching for the name of a person, sound bits may have to be retrieved and video images scanned for sounds or pictures of the person.

Meeting that design challenge requires an architecture incorporating the meaning of document components, i.e. a meta-structure with a secondary level of coding. This meta-structure may be defined at the moment of document creation by the document user, or the system has to incorporate sophisticated pattern matching to extract meaning from document components automatically. With hypertext-type links connecting all references of the person in our example across different media, the task of finding all references comes down to a simple graph-traversal. For pattern matching to automatically extract meaning from video, sound, graphics and text, it is likely that only application-specific pattern matching programs will be available in the foreseeable future. Note that even with modern pattern matching, the more structure is provided up front, the easier it is to manage the document along its life cycle. Since there is no structure appropriate for all tasks,

a key for success in EDM is to develop application-specific structures. A profound understanding of the use and meanings of the electronic document components is required.

### **5.2. Organizational support challenges**

Reaping the benefits of EDM requires organizational support. There are three particularly important challenges: intra- and interorganizational standardization, interdisciplinary cooperation, and business process reengineering.

Since documents are so pervasive in organizations, support for EDM will be required from all departments. The early goal has to be standardization of document formats and contents between departments (Bormann & Bormann, 1991). The benefits for an organization that cannot use electronic documents to communicate between departments will not be sufficient to justify the effort required. In fact, standardization also needs to be cross-organizational. This emphasizes the importance of national and international standardization committees and an organization's participation in the standard setting process. The long time needed for establishing international electronic data interchange (EDI) standards illustrates the significant effort necessary for reaching this goal.

Establishing successful EDM requires interdisciplinary cooperation between specialists who, in most organizations, belong to different functional departments or even to different corporate subcultures. The departments with most of the traditional responsibility for documents include the I/S department, Records Management, Office Management, Library, Reproduction and Printing, and Training/Education. MIS professionals will have to work together with all of these departments, especially librarians and publishing experts, to provide an integrated technology infrastructure for EDM. Along with this interdisciplinary cooperation, IS professionals must shift their qualifications and focus from managing numeric data to managing documents (Keen, 1991). Otherwise, interviews with two large manufacturing organizations that are currently experimenting with EDM suggest that EDM may never be anything more than "islands of automation" that result from the "islands of experimentation" in various departments.

Finally, business process reengineering is an opportunity and a prerequisite for electronic document management. Any redesign effort should be preceded by a careful analysis of business processes and the way in which they will be affected by EDM. Electronic documents should not be used just to automate existing paper-based manuals. Instead, a process redesign may be needed as a fundamental first step in the introduction of EDM. The introduction of Hughes' Electronic Routing and Approval System (ERAS) provides a good example. ERAS' designers found that they could

reduce the number of signatures needed for approval of forms by 20-30 percent before even implementing the system (Mantelman, 1992).

Redesign opportunities through EDM should be evaluated with regard to organizational simplicity, personalization of communication, structure- and location-independence, facilitation of collaboration, and ease of communication (Keen, 1991).

### **5.3. Implementation challenges**

Implementation challenges facing first-movers are numerous. We shall concentrate in this section on two issues that stand out in the introduction of EDM: conversion of existing documents, and the quantification of benefits.

The transition from paper to electronic document management is an enormous project which poses considerable management challenges. The most important of these is to transfer large quantities of existing documents into the electronic document system automatically. First attempts to convert machine-readable documents into hypertext documents have shown promise, but human intervention still appears to be necessary to produce well-structured electronic documents (Wilson, 1989). Libraries are also trying to convert micrographic preservation programs into electronic imaging, a basic step that can help in this crucial challenge (Waters, 1991). Practical experience shows that it costs between US\$1 and US\$4 per page to convert to an electronic format (Waters, 1991). Thus, conversion costs need to be factored into the justification analysis of EDM investments.

Quantifying the benefits of EDM is necessary early, given the large effort needed to establish an integrated environment. Fortunately, the technological advances, especially in digital image processing, often generate cost savings and efficiency improvements that have not been seen since the early days of data processing. Unfortunately, the real benefits often result from the restructuring of processes, as mentioned earlier. These benefits are often difficult to identify and quantify in advance. Moreover, many current telecommunication infrastructures cannot support the necessary data transmission volume for EDM, and the traditional character-based workstations do not have the necessary power or quality of display screen. This implies major infrastructure investments in addition to the application development effort. Quantifying benefits and especially rationalization effects is necessary to put this effort in perspective.

## **6. Conclusion**

This paper has defined electronic document management and identified its potential to generate benefits in three

generic areas. Documents play a critical role in organizational memory, communication, and in business processes. There have been limitations in the technology used to manage documents for these purposes, except for the special case of constrained structure, limited media "documents" in the form of data records. Technology advances are promising to increase the computability of documents with rich media and complex structure to gain benefits in quality, speed, and efficiency of information management in organizations.

Reaping these benefits will require meeting management challenges in design, organizational support, and system implementation. This paper has illustrated the great potential inherent in electronic document management. We are convinced that electronic document management will provide a rich area for practitioners and researchers alike in the years to come. Now is the time to prepare for it.

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