TECHNICAL REPORT

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Technical product documentation — Metadata for construction documentation

Documentation technique de produits — Métadonnées pour la documentation de construction

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard (“state of the art”, for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 19033 was prepared by Technical Committee ISO/TC 10, *Technical drawings, product definition and related documentation*, Subcommittee SC 8, *Construction documentation*.

Introduction

During the last two decades the construction industry has undergone a thorough transition from manual practice to computer support for the production and exchange of information. However, the manual practices and standards for handling construction documentation have not undergone a corresponding change. Instead, the well-documented manual methods for design cooperation and coordination, a system for process quality assurance common to the industry, are being replaced by procedures specific to projects and companies. The result is that, although every individual participant strives to assure the quality of his or her own products and services, the process may fail to improve overall product quality. In this situation, the information interfaces and networking become key factors.

Nevertheless, electronic document management technologies are well suited to handle the large numbers of documents used in the construction process, together with the associated reference information. Cost reductions and quality improvements are immediate incentives. The potential benefits include:

— efficient search and retrieval of specific documents;

— quick and direct propagation of changes;

— automatic workflow procedures;

— documentation of dependent information in document collections;

— reduced administration through integration of document production and management;

— retrieval of knowledge gained from previous projects and common industry sources.

As document management is by its nature an instrument for the exchange of information, the need for standardization is evident. Specific properties of the construction process, in particular the presence of many participants temporarily involved but over a long period of time, make it extremely difficult to arrive at specific agreements between the different parties and thus promote the importance of standards common to the entire industry. The lack of dominant actors who would be able to set de-facto standards, as well as the ongoing internationalization of the construction industry makes dejure standardization within ISO the natural choice for a successful strategy.

ISO/TC 10/SC 8 has identified metadata for technical documents as being a field where the construction industry would immediately benefit from standardization, and where no standards are presently available. The purpose of this Technical Report is to further investigate and describe those standardization needs, and to propose standardization activities within the ambit of ISO/TC 10/SC 8.

Technical product documentation — Metadata for construction documentation

1 Scope

This Technical Report gives guidelines for the electronic management of documents used in the construction industry. It pays particular attention to the transition from manual to computerized processes, and the use of metadata in document exchange.

2 Basic concepts

2.1 Documents and files

In common language, a document is of paper and contains written or drawn information for a particular purpose. In many cases, the term document also has a legal aspect, for example, as proof of a legally valid obligation.

In the digital environment, the paper is replaced by a computer-file stored on a digital medium. However, there is no one-to-one relationship between document and file. The document can be composed of several files, and a file could contain several documents. Mixed environments, with paper-based documents, also exist.

An extended definition of the term document is offered by ISO/IEC 8613-1. It is “a structured amount of information for human perception that can be interchanged as a unit between users and systems”. A document can be on paper or any other media, including computer files or parts thereof, and audio and videotapes.

In this Technical Report paper-based documents and computer files are both regarded as manageable units in the information-exchange process.

The term document is used to refer to all kinds of units of information that can be managed using an electronic document management system (EDMS), the normal term for a computer application that manages documents and files.

2.2 Compound documents and document sets

Documents can be combined in two conceptually distinctive ways:

— a compound document is a homogenous document, consisting of several parts or sections (e.g. a technical specification made up of sections or a drawing that contains several views);

— a document set is a collection of individual documents, grouped for a specific purpose (e.g. the drawings and specifications needed for the procurement of a subcontract).

Document management has to consider both combinations and their parts, regardless of whether or not they are stored as individual computer files. The term collection of documents is used when discussing a number of documents that are managed together, but not directly related.

2.3 Metadata

In the process of exchanging documents, additional information will need to be attached to each document, to document sets and to separate files that are parts of compound documents. Metadata is the term used for this “information about the information”. It includes information that is usually part of the document header as well as all other

kinds of information needed to organize and manage the documents. In manual practice, metadata is transferred using a number of media, such as letters, labels on envelopes or floppy disks, telephone calls or meetings.

2.4 Model

A model is the representation of real-world objects and their relationships.

A model is built, or instantiated, using a conceptual schema that defines the kinds of objects and relations that exist in the model. Two kinds of models are of particular interest.

— A building product model describes the physical parts of a building. The conceptual schema for this kind of model defines the properties of the parts and the relationships between them.

  EXAMPLE That a column has length, width, height and material properties, that it connects to floor and a ceiling, and that it is part of the load-bearing structure.

— A documentation model describes the documents. The conceptual schema for this kind of model defines the properties of a document and its relations with other documents.

  EXAMPLE A plan drawing has size, scale and creator properties, it refers to detail and section drawings and is part of a set of working drawings. Such properties and relations are metadata for the document.

In the subsequent clauses of this report, the model concept is further elaborated.

3 Document management in manual practice

3.1 General

The tradition of managing documents in manual practice has produced a number of methods for organizing and exchanging information. Electronic document management has to consider the same basic needs, and provide a smooth transition path from manual methods. Each manual operation on a document, or one associated with a document, corresponds to a similar operation when using computer applications. What follows is a step-by-step description of the life cycle of technical documents, comparing manual practice with possible computer-aided equivalents.

3.2 Creation of documents

3.2.1 Manual practice

In most cases, before technical documents are created, documentation planning is performed. Preliminary document lists are made and boundaries for drawings defined. When the documents are created, document headers and title blocks are filled out with content that is standardized nationally or specified by the client.

3.2.2 Computer-aided equivalent

Here, the planning is done by registering the documents-to-be in a document-management database. Their identities and positions in the document-set structure and, where applicable, in a compound document, are defined. The metadata for each document can be registered when planning the documentation, or later, when the actual document is created, stored or otherwise managed.

3.3 Reuse of documents

3.3.1 Manual practice

New documents are often based on older ones. In its most systematic form, template documents or references to type documents are used. Old documents are used as copies or, when using minor parts thereof, rewritten or redrawn. The identity of the old document is sometimes preserved, in particular when there is a copyright requirement.

3.3.2 Computer-aided equivalent

Paper-based documents can be reused by capturing them by scanning and optical recognition of characters (OCR) or lines (vectorization). The existing documents can then be edited or portions of them can be included in new documents. Reusing digital documents is of course easier; either copies of, or links to, the documents can be created. In all cases, metadata that identify the origin of the document can be valuable.

3.4 Document distribution

3.4.1 Manual practice

For each version of a document, distribution is according to agreed distribution lists. A missive explaining the status of the document and the further particulars regarding the distribution may accompany the document. The receiver may also acknowledge the distribution.

3.4.2 Computer-aided equivalent

When using computer networks, distribution is easily accomplished automatically by data-communication. Distribution lists in electronic form can be applied to support the automated routines. Alternatively, no actual distribution is performed but documents are stored somewhere accessible to project members, and the existence of new versions is signalled by a message to all those on the distribution list. It is then the responsibility of each to open the document. Using appropriate supervision applications, all sending, receiving and reading of documents and messages can thus be logged.

3.5 Checking and approval of documents

3.5.1 Manual practice

Before a document is used for its final purpose, it is usually quality assured through an approval process that can contain several steps. In a typical document workflow, the document is first checked internally by the issuer, then in coordination with other specialists. After any necessary changes have been made, the client finally approves the document. In principle, the same procedure is applied to every subsequent revision of the document.

3.5.2 Computer-aided equivalent

Workflow applications allow the setting up of the workflow for approval processes, generally for a project or individually for a document, document category or set of documents.

3.6 Coordination of documents

3.6.1 Manual practice

Technical documents produced by different actors are usually checked against each other before final release. This applies in particular to drawings, but also to technical specifications, etc. In the coordination process, special atten-

tion is given to potential conflict points and zones, where several systems meet or intersect. Quite often, coordination is performed in steps, for example, technical installations are coordinated first, and then coordinated with the load-bearing and complementing structures.

3.6.2 Computer-aided equivalent

Analysis can be much enhanced by search and overlay techniques in computer applications. For example, all references to a section in a specification document or all occurrences of a specific term can be traced, and layers from computer-aided design (CAD) drawings showing the different technical systems can be overlaid to show collisions and other conflicts. The documentation of errors is possible, with links to the affected documents in a document management database.

3.7 Storage, search and retrieval of documents

3.7.1 Manual practice

Documents are stored in some structured order that facilitates finding and retrieving them. The usual storage systems in folders, binders and drawers are often standardized within companies, but seldom subject to formal standardization on a wider level. However, national classification systems for building elements, etc. are often used for the ordering of documents. In addition to the physical placement of the documents, document lists for each project, as well as project lists for the company, are used.

3.7.2 Computer-aided equivalent

At the basic level, all computer systems use file/directory structures that can be considered equivalent to binders and drawers in manual practice. Search and retrieval of documents is a basic function of document management systems. Search is based either on metadata or on the content of the documents (free text search).

For graphical documents, metadata is the most frequent search method (graphical pattern recognition is not yet a widely exploited technology). Many text documents can be found using free text search, although the existence of key words and other metadata can substantially improve the quality of searching. Retrieving the documents for viewing, printing or editing purposes requires knowledge of whether computer applications being used are able to read the data format, and often how the document is structured (in sections, layers, etc.).

3.8 Revision of documents

3.8.1 Manual practice

Changes prior to the official release of a document are often conducted informally. Revisions on a completed and released document have to be fully checked and approved, and every actor or party that will be affected has to be notified in accordance with routines established for the project or by standards.

3.8.2 Computer-aided equivalent

An important role of the EDMS is to assure that each document used is the correct version, and that revisions are correctly performed. Workflow functions can be used to manage revision activities. However, the need for more informal, but still sufficiently safe, procedures is seldom complied with by existing EDMSs.

3.9 Archiving and deletion of documents

3.9.1 Manual practice

When a construction project is completed, the documents produced and stored during the project are of varying interest for the future. Some can be directly disposed of, others contain knowledge that can be reused in other projects, while a third category is documents to be kept and used during the maintenance phase. Sorting can be done by tabs in the project binder or drawers for sketches and drawings. A similar structure for storing and classifying documents during the construction and maintenance phases, respectively, facilitates the management of documents during the entire lifecycle of a building.

3.9.2 Computer-aided equivalent

The sorting of documents can be done efficiently in much the same way, using file structures and metadata. Nevertheless, the long-term readability of documents poses a number of questions concerning the structure of document sets and compound documents, changing data formats and storage media.

4 Problems in document exchange

4.1 General

Document exchange is conducted frequently during the construction process, as well as during the lifecycle of the completed building. A number of information problems appear at each exchange stage. The manner in which these problems are approached often determines whether the document can be efficiently handled and properly used, in both the short and long term.

Four main problem areas for which information exchange solutions need to be provided can be identified:

— the reading and reproduction of documents (the presentation dimension);

— the identification of related documents (the organizational dimension);

— workflow and the archiving of the document (the life-cycle dimension);

— the connection between documents and parts of the building (the product dimension).

The exchange of metadata between users and systems is yet another problem area.

4.2 Reading and reproduction

A paper-based document can be read without tools other than the reader's senses, but reading a digital document requires a computer application. When exchanging documents, the receiver must have access to such an application, and he or she must also be informed in some way as to which application to use. Also, he or she needs to be familiar with the structure of the document or document set, as well as how and where it is stored. Metadata in a standardized format such as pure text is a way of providing such information. Some of these data can refer to national classification and other industry standards (e.g. document categories).

Furthermore, minor differences, such as application versions, screen and printer-driver software or installed typefaces can affect the appearance of documents, line breaks, page breaks, etc. If exact reproduction must be guaranteed, all such factors have to be controlled. In practice, this cannot be achieved without limiting potential errors, for example, by choosing a printing format that explicitly describes the exact page layout.

4.3 Organization and relating of documents

When organizing documents related to a project, all participants must agree on a structure for storing and managing the documents, with special attention given to compound documents and document sets. The structure can be used

directly by each of the participants, or form an “intermediate structure” used exclusively in a project network with common storage.

The simplest form of ordering documents for such purposes is the file/directory system. But as soon as there is more than one way of organizing documents, (e.g. one document is part of two or more document sets), additional information has to be provided. The file structure must also be preserved when linked documents are transferred from one storage place to another. Many communication methods, such as attachments to e-mail messages, do not provide such mechanisms, but the structure has to be recreated by the recipient.

Under current practice, several methods are combined, ad hoc, for controlling the document structures of digitally produced and stored documents. A part may be organized in a document management system, but project-specific manuals, especially for CAD, often play an important role, as do written or verbal agreements. One reason for this is the incompleteness of most EDMS applications for technical documents, while another is the lack of standards for the very complex information structures that are often used and the kind of information needed to describe the structures. The less coordinated the management, the greater the liklihood of errors.

Even more difficult to manage than compound documents consisting of linked files are documents extracted from databases using various kinds of filters for sorting information. Moreover, there is a need for various kinds of references and relationships between documents.

4.4 Quality assurance and workflow

Quality assurance within companies is normally subject to strict routines and is set down in manuals. In the project environment, however, coordinated routines for quality assurance are rare. Fundamental rules for the approval of documents exist at the national level, but the procedures for coordination of document sets are defined specifically for each project.

In order to perform a workflow, several pieces of metadata have to be exchanged. The access rights have also to be controlled, so that every participant can perform the authorized operations on the document, but nothing more. In many cases this will mean that only certain parts of a compound document ought to be accessible. When a document is approved, it should be locked to prevent changes.

4.5 Archiving

For long-term storage, information must be made independent of the person(s) who created it, as well as of the technical platform (software, hardware and storage medium) used in its creation. Retrieval must be guaranteed through the use of stable data formats and media. Often, the data will also have to be transformed to accommodate new technical platforms. The same applies for the information within documents and the metadata used for document management.

All information needed to search for and retrieve a document must be explicit to a degreee unnecessary during the project. Additionally, the long lifecycle of buildings often makes it necessary to adapt the information to the user’s existing storage systems.

4.6 Connection to product

In general, technical documents describe products. For production as well as maintenance purposes, a specific part or position in the building is a primary search path to documents. The document-management system must provide connections between specific parts of the building, as well as between product categories and other references.

4.7 Exchange of metadata

Most document-management systems use proprietary solutions for the structuring of metadata, and many also use them for the format for storing metadata. In a temporary organization such as a construction project, it is of vital importance that the information systems involved be able to exchange information. The demand for neutral formats and standardized definitions for metadata is obvious.

A parallel can be found in the CAD domain, where the use of proprietary systems for many years constituted an obstacle to their more widespread use in the construction sector. Not until industry standards for exchange were established did CAD become accepted for all kinds and sizes of projects. It can be assumed that the slow introduction of EDMS in the construction sector has similar causes, and even to a greater extent, as document management is primarily a tool for communication and collaboration rather than the production of documents.

5 State-of-the-art document management

5.1 Environments

Different overall purposes and preconditions for document management can be distinguished by considering the environment in which the document management is to be implemented. One kind of environment is the relatively stable context of a company or other organization. Another is the temporary production set-up of a project. Yet another is the source environment for knowledge to be used in companies as well as project groups. In 5.2, EDMS applications within these three environments are presented, including examples of practice. The solutions include a variety of technologies, whose main approaches are given.

5.2 Six technological approaches to document management

5.2.1 General

Present and evolving technology offers several levels of implementation according to the type of information handled by the system. Requirements for document management can be satisfied to varying extents. For each level the general functionality is briefly described in Table 1.

Table 1 — Levels of document management and functionality

Model-based EDMS Documents extracted from models	
Table of contents	for documents, models and objects
Document search	by any properties of the model objects
Access control	by DBMS, on object level
Revision management	for objects or documents
Reports	freely defined
Dependency network-based EDMS Change management through document dependencies	
Table of contents	for documents and links, network or hierarchical
Document search	related document parts
Access control	operating system or application
Revision management	for document and related document parts
Reports	defined by system functions
Hypermedia-based EDMS Navigation between documents	
Table of contents	for documents and links, network or hierarchical
Document search	by links or free text
Access control	operating system, application or routing and firewall technology
Revision management	for document and document part
Reports	defined by system functions

Table 1 — Levels of document management and functionality (Continued)

Document content-based EDMS Search based on document content	
Table of contents	for documents and document parts
Document search	free text search or interior structure of documents, e.g. CAD layers and entities
Access control	operating system or application
Revision management	for document or document part
Reports	access and revision of document parts
Metadata-based EDMS Search and management based on metadata	
Table of contents	sorted by metadata, e.g. document type
Document search	by metadata
Access control	operating system or application
Revision management	on document level
Reports	access and revision of entire documents
File hierarchy-based EDMS File manager services	
Table of contents	catalogue listings
Document search	by (parts of) file name and directory
Access control	operating system
Revision management	none
Reports	operating system logs
Generic functions for all levels Orthogonal services	
Create / Modify documents	
Network support	
Distribution	

5.2.2 File-hierarchy based systems

A basic structuring of documents that allows storage, search and retrieval using standard methods can be achieved using the computer's file and directory system. A methodical implementation applies a standardized information structure that includes the naming of files and the naming and ordering of directories. Information about the documents is restricted to the naming and organization of files and directories and, often, the application needed to edit the file. The information about time of revision is not reliable, since the operating system only records the time the file was saved to the directory.

In its simplest form, this kind of document management requires no tools other than those provided by the operating system. However, additional tools that handle the file structure can be used to enhance functionality and the user interface, and for creating and changing the file structure for assistance in naming and creating, searching, sorting, printing and distributing documents. For viewing documents, standard applications are available to users that neither need nor have access to the full version application.

5.2.3 Metadata-based systems

Metadata is data *about* the document, usually stored externally in relation to the document. Reference data are primarily used to add search facilities, but are also used for version control, workflow and other functionalities that can be related to a document. In this kind of system, the document itself is regarded as a black box, meaning that the system does not read or know anything about the internal structure or content of the document.

Current EDMS practice is heavily oriented towards metadata-based applications. This type of application is particularly suited for large amounts of well-organized information, where the need for systematic search can be based on good user knowledge of the information structure and classification systems. It is useful in the more stable and methodically organized phases of the construction and property management process, from detailed design onwards. It is less suited for situations where information is of widely varying types, and not easily classified, and when the process is dynamic, as in the early phases of a construction project. This disadvantage applies to file-based systems as well.

A large number of commercial-reference data-based EDMSs are available. Functionality differs widely, ranging from simple registers with some viewing functionality for documents, to highly specialized workflow systems for industry and administration. An important difference between systems is the method for storing documents and metadata. The most transparent stores metadata in a standard database format, referring to file names and directory paths set by the user. A middle level uses automatic file-naming, not interpretable without access to the EDMS. The most integrated embeds documents together with metadata in the database, applying binary large objects (BLOB) technology. The reason for automatic file-naming or embedding documents in a database is that documents should only be accessed via the EDMS. Some systems use proprietary databases, an inferior alternative with respect to forward compatibility and information transfer.

5.2.4 Document content-based systems

This kind of system does not rely on externally registered reference data, but uses the content of text or images in the document for search purposes. Thus any document can be used regardless of its internal structure. One necessary prerequisite, though, is that the data format be known and readable by the system. Documents in unknown formats cannot in principle be managed at all.

This kind of system is often combined with imaging, when the system determines the resulting format. Imaging technologies present paper-based documents on computer screens. The images used are created by reading the documents into computer-readable format using a scanner. They are then stored either as pure images in a bitmap-data format, or processed through an optical character recognition (OCR) application to be stored in text format. Software with similar functionality can also be used to identify bitmap patterns on a scanned graphical image, such as a drawing, and convert them to vector graphics to be stored in CAD format (automatic vectorization). It is also possible to overlay layers of structured information on the scanned image, and thus work on the digital document using intelligent tools.

This technology, which is called hybrid editing, is particularly suited for drawings and other graphic (non-text) documents. It opens a way to reuse the vast amounts of valuable material that up until now have been stored on paper in the archives of technical consultants, property-owners and authorities. Imaging is often described as a way to move towards the “paperless office”.

Imaging capabilities can be added to EDMs, and are in fact integrated in many currently available systems. The possibilities for managing paper-based documents in an electronic environment can give substantial benefits in the form of less storage space and a reduction in the time for search and retrieval of documents. In addition, reference information and search information not included in the actual document can be added to the document-management database, thus forming an electronic archive that offers considerably improved accessibility and search functions in comparison with traditional, paper-based archives.

Using a standard format for raster images instead of proprietary data formats for different application software also facilitates information exchange between users and organizations. All documents can be viewed using one application and a single user interface. A variation on this theme is software such as Adobe Acrobat[1)], which applies a more “intelligent” format to documents produced by various types of application software. In the case of Acrobat, a variety of PostScript is used, and the documents are simply “printed” from the application that originally produced them. In addition to viewing, this technology also allows search in the text and structure of the documents.

In the construction industry, document-content-based EDMSs can be useful when managing general information of varying formats and structures, whether from external sources or from a company's knowledge base. One weakness

1) Adobe Acrobat® is an example of a suitable product available commercially. This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of this product.

of this kind of system is its heavy dependence on text content for searching. CAD and other graphic documents are not as easily integrated; no possibilities for free-text search are present.

Speed is another important issue with systems of this kind. In order to achieve fast search and reliable search results, efficient indexing of the contents of all documents stored within the system must be performed continuously. The issue of search times can be considered a major overall success factor. Searching in an EDMS is to be contrasted with searching a bookshelf or library. The time gained can be quite substantial and, when translated into cost, will affect the competitiveness of the company. However, expected response time from a computer is short and the tolerance of most users is low, so the system has to be fast to be widely accepted.

5.2.5 Hypermedia-based systems

This kind of system is based on the idea that related pieces of information within a context can be linked to each other. The context may be a construction project or the global environment of the World Wide Web. The links consist of words or sentences, pictures or other elements in the document, and are live, so that the user can move directly from one position to another with a mouse click. Searching is rendered “intuitive”. For example, a list of drawings can contain links to all the actual drawings, and a technical specification can contain links to referenced standards.

In a still more developed environment, building components in drawings, specifications, 3D models and photographic documentation can be interrelated. One problem is that, in order to take advantage of such an interrelated documentation, all parts must be immediately available to the user. Another is the lack of a conceivable structure, if the hyperlinks are created without careful planning. To achieve efficient searching, the overall organization needs to be designed to appear obvious to the user, by using simple principles and, whenever needed, documents that explicitly present the structure.

5.2.6 New types in development

5.2.6.1 Overview

The four approaches described in 5.2.2 to 5.2.5 are all represented by commercially available EDMSs, used in practice. As modelling techniques are developed, it becomes increasingly evident that documents can be seen as presentation views of an underlying model, whether an information or product model. Two new and conceptually different principles for document management are being discussed and prototyped as a result of these ideas.

5.2.6.2 Dependency network-based

The contents of separate documents are often related, in the sense that a change in one document will necessitate changes in one or more other documents. While hypermedia technology allows search and navigation through compound documents, this kind of system is also relevant to the production and revision of documents. A conceptual schema for the information contains links between information elements in documents using more complex relations to support the propagation of changes throughout the compound document.

EXAMPLE Technical specifications for a building: when, for example, a material is changed, all references to this material in the specifications also have to be changed. Some changes can be propagated automatically, while others have to be decided on by a human expert. In the latter case, the EDMS can help by identifying the dependent elements and producing a task list.

One method for defining compound documents is the structured generalized markup language (SGML) standard, which can be used to define a document type definition (DTD) for a particular purpose. The Internet standard hypertext markup language (HTML) is a DTD for hypertext documents. The emerging extensible markup language (XML) standard is developed from SGML with the aim of providing a more flexible method for structuring information. The DTD concept is abandoned and the entire definition for the structure contained in the document.

5.2.6.3 Product model-based

The most far-reaching of the approaches is based on a product model. In this context, documents are merely filtered views of information from a database containing product-model data. The document management system can be

considered as the filter, managing the parameters needed to select appropriate information for a certain document or type of document, and presenting that information in a way suited to the purpose. The document can then be produced on demand, and only the information needed to produce the document will be stored.

Even if the product model can be viewed at random, there will still be a need to define and manage the documents. They could be quite different from those we are used to, incorporating new media including 3D presentation, interactivity, video, etc. However, in order to ensure sufficient and correct information, (e.g. to all members of a construction team), exact views will have to be defined, versions controlled, distribution or notification of changes managed, etc.

6 Examples

6.1 Company-wide integration (FFNS)

6.1.1 Background

FFNS Arkitekter is an architectural consulting company employing about 500 staff at 25 locations in Sweden. It is a subsidiary of SWECO, a corporation spanning several disciplines of architectural and technical consulting. In 1994, FFNS decided to develop a company-wide IT strategy, with the main focus on cooperation within the entire organization, between branch offices as well as persons with specialist knowledge. Key factors considered were the organization of information and the building of an IT infrastructure for the company.

6.1.2 Document management type

FFNS uses a common file-based information structure throughout its wide area network (WAN). The FFNS company standard for consistent naming and structuring is applied all the way from naming of the branch offices (top level in the common network domain) down to individual files in a project. The directories are conceptually organized, mirroring the company organization, which is illustrated using the bookshelf metaphor (Figure 1).

File names are composed of document type and issue date, thus allowing a two-dimensional search in addition to the directory properties.

In order to facilitate use at the project level, company-specific software has been developed for creating and managing the project structure, including directories and template files. The “project arranger” used for this purpose offers a choice of standard information structures for projects of varying complexity and types.

Quality assurance is another important issue within document management. The very essence of QA is good order. In this respect, the degree of standard structures and the ability to maintain routines for managing them are more important than the technology that supports the work. An important factor behind FFNS’s choice of a file-based information structure was that, being a low-level system based on standard products, it can be applied to internal document management as well as to project document management, involving temporary partners.

In addition, because the company is part of a larger corporation, the uniform file structure is considered important in promoting cooperation between specialists in different disciplines and locations within the larger organization. The SWECO WAN is designed to give access to all local area networks (LANs) at a single point of log-on. Local administrators give access rights to remote users for selected parts of the file structure on the LAN. No further instructions are necessary for navigating the file structure, as it is well known to all employees in the company.

6.1.3 Strength and weakness

The main strength of the system is the absence of any specific application software. This also minimizes the threshold for introduction in projects; no investment or installation, and almost no education, is required. The existence of a ready-to-use project structure eliminates the need to design a common, project-specific one for the team, thus making the system applicable to even very small projects on tight time schedules.

The restricted identification of documents by file name alone is an apparent weakness of the system. The method works fairly well in a project environment, where there is a strict practice of document categorization. For common

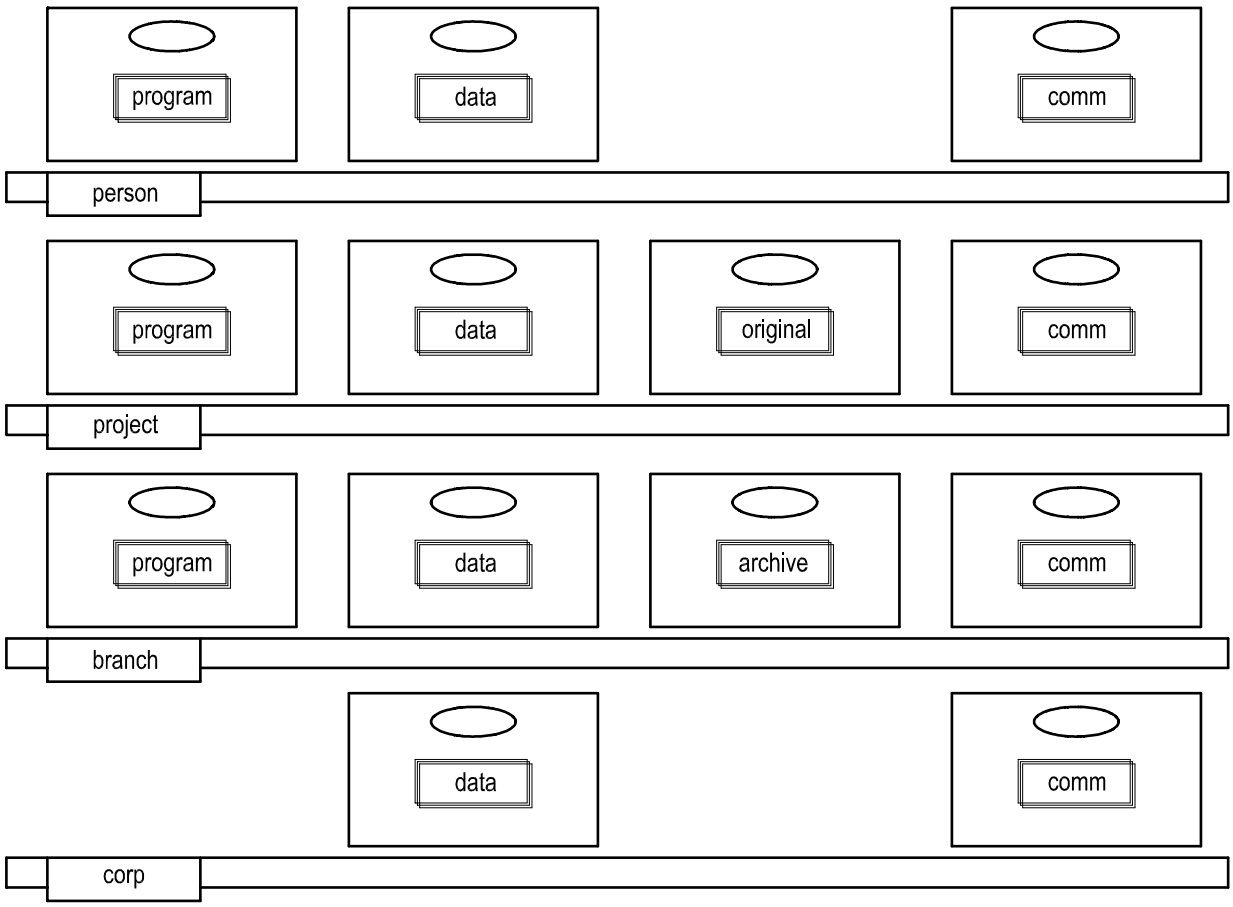

Figure 1 — Main directory categories in the FFNS information structure

company information, however, the introduction of the common file structure has been less successful. In order to facilitate their own navigation, many users have individual directories and file-names for these files. Common access is thereby decreased, and searching made dependent the creator's presence. A solution would be to transfer the vital parts of this information to an Intranet that uses the same overall concepts for subdividing information as the file structure. However, with the deployment of web technology, a number of additional facilities have become available for identifying and searching information, including:

— files linked from additional descriptive information;

— multiple sorting, using different properties;

— cross-linking of information from different web pages;

— free-text indexing and search.

6.2 Project integration, document control (Kvaerner)

6.2.1 Background

Kvaerner Construction Limited is a part of the Kvaerner ASA group, one of the five largest contractors in the UK. Trollope & Colls, a subsidiary, is participating in the CONDOR project (see 8.2). The London-based group specializes in office and commercial property development and high quality interiors. Most of the work is gained by a competitive tendering process. Kvaerner and its divisions have had BS5750/ISO 9000 accreditation since the late nineteen-eighties.

6.2.2 Document management type

6.2.2.1 General

The document management system concentrates on “document control”, meaning that the issuing and communication of documents is emphasized. There is much attention to the approval and audit processes. The goal is to significantly reduce the time taken to transmit documents between the design office and construction site, as well as that required to complete a review and comment cycle.

The system is based on reference data, i.e. each document has a set of attributes describing selected characteristics of the document. The search and retrieval of documents is totally dependent on the quality of these data.

The document controller system provides a number of services (see Figure 2). It serves as an electronic hub for all parties involved in a construction project, taking care of the receipt, registration and distribution of documents. The system consists of three modules, correspondence, drawings and information and instruction control, developed in-house starting in 1989. The modules can be used independent of one another.

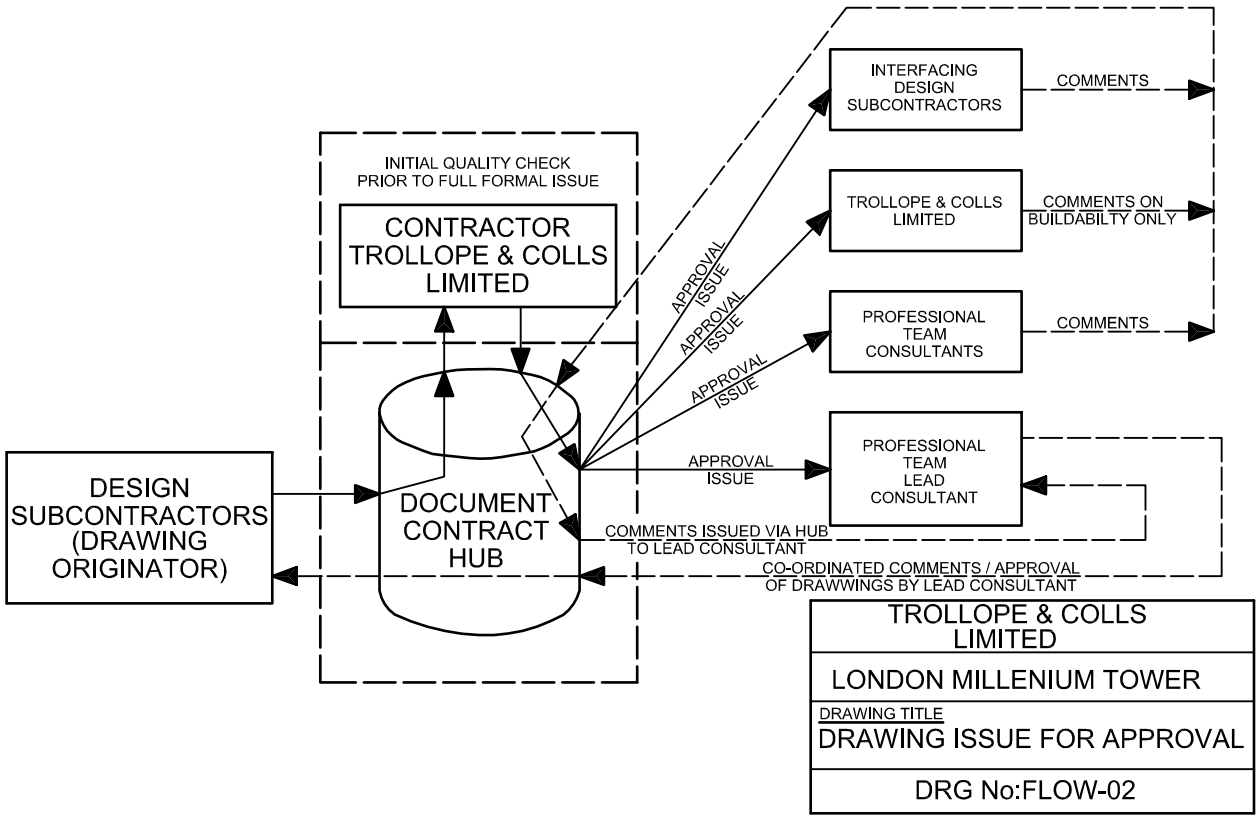

Figure 2 — Some document flows in the Kvaerner system

6.2.2.2 Module one — Correspondence control

This module is used by the document controller to manually register all incoming mail; the paper documents are scanned into the system and OCRed. The documents are then distributed within the project organization (and externally), with a simple workflow function defining the action to be taken by the addressee. Outgoing documents are also scanned and linked to other documents to which they correspond.

6.2.2.3 Module two — Drawings

This module is also maintained by the document controller, to whom all drawings are submitted “in the most intelligent form possible”, checked and distributed according to package distribution lists. Each drawing is issued in as many as three stages, and progress in relation to anticipated dates is reported by the system. Documents are covered by a transmission sheet, and the receipt acknowledged. The database for drawings contains reference information other than for correspondence.

6.2.2.4 Module three — Information and instruction control

This module is used for documents specific to the operation of a construction project. The documents are of three classes: requests for information, confirmation of verbal instructions and architect's instructions. The module contains functionality for preparing as well as distributing and managing the response to these documents. Reference information for these documents is the same, with some additional data for instructions.

6.2.3 Strengths and weakness

The system is expected to enable rapid response to technical and construction problems (lead times), reduce the number of hard copy prints, and enable team-building between company personnel and sub-contractors.

The system is designed primarily for the construction phase in large projects. The necessary project overhead, in the form of a manned document control hub, the installation and customization for the project, etc., makes it less suited for smaller projects or for early project phases.

6.3 Company database (INCOORD)

6.3.1 Background

INCOORD is a medium-sized consulting company active mainly in heating, ventilation and air-conditioning (HVAC) design and, to a lesser extent, in evaluation, control and general consultancy on building installations. The company employs about 35 people at a single office in the Stockholm area. INCOORD has a comparatively long experience of document management.

During the recession of the early nineties, the company decided to sharpen its competitive edge by increasing quality, creativity and efficiency through the use of new methods. An initial analysis showed that the information management part of the design process was constantly growing. Thus it was decided that improved information management should be a primary aim. High priority was given to the availability of common information within the company, “the engineer's bookshelf”.

6.3.2 Document management type

6.3.2.1 First edition

A thorough inventory of existing information led to the identification of a number of source-document categories, and the definition of a common structure for storing information. Requirements for efficient information management were also set up. Those seen as most important were:

— free-text search for documents digitally produced within the company (written documents as well as CAD drawings);

— capture and search of external documents as well as internal hand-written memos;

— automatic launch of the native application for editing the document;

— cut and paste between documents;

— fax and e-mail available from each computer;

— connection to external databases, e.g. literature and building materials;

— a simple and easy-to-learn user interface;

— minimum threshold in the effort to input and register documents with the system;

— easy to customize;

— a typical search time of less than two seconds.

In 1994 the company decided to use a software package which promised to fulfil most of these requirements. One important exception was the ability for free-text search of CAD drawings. Additionally, some limitations specific to the particular platform used were revealed during testing.

The personal application runs as a client-server solution with a virtual memory system (VMS) server. Attached to this server were workstation computers (PC). The system is a basic document management system with imaging capabilities added, including OCR. Documents are saved within the system using a four-level hierarchical structure. Each document is contained in a folder, within a drawer, within an archive. The search is based on the indexed text of documents. No reference data is input separately. In order to enable search for CAD files, lists of drawings were produced in word processing format.

6.3.2.2 Intranet

The next major step was taken in 1997, when vendor support for the software ceased. Instead of choosing another proprietary solution, the company decided to build an Intranet, using industry-standard software only. The Intranet would include the document management as well as dissemination of other company-internal information. This decision was based primarily on the perceived benefits of having a uniform and familiar user interface. Basically, the same functionality as that of the earlier system was demanded. The information was to be migrated to the new platform.

The new system is built around a Windows NT[2)] server, used as a file and print server as well as web and index server. All information is stored on this server. A standard web browser is complemented with plug-in viewers, allowing the users to directly view all documents stored on the server (Figure 3).

The directory structure of the file server is visible from the web browser. The first search step is to navigate down the directory tree to the level where the search should begin, thus limiting the number of documents searched. There is a choice between simple search of text only, or an advanced search using document reference data. Reference data is limited to:

— document title;

— author;

— company;

— date and time.

Document title is input by the author when the document is stored. The other reference data is automatically imported from system variables. Reference data is embedded in documents; no separate database exists. No reference data are stored for CAD documents.

6.3.3 Strengths and weaknesses

The original system was quite expensive, and the technical platform became obsolete after a few years. The migration of document information has also presented difficulties.

2) Windows NT® is an example of a suitable product available commercially. This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of this product.

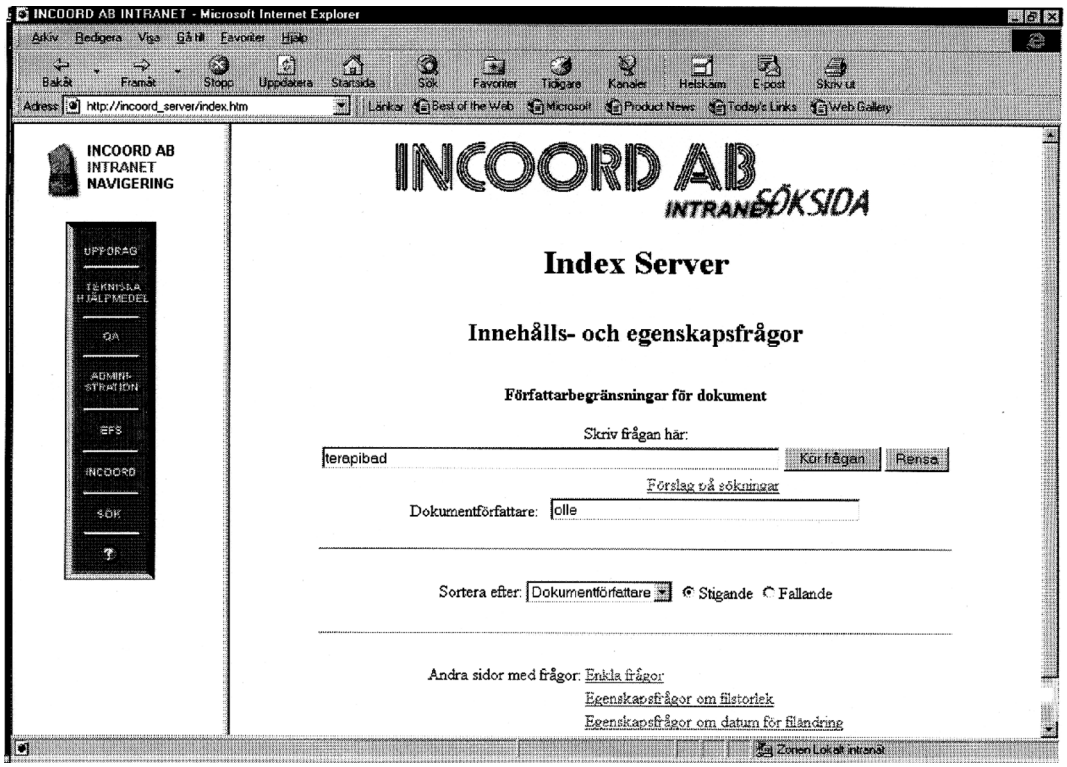

Figure 3 — Intranet user interface for document search

The amount of time and effort spent on developing the Intranet was surprisingly small: a total of about three man-months of in-house work. Important factors for achieving this were the decision to use standard software and to limit functionality to basic document management.

Search speed using the original system was extremely high. With the Intranet, the speed is considerably reduced (typically five to 10 seconds vs. less than 2 seconds). However, this has been accepted by users.

The Intranet contains no support for the process, either in the form of versioning or workflow or groupware functions. In the EFS system, previous versions of a document are automatically saved, and can be traced.

The Intranet solution does not limit the information to those parts stored with the company server, but links to reliable information sources on the Internet can be included. As the responsibility for maintaining the information is taken by the information provider, it is much easier to keep information up-to-date. However, the quality of information published on the Internet varies greatly, and there is little similarity in the structure of different web-sites, (e.g. for product information).

CAD documents and models are considered a problem. They cannot be automatically indexed by the systems used, and reference data cannot be automatically extracted, even if present within the file. File naming and file structure are the only remaining search concepts.

7 Views of different parties

Throughout the composite process of construction and facilities management a vast number of parties are active. Each actor or participant has a specific view on the information managed by the process (see Table 2).

There are many parties involved with information throughout the life of a facility. Although in a never-ending circle, for the purposes of this Technical Report, the planner and designer will be identified as the first parties involved with a facility in the lifecycle. They are the ones required to gather or create the initial project information. This information can either be collected from direct observation or, preferably, obtained from an existing information utility. Once cre-

ated and formed into a project, the information is then passed on to the contractor in the form of plans and specifications on which bids are prepared and the facility ultimately built.

Table 2 — Needs or viewpoints of the different parties involved

Actor	Need or viewpoint
Planner	Related facility, real estate, land use restrictions, general needs of owner
Designers	Program needs and development, sharing information between designers, production of plans and specifications, existing surrounding or attached facilities
Bid process	Making information available to prospective contractors, delivering addenda
Construction contractor	Providing plans and specs to sub-contractors, coordination of construction trades, submissions and catalogue cuts of proposed materials
Operator	Operating manuals for products included in facility, design intent, concept of operations
Maintainer	Repair manuals and warranty information. Set points and required preventative maintenance
Occupant	Space planning, occupancy, cable management, key management

During construction, additional information should be added relating to the actual materials used in construction of the facility, including equipment installed. This information should be, but is often not, passed on to the organization operating and maintaining the facility. Each of these parties has a different need for the information and to look at essentially the same information in different ways, searched by differing primary keys and information displayed in the response (see Figure 4).

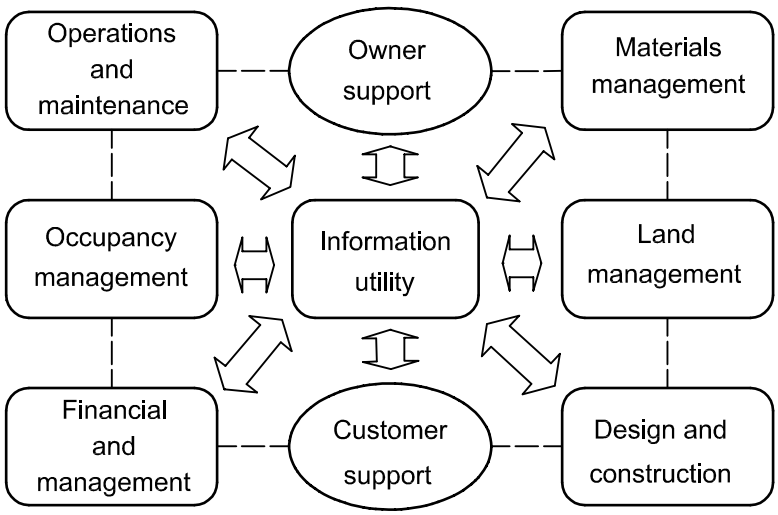

Figure 4 — Applications of information utility

Current practice is typically to pass information by paper media. There are the beginnings of a migration to automated forms, however the process is still in its infancy. Much of today's information is unintelligent, composed merely of images of the documents. Ultimately, electronic facility models will be created and enhanced with additional intelligence as they pass from phase to phase. The concept of a central information utility that all players can access throughout the process should be sought instead of the current linear, project-oriented approach. The information utility concept requires a different approach to EDMS. This approach is function-oriented so that various users/roles can have their own view of the data.

The facility owner is the actor who needs to demand this information-centred approach, as information about the facility is ultimately most valuable to the owner, who has need of the information for the longest period of time in the life cycle. The facility is a long term asset and certain financial needs such as insurance records and tax depreciation schedules can be supported with the same information as that being used to operate and maintain occupy it.

The most important aspect of this approach is that it will keep the data “alive”. One of the most significant and costly problems related to electronic information is that if it is not used it quickly becomes “stale”. Although some of the fa-

cility information is relatively static, much of it has an associated status which changes in real time. For example, the overall HVAC system remains static while the status of the filter changes, as the time when the filter was last changed must be recorded. In addition, the fan motor must be serviced or shown to be on or off in respect of the software.

Additionally, information gathered at any point in time will be stored using a specific version of a software program, using particular hardware and stored on a certain type of media. Although saving the software is possible, saving the hardware is often impractical (the 8-inch, or even the 5.25-inch floppy disk drives, for example). On the other hand, using the information on a daily basis for operations and maintenance will cause it to be naturally migrated to new versions of software and new backup and archive media.

Table 2 shows how the various parties involved in the life cycle need and use various related information. It also indicates the wide variety of information required for a facility and the benefit of keeping information about larger-scale information related to all impacts on the facility from the surrounding environment. The information utility is most valuable to owners of large holdings or facilities, such as plant owners, directors of universities and the managers of military bases.

The impact on the form the EDMS takes and the metadata kept for an information-centred approach is significant. The metadata must be structured so that it is usable yet supports the various viewpoints of all the parties involved. To this end information and metadata grow and shrink throughout the life of a project. For example, having placeholders for the name and phone number of a person occupying a space is not practical during the programming phase of a project. It may also be just as unrealistic to maintain detailed information about each design revision, once the facility is operational.

How can the EDMS support the user in expansion and contraction of information? It is recommended that a sectional, hierarchical approach be taken. The sections are divided by lifecycle phase and the hierarchy deals with the level of detail desired. Again viewpoint needs to be kept in mind. Who is looking at the data and how can the system provide only the information that is needed while not cluttering or making unnecessarily complex the search process?

The value of the information stored is measured by the ability of the user to access accurate information in a timely way. If it is not easily accessible the system will not be used and the cost of data collection and organization will be for naught.

8 Standards used in document management

8.1 General recommendations

Document management as an application domain has a vast number of facets, owing to the diverse processes and types of document collections it has to support (projects, trade, manufacturing, government administration, etc.). As document management is also used to link documents to each other and to document sets, the interfacing of document content becomes an issue.

There are a number of official standards as well as industry standards for document management. The domain is much too wide to give an exhaustive list here. All the standards mentioned are general to all industries. Still missing are standards that deal with the specific information to be used in document management for construction. The majority concern technical solutions for document management, or the basic information structures needed in order to design technical solutions. Another kind of standard is represented by the British Standards Institute (BSI) standards dealing with principles of good practice for information management, and with the legal admissibility of information stored in EDMS. These reflect the situation in the U.K., where electronic document management has been used for recording the process in the event of disputes and litigation.

8.2 Basic format for metadata

The International Electrotechnical Commission (IEC) has produced a number of standards for designation, systems which have paved the way for a structured view of information, (e.g. IEC 61346-1). A more detailed standard for classification of documents (one type of metadata) is IEC 61355. To be published is a standard on the structure of metadata for technical documents.

A similar kind of standard is being used for bibliographical information on the Internet; EDMS vendors in the USA have formed the document management alliance (DMA).

Within the construction industry, another approach is Europe's CONDOR project (see Table 3) for technology and processes for integrated construction project documentation, where application-programming interfaces (APIs) are defined for common operations on the document database. Among industry standards for metadata, the metadata coalition, consisting of a number of software vendors/developers, has issued a draft specification for the interchange of metadata. The property definitions for files in the Windows[3)] environment and the property sheets of the Microsoft Office[3)] application programs may also be mentioned as examples of commercially established mechanisms for recording and storing metadata.

Table 3 — Metadata identified in practice (CONDOR European project)

Related to:	Type of information
Actor	Actioned parties, address, addressee, customer, originator, originator's document number, owner, recipient attributes, recipients, signature
Distribution	Date, date received, delays, distribution, distribution list attributes, purpose of sent document, response date, response description, response time, transmittal note
Document	Category, date of document, description 1, description 2, description 3, document ID, document numbers, document revision attributes, document time stamp, documents which link to instruction, drawing attribute, file name, file number, letter attributes, revision, scales, status, subject, titles, type
Process	Acknowledgement note, actual drawing commenced, actual issue for approval, actual issue for construction, anticipated drawing commenced, anticipated issue for approval, anticipated issue for construction, area affected, completion date, confidentiality rating, contract number, drawing issue attributes, instruction attributes, instruction component attributes, instruction issue, issue date, items affected, items affected attributes, package, programme activity code, request description
Product	Location, origin, relevant dates, various cost and planning data to be agreed on

A considerable portion of existing standards for document management concern imaging applications. These standards are in general less interesting for implementation purposes, but very much concerned with the technology used in imaging systems.

8.3 Exchange data formats

The definition of standardized formats for data exchange is an area of great interest for document management in general, and for documents that have to be accessed over a long period of time, or by a large number of remote users, in particular. Some such dominating standards are de facto ones defined by various vendors or organisations. An influential party in authorizing the use of neutral file formats is the U.S. Department of Defence, which has formed a strategic alliance with industry in defining continuous acquisition and life-cycle support (CALS), including recommendations for formats for different purposes.

The impact of the Internet has also helped in the establishment of file formats, especially formats for bitmap images. The problem of securing exact reproduction of digitally transferred documents can be solved by using formats directly describing the output to printers or plotters.

8.4 Workflow

An attempt to create a vendor-independent interface between workflow systems, enabling them to interact in performing a workflow that can be composed of several parts added by the cooperating systems, has been made by the USA-based workflow management coalition (WfMC). The standard is targeted towards Internet communication by including an e-mail multipurpose internet mail extension (MIME) binding. Interoperability information is placed into an e-mail message to move data from one workflow engine to another.

3) Windows® and Microsoft Office® are exemples of suitable products available commercially. This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of these products.

8.5 Document structure

The internal structure of documents can be defined using the ISO standard, SGML, which states that the structure for a certain type of document is carried by a DTD. The most widely known DTD is the language used for web pages, HTML. SGML is being complemented by XML. Through use in the Internet sphere, these standards have gained general acceptance, and there are no seriously competing initiatives. SGML and XML are primarily oriented towards text documents, which can be logically subdivided into structural elements.

For graphically oriented documents or models, the structure is more complex, and the applications use diverse structuring mechanisms. An attempt to specify structuring according to a single mechanism used by most CAD systems is the CAD layering standard ISO 13567. This standard also recognizes the need for alternative structuring using file references, and the migration to future information systems using product-based databases instead of graphically based files.

8.6 Product models

As the document-oriented view on information is replaced by an object- or model-oriented view, standards for the sharing and exchange of product models are developed. The ISO/STEP standard for product models defines a framework of resource models that are used when creating the industry-specific application protocols for domains such as shipbuilding, steel structures or HVAC.

The corresponding industry initiative for the construction industry, IFC, concentrates on the definition of product and process objects for construction products. The IFC standard is in the prototype implementation phase, while STEP standards have already entered into commercial use in other areas of the industry.

8.7 Techniques for metadata format and syntax

The choice of format and syntax for metadata is a strategic issue that affects the implementation of an information standard in the short- as well as the long-term.

The simplest format for data is the ASCII text file, where the data are delimited in standard ways. A metadata file using such a format is easily readable and can be exchanged between document-management systems using standard export and import functions. A weakness of such files is the difficulty in describing multiple relations.

HTML and XML are text-based languages well suited to describing complex structures. HTML is a simple standard for linking text segments, while XML is more flexible. However, the need for common agreements grows with flexibility. DTDs have to be defined in common between users who wish to exchange data using XML.

When data are to be shared rather than exchanged, a database for the metadata offers an efficient solution. This can be considered as a more consistent way of managing the data than separate files, reducing the risk of redundancy, conflicting versions, etc. It requires that document-management systems develop interfaces with the database, and must be implemented by developers rather than end-users.

When encouraging rapid implementation, while at the same time preparing for the long-time use of data, the structural issues are of fundamental importance. In the short term, the exchange of metadata between users and systems requires a clear syntax and an easily-converted format that can be applied by end-users as well as software developers.

In the future, a probable development will be the incorporation of metadata and document definitions into product models. Therefore, some fundamental rules for database design should be applied from the beginning. A clear separation between concepts, syntax and format is desirable. The definition of metadata should follow accepted standards for describing data elements. Using a clear base, the standard will allow different solutions, agreed by a project group, companies or at a national level. Future migration to other technologies will be facilitated.

The practical issue of where to store document metadata must also be considered. Traditionally, metadata are stored within documents, in headers or title blocks. The presentation of documents requires such elements containing metadata. For integrity reasons, the location of primary storage of metadata must be clear. In most cases, metadata stored externally from the documents is preferable. This allows the metadata to be read and managed independently,

without the need for specific application software for access. The presentation of metadata within the documents can be achieved by importing the externally stored data.

9 Demand for standardization

9.1 Structure

The internal structure of a document is essential for integrating information in a collection of, for example, CAD drawings derived from views of a CAD model, or compound text documents containing technical specifications for a facility. An agreed internal structure will also become important for later retrieval of published or archived documents.

A external or file structure serves to a large extent the same purposes as an internal structure, and the borderline between subdivision of files or elements within files depends largely on the application. As links between files become more common, standards for structuring of documents will have to span both internal and external structures.

9.2 Management

Concepts, format and syntax are three levels of definition for metadata. Common concepts are required on a basic level before the format and syntax can be defined. Different kinds of metadata play different information roles in documentation. Two major areas are managing documents in projects and other processes, and publishing or storing, searching and retrieving documents in a database.

In the construction industry, project document management is demanded for project groups, typically limited in terms of time and budget, formed for each new project and organized with new members in remote locations. Such organization will benefit from high-level standards that can be applied with a minimum of project-specific planning and agreement.

9.3 Interfaces

Document databases are not only the archives of individual companies, which can be managed without formal standards, but also general information such as product information and specification templates that should be available to all organizations within the construction industry. Efficient use of the latter category is impossible without standardized data interfaces, since specific agreements cannot be made for each case of exchange.

Exchange mechanisms are concerned with how data are transferred and converted between systems and users. They can be subdivided into methods and technology, where the methods are process-dependent and the technology considered as a base common to all processes.

10 Organization of the standardization work

10.1 Allocation of the work

The scope of ISO/TC10/SC8 is limited to technical documentation for construction. International Standards general to all industry branches are produced by ISO/TC 10/SC 1 and form the basis for construction-specific extensions produced by SC 8. The International Standards produced by SC 8 will therefore contain only those aspects specific to construction.

10.2 Extension of activities

When dealing with electronic documents, the life cycle of the data is equal to that of the building. Information produced during the construction phase is reused when using the building and vice versa. Therefore, the scope of ISO/TC 10/SC 8 will have to be extended to cover the building lifecycle, in order to interface with information used for facility management, operations and maintenance. An extended scope for the committee's activities will allow more

integrated management of document life-cycle information. As no other ISO technical committee satisfies this demand, the extension is desirable.

10.3 Phases

In light of the foregoing, and the fact that general standards for metadata are being simultaneously developed by other standardization bodies, a process divided into phases seems appropriate.

— **Phase 1** aims to satisfy immediate needs in construction projects as well as to establish a foundation for the use of metadata throughout the document lifecycle. The result is expected to be an International Standard that specifies the semantics and classification for construction document metadata in a way that can be immediately applied for the sharing and exchange of metadata in the design and construction phases, and for transfer between electronic document management systems. For technical documents, there is a particular need to define metadata that cover the documentation of linked files and document sets.

— **Phase 2** aims at extending the scope to metadata used during the lifecycle, adding specifications suited to search, retrieval and reuse of information from a long-term and industry-wide perspective.

— A possible **phase 3** would address the total integration of metadata for documents and products in a model-oriented environment.

11 Related standards work/activities

11.1 General

There are a number of ongoing activities within the area. Some have already been mentioned in this Technical Report. Clause 11 is an overview of known activities where coordination is needed or where WG 13 will need to keep informed of progress.

11.2 Metadata

General issues on metadata are treated by ISO-IEC/JTC 1/SC 32/WG 2. This work group arranges open forums on the relevant issues. Record management standards are also developed within ISO/TC 171.

Technical documentation standards are developed by ISO/TC 10 and IEC/TC 3. Work on metadata is coordinated in the joint working group JWG 15. The International Standard for construction document metadata will be aimed at integrating with ISO 7200, ISO 11442 and work in progress at ISO and IEC.

11.3 Classification of information

The classification framework for construction is developed by ISO/TC 59/SC 13. A formal liaison with ISO/TC 10/SC 8 has been established. ISO/TR 14177 outlines the framework.

11.4 Electronic messages

Messages for electronic trade are developed by the UN/EDIFACT organization. Specific messages for construction are to a large extent developed by associated organizations, then integrated into standards. WG 13 has established contact with participants in this development work (e.g. ISO 9735).

11.5 Product models

Product model standards are developed formally within ISO/TC 184 as well as through the industry initiative, the International Alliance for Interoperability (IAI). IAI is aimed specifically at the construction industry, while ISO/TC 184 covers all industry sectors. Efforts are coordinated. WG 13 has direct contact through experts active in both organi-

zations. A liaison between ISO/TC 10 and ISO/TC 184 has also been established [e.g. ISO 10303, IFC (IAI Industry Foundation Classes)].

11.6 Other related activites

The XML specification and other de facto standards for the structuring of documents for the Internet are managed by the World Wide Web consortium, WC 3. The technical solutions using these specifications will be constantly referred to when developing metadata standards.

Industry-led activities such as the Meta Data Coalition, the Workflow Management Coalition and the Document Management Alliance will also be monitored and mutual coordination established.

12 Proposed time schedule

With the need for metadata standards becoming urgent, the standardization work ought to proceed as quickly as ISO rules permit. This Technical Report is aimed at initiating immediate standardization to the extent described as Phase 1 in 10.3.

In parallel with developing an International Standard, the group will seek to promote it by publishing other paper-based and web-based material aiming at implementation. The members of WG 13 will seek to initiate prototype implementation on the national level from the CD stage and onwards. Vendor contacts will be kept in order to assure that the International Standard is developed with due regard to the development of technical platforms.

As the work for Phase 1 has already commenced, the group intends to initiate a discussion in SC 8 on the work in Phase 2, in conjunction with a discussion about extending the scope of SC 8. The 1999 meeting of SC 8 was the starting-point for this discussion.

Phase 3 is dependent on the rate and speed of implementation of product modelling in the construction industry. At present, the level is low and applications are limited to narrow domains such as steel structures, but it will soon become apparent whether the rate of speed will pick up.

The work will be continually coordinated with that of ISO/TC 10-IEC/TC 3/SC 3B/JWG 15. Members of WG 13 will participate in JWG 15. All efforts will be made to find forms allowing these ISO and IEC groups to work in parallel, without delay.

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