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DEVELOPING DOCUMENT MANAGEMENT FOR A LARGE-SCALE ENGINEERING PROJECT

The case of ALICE-EDMS with TuoviWDM interface

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ABSTRACT

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In large-scale and one-of-a-kind industry document management of a product plays a vital role, because huge amounts of data has to be collected and stored. The ALICE Collaboration will build a dedicated heavy ion detector due to be operational in 2005. The focus of this research was on integration of document and product data management in this case organisation. The target organisation is based on collaborative action through 115 international research institutes. This was a major challenge of global scale for efficient communication and information storage. In the case study, the document management was studied and developed by a document management group to enable the implementation of an information technology (IT) tool.

The end user's point of view was used to define and accommodate IT tool and document management processes in the case project. This meant studying and testing the TuoviWDM/EDMS system and studying documents and their life cycles during the research and design phase of a detector. TuoviWDM is a WWW-based data management system, which was used as an interface to Engineering Data Management System (EDMS) at CERN.

This study pointed out the needs for the phases of a research work based on literature study, participation-observation in the development group meetings including documentation, and six demonstrations. Other development activities were related to the study of user needs, a proposal of the interface including metadata, testing the stability of the system, and an inventory of documents. The development work resulted in implementation of the case study database into the EDMS and releasing of the system to the whole collaboration.

Based on the research it can be stated that the development phases and activities can be speeded up in order to achieve the implementation phase faster. However, it seems that organisation itself needs more time to adopt the new way of electronic document handling and management. Because of the huge amount of data and documents it might be relevant to categorise documents to criticality and relevance. Documents needed in an engineering project can be divided into critical and other documents. Critical documents belong into the EDMS system where they follow strict processes so that their validity can be ensured. Other documents can be managed through local workspaces with less discipline. This will remarkably reduce the number of documents, which need to be managed.

KEYWORDS: document, document management, product data management, project, TuoviWDM, EDMS

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Projektitoimintaa ja komleksisia tuotteita koskevassa teollisuudessa on tuotteen dokumenttien hallinnalla merkittävä rooli, koska tietoja pitää kerätä ja tallettaa huomattavan suuria määriä. ALICE yhteistyöprojektin tarkoituksena on rakentaa ydinfysiikan detektori, joka aloittaa toimintansa vuonna 2005. Tässä tutkimuksessa tarkasteltiin dokumenttien ja tuotteen tietojen hallinnan yhdistämistä osana tuotetiedonhallinnan kehittämistä tässä kohdeorganisaatiossa. Kohdeorganisaation toiminta perustuu tieteellisten tutkimuslaitosten yhteistyöprojektiin, jolloin ongelmina ovat maailmanlaajuinen ajantasaisen informaation jakaminen ja tietojen talteen saaminen. Tapaustutkimuksessa dokumenttien hallintaa tarkasteli ja tutki dokumenttien hallinnan työryhmä, johon tutkija osallistui.

Peruskäyttäjän näkökulmaa käytettiin määriteltäessä haluttua sovelluksen ulkoasua ja dokumenttien hallinnan työnkulkuja. Käytännössä tämä tarkoitti TuoviWDM-EDMS käyttöliittymän kokeilua ja testausta sekä dokumenttien ja niiden elinkaarien tutkimista hiukkasilmaisimen suunnitteluvaiheen aikana. TuoviWDM on WWW-pohjainen tuotetietojen ja dokumenttien hallintajärjestelmä, joka on käyttöliittymänä Engineering Data Management System (EDMS) -järjestelmään CERNissä.

Tutkimustyön vaiheisiin syvennyttiin kirjallisuuteen perehetymällä, havaintoja tekemällä, osallistumalla kehitysryhmän kokouksiin ja tuottamalla niiden dokumentaatio sekä järjestämällä työryhmän kuudelle jäsenelle käyttötutkimukset. Muita kehitystoimia olivat käyttäjien tarpeiden tutkiminen, käyttöliittymäehdotusten tekeminen, joihin sisältyi metadatan tarkastelu, järjestelmän vakauden testaaminen ja dokumenttien inventoiminen. Kehitystoimet johtivat kohdeorganisaation tietokannan integroimiseen CERNin EDMS:ään ja järjestelmän julkistamiseen koko projektiyhteisölle.

Tutkimuksen tulosten perusteella voitiin todeta, että kehitystyön eri vaiheita ja toimia on mahdollisuus nopeuttaa ja tehostaa, jos halutaan saavuttaa järjestelmän käyttöönottovaihe nopeammin. Näyttää kuitenkin siltä, että aikaa tarvitaan organisaation sopeutumiseen uuteen elektronisten dokumenttien käsittelyyn ja hallintaan. Tarvittavien tietojen suuren määrän vuoksi pitäisi dokumentit luokitella kriittisyyden ja merkityksellisyyden mukaan. Kriittiset dokumentit kuuluisivat EDMS –järjestelmään, jossa ne noudattaisivat tiukkoja työnkulkuja validiteetin noudattamiseksi. Muut dokumentit käsiteltäisiin ja hallittaisiin paikallisissa järjestelmissä, jolloin kurinalaisesti käsiteltävien ja hallittavien dokumenttien määrää vähenisi huomattavasti.

AVAINSANAT: dokumentti, dokumenttien hallinta, tuotetiedon hallinta, kehitysprojekti, TuoviWDM, EDMS

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LIST OF ABBREVIATIONS AND ACRONYMS

ALICE	A Large Ion Collider Experiment
ASCII	American Standard Code for Information Interchange
ATLAS	A Compact Solenoid Detector
BOM	A bill of material
CAD	Computer Aided Design
CADIM	Computer Aided Data Integration Manager
CADIM/EDB	Computer Aided Data Integration Manager/Engineering DataBase
CDD	CERN Drawings Directory
CEDAR	CERN Engineering Data Management System for LHC Detectors and Accelerator
CERN	Conseil Europeen pour la Recherche Nucleaire
CM	Configuration management
CMS	Compact Muon Solenoid
DAQ	Data acquisition
DM	Document management
DRO	Divisional Record Officer
EDMS	Engineering Data Management System
HTML	HyperText Markup Language
IGES	Initial Graphics Exchange Specification
IT	Information technology
MCHF	A Million Swiss francs
LHC	Large Hadron Collider
LHCb	The Large Hadron Collider Beauty experiment
MOSAIC	A Web browser developed by Marc Andreessen, Eric Bina and their colleagues at NCSA, National Center for supercomputing Applications at the University of Illinois
PDM	Product Data Management
QGP	Quark-Gluon Plasma
TDR	Technical Design Report
TuoviWDM	Tuovi Web Data/Document Management system
WWW, Web	World Wide Web

1. INTRODUCTION

This research concentrates on the management of engineering and project-related documents. The aim is to create an electronic alternative to manual systems to manage documents with a document management system. The case is a large-scale and distributed research and development project to design one-of-a-kind product. Here the term *one-of-a-kind* refers to a unique and exceptional complex product like a detector of physics or a spacecraft. Problems on the domain are loss of information and communication: documentation is neglected, information is not shared, documents are not easy to find or do not exist, and systems to create and manage documents are not easy to use. The research problems will be studied from views of document management and an end user.

Industry estimates that from 10% to 20% of all recorded corporate knowledge is stored in data while the rest, 80% of corporate knowledge assets is saved in documents [Bielawski & Boyle 1997, pp. 16, 36]. This means that a fifth of the information is controlled and managed in databases while the rest is left nearly on its own on desktop and other applications. Therefore, also this information in documents has to be managed electronically.

A balance has to be discovered between distribution and centralisation. On the other hand, ensuring centralised storage to avoid loss of information [Berners-Lee 1989]. A typical professional spends from 20% to 40% of a workday looking for information [Bielawsky & Boyle 1997, p. 14]. According to Stark [1992, p. 41] an average engineer spends from 30% to 50% percent of his or her time searching for information. These reasons offer a good starting point to study and develop document management activities.

In a large-scale project, the fundamental difficulties of not achieving the project goals may originate from several reasons [Hameri 1997, p. 151]. Many of the difficulties are more related to people than to technology. For example, ignorance of what other project teams are doing or, diverse views on what are the objectives of the project. Problems may also arise from rigid project planning and scheduling routines, poor reactivity to sudden changes in the project environment or, lack of discipline in design change control and unforeseen technological hinders. Large-scale projects have to be separated into sub-projects to overcome these difficulties of communication.

The case study environment is CERN, Conseil Europeen pour la Recherche Nucleaire, the European Laboratory for Particle Physics [CERN, 1999]. One of the experiments is the Large Hadron Collider, LHC, which will be built into the accelerator tunnel of 27 km of circumference about 100 meters under ground. In the study, an engineering data management system, an EDMS, has been investigated and further developed for the distributed information and document management needs of LHC at CERN. Tuovi Web Data/Document Management system, TuoviWDM, has been chosen as the universal interface to the EDMS system for the LHC projects [Helsinki Institute of Physics, 1999]. The TuoviWDM system has been created and developed as a joint venture project by the Helsinki Institute of Physics. The combination of the TuoviWDM system and the EDMS system is visualised in the expression 'TuoviWDM/EDMS' in which the slash implicates the interface between an end user and the computing system.

Scope

This study investigates electronic document management from three perspectives: people in an organisation, information technology tools, and documents. The study concentrates on a research and design phase of a large-scale and distributed project. The three perspectives of the framework of this master's thesis are the end user with his or her work, the information technology (IT) tool with its functions, and documents with their life cycles (Figure 1).

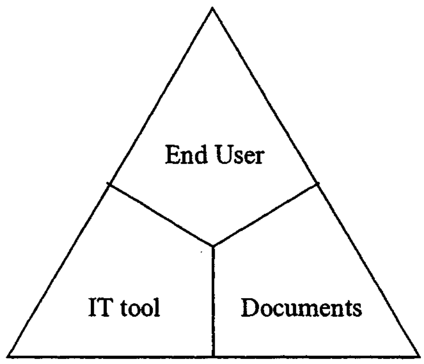


Figure 1. The three perspectives to document management.

Needs and expectations of an end user are central because nearly all workers need IT in their work. These are regarded as the basis for the development activities in this research. The point of view of a user is often ignored and users are not involved in development projects. This work excludes consideration of organisational structures. Out of scope are also technical items of computing with the exception of the functionality of the engineering data management system.

Within the scope are the functions of the system because they enable users' fluent and effective work in practise and speeding up the adaptation process to take the system into use. A great deal of the work in a large-scale project is done with computers. Electronic document management system is vital for modern information management of a project. When work carried out in distinct environment fluent functions are most important in a distributed environment of the work. Documents are seen as assets of information. They are units of information and have life cycles and work flows of their own. To manage them effectively metadata is associated with documents [Koulopoulos & Frappaolo 1995]. The scope of the work does not include the content of documents, for example, document structures.

Research method and research questions

This study is a descriptive and exploratory case study. According to Yin [1994, pp. 1, 15], the case study method is preferred when "why" or "how" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context. The purpose of the descriptive strategy is to describe an intervention and the real-life context in which it has occurred. The exploratory strategy is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes [Yin 1994, p. 29]. The case study method is augmented in the work by some features of the action research method [Koch et al. 1997]. In the case, the researcher has been actively involved in the development activities of the case project and the study is intended to benefit both research and the case organisation.

The research questions of the study are the following:

1. **How document management and product data management can be integrated and implemented into an information technology tool in a large-scale engineering project?**
2. **What are the typical problems in building the solution?**
3. **How the needs and expectations of end users can be studied?**
4. **What metadata is needed for this kind of project documents?**

The general goal was to understand and describe document management related to product data in the ALICE, A Large Ion Collider Experiment, Project and the EDMS as the means to manage it. The practical aim was to find good solutions for the document management at ALICE. Another aim was to collect new knowledge for the research society.

Multiple qualitative and quantitative research data collection methods are used according the case study method [Yin 1994, p. 80; Eisenhardt 1989]: group meetings and discussions, literal sources, and participant-observation. When gathering the evidence, confidential, public, personal, and institutional sources of documents and information play a role [Holme & Solvang 1991, p. 140]. Data includes six demonstrations [Virzi 1992, p. 457]. The cathered data was transformed into the proposal of the interface. Descriptions of states of document life cycles were made to enable the transformation of them into the engineering data management system.

Structure of the report

The introduction presented the background for this research and the main problems as well as main research methods of the research. Chapter 2 presents the main concepts and related research on the area. Chapter 3 discusses the methods used. Chapter 4 describes the case environment and organisation as well as the IT tools used for the engineering data management. Chapter 5 expresses the development activities in the chronological order. Chapter 6 draws implications from the study both for the case organisation and for research. The executed research is summarised and some suggestions for future research are given in the last chapter.

2. MAIN CONCEPTS AND RELATED RESEARCH

This chapter introduces the findings of the literature survey, and the main concepts of the study. The aim is to support understanding of the basics of one-of-a-kind projects and success factors of them because in this kind of a project possibility for rehearsal is limited. Distributed projects need global communication facilities to overcome the problems of huge distances and sharing of information.

2.1 Main concepts

The most central concepts are project, World Wide Web, document management, and product data management system. Document management improvement and alignment of principles and techniques are seen as a part of information management. These concepts are introduced in this section. Other related concepts will be introduced later.

A project is an organisation of people dedicated to a specific purpose or objective for restricted time [Pinto & Slevin 1988, pp. 480-481]. This purpose usually is a series of complex or interrelated activities. A project can involve large, expensive, unique or high-risk undertakings with limited time and money, and expected level of performance in a turbulent, unpredictable, or dynamic environment.

World Wide Web (WWW) is a global information retrieval system based on computer networking and hypertext on client-server architecture on the Internet [Berners-Lee 1989, 1999]. Hypertext is text with links to further information items and a way to organise documents. Information can be addressed by navigating from one web page to another.

Documents are recorded communication with recognisable structure, on any medium, intelligible without further processing except for presentation on screen or on the printed page. Not all documents are records in the archival or legal sense. *Records* are recorded evidence of organisation's or individual functions, activities and transactions. To be evidence a record must have content, context and structure [IESC 1995]. This research will use the term document including records, technical drawings, and electronic documents.

Document management, DM is defined as a process of overseeing an enterprise's business transactions, decision-making records, and transitory information of importance, which are represented in the format of documents [Sutton 1996, pp. 7-11]. Document management of an organisation is a cross-functional activity, which covers and is compound somehow to all the other activities of an organisation [Dollar 1992]. The main elements of document management are people, technology, and documents. The traditional view of document management, archival and records management, includes functions of planning, organising, co-ordinating, directing, controlling, and supervising all types of record within a corporation or organisation from their creation to final disposition [Couture & Rousseau 1987, p. 301].

Product Data Management, PDM system is an information technology software tool that helps engineers and designers to manage both data and product development process. The product data management system keeps track of the vast amounts of data and information required to design, manufacture or build, and then to support and maintain products [CIMdata 1998].

2.2 Features of a large-scale project

Projects usually act within an organisation. According to Laudon and Laudon [1998, p. 78-89] there are common and unique features of organisations. The common features are the formal structure or a hierarchy, standard operating procedures according to explicit rules and procedures, policies, and culture of the organisation. For workers there are technical qualifications for positions and effort for maximum organisational efficiency.

Policies and cultures may vary largely but common is that those do exist, implicitly or explicitly.

The unique features of organisations [Laudon & Laudon 1998, pp. 80-83] are many. The organisational types differ from small entrepreneurial firms to professional bureaucracies as well the environments, and goals. Other unique features may be constituencies, functions, leadership, and tasks as well as technology, processes, and levels within an organisation. These features are not to define a unique organisation but to show the many possibilities to create an organisation out of these common and unique features. It can be summed up that every organisation is unique in its complexity, which is built up as a mixture of these features.

The main features of a large-scale project are the following: the problem-solving nature, a prefixed budget, a temporarily mantled project organisation, a minimum of a decade's duration, a technologically non-trivial nature, and a global industrial and public collaboration [Hameri 1997, pp. 151-152]. Other features are communication media and protocols to manage geographically distributed design, engineering and production activities, controlling and measuring the communication flow. The larger the project, the more important the role of communication is because it is the necessary prerequisite for the operation of all human organisations.

2.2.1 Collaborative work

Large-scale projects require intense collaboration from participants in group-oriented activities organised and executed in-groups. This makes them subject to all prominent problems related to group dynamics, interactions, co-ordination, and communication [Ewusi-Mensah 1997, pp. 74-75]. Two examples of this kind of problems are different backgrounds and speech. Diverse backgrounds of the team members and several languages in use make the ability to communicate an extremely vital issue [Laudon & Laudon 1998, pp. 515-516]. Implicit speech and undefined and confusing use of terms

[King 1988, p. 130] create many misunderstandings and loss of information. These kinds of problems have to be taken into account to avoid them as far as possible.

2.2.2 Management of a one-of-a-kind project

Trends of communication and product data management will in the future become even more demanding project management issues. There are several reasons for this [Hameri 1997, p. 156-157]. The technological complexity of projects is continuously increasing and the duration of projects tends to get longer all the time. The number of geographically distributed collaborators is increasing due to the diversity of special skills needed in large-scale and one-of-a-kind projects. Needed investments are expanding while the sources of capital have become more demanding of efficient use of resources. At the same time the economic environment of projects requires expeditious and flexible performance. This all insists that granted resources have to be directed only for profitable activities.

Generally a project is considered to be successful when it fulfils the criteria of time, money, and quality [Pinto & Slevin 1988, pp. 481-482; Morris 1988, pp. 49-50]. The first and foremost criterion is that the client, who pays, accepts the results of the project and takes them into use. It is reasonable that any assessment of project implementation success should include these four measures: time, money, effectiveness, and satisfaction.

According to Pinto and Slevin [1998, p. 482-483] a project has four phases in its life cycle. They are conceptualisation, planning, execution, and termination. The conceptualisation phase is the initial project stage, where the project is determined to be necessary. The planning phase involves the establishment of a more formalised set of plans to accomplish the initially developed goals. Planning activities are, for example, scheduling, budgeting, and the allocation of other specific tasks and resources. The execution phase is to procure materials and resources as well as to verify the performance capabilities. In the termination phase the project is completed. Then it is time to release the resources, transfer the project results to the clients, and reassign the personnel of the project team.

2.3 WWW as an communication network

Communication network is one means to overcome communication and other problems in a project. World Wide Web is beginning to have a wide impact on the relationships inside and outside organisations. The technical foundations of WWW are not in the focus of this research but the human aspects in the use of WWW are.

The term *distributed* in this context means a work or an activity to be done in a decentralised manner. This is possible with a distributed computer network, which enables simultaneous global participation in one project. Some of the processing is done by the individual workstations of the network and information is shared by and often stored at the workstations. The analogy between physically distributed, yet logically centralised, computer databases depicts well the mode of working in a project [Hameri, 1997, p. 157]. Networking seems to be the mode of distributed work.

Tim Berners-Lee developed WWW in the year 1989. It was to be a tool for the collaboration in the high-energy physics community at and in the participating institutes. The aim was to develop a tool for easy way to access information in global projects. A computer, a connection to the Internet, and a browser are needed to use WWW. They together make a powerful and easy to use global information system that connects remote partners easily and quickly. Hypertext is text with links to further information on the reference model and hypertext is a way to organise documents in an unstructured way. The navigation is made with a mouse and by wandering form one web page to another. [Berners-Lee 1989, 1999]

The idea of WWW was represented in "A Proposal for Information Management at CERN". The abstract of the proposal gives the picture of the same kind of problems like today as follows:

> This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about a complex evolving systems and derives a solution based on a distributed hypertext system. [Berners-Lee 1989]

WWW is based on five essential features, which are a reference, the address system, a network protocol, a mark-up language, and availability of the data [Berners-Lee et al. 1994]. In a boundless information world every item has a reference by which it can be retrieved. The address system, universal resource locators enable this reference model despite many different protocols based on transmission control protocol/Internet protocol. The WWW servers offer performance and features, which may not be available otherwise. A hypertext mark-up language is used for the transmission among client/server architecture and it is required that every client server understands it.

A browser application offers a universal access to information on the Internet and whatever type of the server, the user interface is the same [Berners-Lee et. al. 1994]. End users do not need to understand the many protocols in use. The model of HTML, HyperText Markup Language with text input has proved to be powerful to express the entire user interfaces, while being sufficiently simple to require little training for a new user of WWW. In distributed projects WWW offers a tool to communicate and distribute documents in stead of traditional means. The balance between human and computing communication has to be found because the network communication does not replace the need for real-life face-to-face communication.

According to Laudon and Laudon [1998, pp. 102-104] the WWW alters organisational structures and activities with some determinants. The altering happens through the accessibility, storage, and distribution of information and knowledge for organisations.

The Web enlarges the potential to access information for all participants. Nearly any information can be available anywhere at any time. The WWW enlarges the scope, depth, and range of information storage into a global container in which contributors can constitute any information. The WWW lowers the cost and raises the quality of information distribution and makes it ultimate fast. Wanted and not wanted results might be the simpler business processes, fewer employees, and much flatter organisations along the usage of WWW possibilities.

2.4 Document management as a backbone of an organisation

Cross-functionality of document management [Dollar 1992] is similar to engineering data management [Stark 1992, p. 6; Taylor 1986, p. 12;]: both of them concerns people, information technology, and documents. The fourth important element consists of the core business of the organisation. This element insists to have a special kind of documents, for example, in a hospital those documents are journals of patients, and in industry those are documents of technical engineering devices. Based on these elements document management has no intrinsic value of its own but only compound to the existence of the functional organisation and its support and core activities.

Every function of an organisation has to be a value adding activity. This includes that a system that really adds value delivers the correct information to the right person, at the proper place and time [Bielawski & Boyle 1997, p. 3; Taylor 1986, pp. 16-17]. This traditional value-adding view of archive and records management clarifies and defines the roles, responsibilities, tasks, activities, and overall procedures associated with documents and their life cycles. The aim is that by using common and accepted rules, document management can become accepted, predicable, and trustworthy in an organisation.

According to Sutton [1996, pp. 10, 56], there are three the fundamental objectives of document management. The first is to affix the economical, efficient, and effective use of documents by individuals and by organisations. The second is to maximise the benefits from use of information in the documents, and the third is to minimise the costs of acquiring, processing, using, and disposing of documents. Documents represent the relationships between a worker and tasks, and play a central role in the efficiency of the work.

2.4.1 Documents as carriers of information

In general speech, the terms electronic and digital are used as equivalents. Electronic is related to electrons and in general is based on the use of electricity in intelligence-bearing devices such as televisions, computers and telecommunications. An electronic document can be coded information; for example ASCII or CAD vectors [Koulopoulos & Frappaolo 1995, p. 31]. Digital means the use of bits. This study concentrates on digital documents, which are called also electronic documents or just documents.

Electronic documents are characterised by six features [Koulopoulos & Frappaolo 1995, p. 28; Sprague 1995, pp. 31-32; Bielawski & Boyle 1997, p. 37; Salminen 1999] summed up as follows:

1. Collection of information referring to one topic.
2. Intended and structured for human understanding.
3. Authored for the purpose of sharing.
4. Identified, handled, and stored as a unit or a container.
5. Content may include several formats of data, for example text, images, or animation.
6. Use different media for carrying the information.

The meaning of a document has expanded during the digital era. According to Dollar [1992, p. 57] there exists documents which have no paper analogue, such as products of multimedia systems and geographic information systems. They have no physical entities but rather are virtual documents. They cannot be produced into a paper format but instead on a screen of a computer. Paper format or equivalent does not define the document any more. A document including files in different formats of the same original, emphasis a document as a container [Bielawski & Boyle 1997, p. 37] or as a traditional folder.

Hameri et al. [1999, pp. 1328-1329] have in a case analysis showed the preferred formats of document communication. Inside of an organisation, 26% of document transfer took place in paper format and 73% through network. On the contrary, the transfer mode between suppliers and third parties outside of an organisation was on paper format in 75% and network in 18% of the document transfers. Paper format is most commonly used media in document communication between an organisation and the third parties. Inside an organisation, the electronic medium is networking. These results may be applicable also in the case environment of this study because the case environment of the study of Hameri et al [1999] was complex a paper mill.

2.4.2 Principles of document management

People, as end users are the starting point of document management because they create the knowledge, they record their knowledge into documents, and the work follows predefined processes. Documents are seen as carriers of the information and IT as tools for work. The three elements accompanied with the core business have complicated relationships, which have to be taken into account when planning document management activities. These activities must be guided by the main principles of document management.

The objectives of document management can be achieved by the guidance of principles. Dollar [1992, pp. 48-67] has suggested five principles for document management:

- saving,
- usability,

- appraisal,
- preservation, and
- provenance of the documents.

Documents are to be saved, and knowledge to be shared. Usability is to ensure readability of documents. For example, on beforehand to take account the problems of technology obsolescence and the special handling which machine-readable documents on computer tape require on the long run. Appraisal means the inspection of the value of a document according to the evidential and informational value. Critical documents must be under better control than documents with less value. Preservation aims to keep data and documents alive or in existence. It is a basic function of storing and protecting of records and archives against damage or deterioration and the repair of damaged or deteriorated documents. Provenance means that the context of the document must be known and the information about the context existing for retrieval as metadata.

The transfer from paper to digital media has not changed these basic principles of document management. This is not so obvious when the paradigm of computing and record management are taken into account. For example, there was much talk about a paperless office but that presumption has not come to reality, on the contrary. The amount of paper consumption in computing and in offices has kept on increasing steadily [Koulopoulos & Frappaolo 1995].

Earlier with paper documents the archivist or record manager did his or her part of the job in the end of the document's life cycle and it was a proper phase at that time. Currently organisation and storage of documents has to be planned before information management systems are taken into use [Dollar 1992]. Document management should be proactive and predictable instead of reactive activities. This is needed to avoid extremely expensive and sometimes troublesome configurations of the systems afterwards.

2.4.3 Critical versus other documents

Distinction between mission critical and support documents is important because all documents are not of equal in value and do not need the same management Bielawski and Boyle [1997, p. 38]. Three types of documents can be defined according to the importance and relevance to the organisation [IESC, 1995]. The classification of document relevance is:

1. Critical documents
2. Working documents
3. Personal documents

Critical documents are the most important documents, which are used by the organisation in the course of its business. The documents are judged to have on-going value and they include all documents kept for legal and audit requirements. Critical documents include documents, which originate from outside, when they have reached a stage of development and quality, which certificate them to become part of the organisational archives. Accessibility to these documents depends on security requirements according to the organisation's policy. Critical documents must be identified and controlled by defined procedures, and registered, recorded and stored for corporate access. Critical documents are kept in a data store of the organisation. This may be physically distributed, but has common document registration and access control.

Working documents are either copies of existing critical documents, which are in the process of further development, or documents which relate to policy, program or management issues. Registration of working documents as critical documents may happen after they reached an appropriate level of development and quality. An end user or their work group normally manages working documents. *Personal documents* are the concern and responsibility of an individual only. Those include documents as personal notes, which may be used in the development of working documents but which are not intended to be critical documents as themselves. Personal documents may include private documents. Examples of private documents are job applications and curriculum vitas.

In the model above, it is assumed that some working documents will become critical documents at some stage. Prior to that, a working document may initially be in the possession of a single end user as a rough draft but later may become the property of that person's work group when circulated for comment and review [IESC 1995]. However, until it is not registered as a critical document, it retains its status of relevance as a working document. The level of control that organisation should exercise over working documents is a matter for discussion.

Critical documents of a one-of-a-kind delivery process were analysed by Hameri et al. [1999, pp. 1326-1328]. In the studied case, four document classes were identified as the most used and most critical. The technical specification was needed for the production of 62 other design documents. The second most used document class was the minutes of the meetings with the customer, including decisions affecting the technical spesification. The third class consisted of layout drawings. A layout drawing for key system components consists of one or two large CAD, Computer Aided Design drawings containing the key parameters of the components. The fourth class consists of the factory layout drawing stating the key physical dimensions of the facility. These four document classes account for 47% of all input requirements between the different document classes. The striking reveal according to Hameri et al. [1999, p. 1328] was the small absolute number of the different key input documents. The cumulative percentage of citations by the produced document classes show that 80% of all citations were covered with just 22% of the cited document classes.

The distinction between critical and support documents is essential and aids to reduce the size of the task to manage documents. The basic is the definition of a critical document excluding the less valuable support documents, which never reach the classification of most important documents for the organisation.

2.4.4 The life cycle of a document

The idea of a universal life cycle concept emphasises an object, which has an exact beginning and exact ending with process phases in between. This means a process in order to achieve the desired objective and this process is possible only by living it through [Morris 1988, p. 19]. A life cycle concept includes the actual and most important activities during different phases of a life cycle in specific document type. This enables also to review the progress of sub-tasks and of the whole process of development. Anyhow, a life cycle may not be seen only as segmented but rather as a continuum and sometimes overlapping phases.

Among others Dollar [1992, p. 58] and Couture and Rousseau [1987, p. 37] have introduced the life cycle of a document to consist of four phases: creation, appraisal, control and use, and retention. The first phase is *creation* as the starting point. 100% of documents have lived this phase. The *appraisal* means the act of estimating or judging the nature, value, or importance of the document. The *control and use* is the active phase of a document when its primary value is in maximum. Some documents are with less value and so they are eliminated in this phase. For example short term emails, which carry no long-term importance. In the *retention* phase the documents are inactive and carry little or no value. Some documents are eliminated and only 5 to 10% of all documents are left. These documents with maximum secondary value belong to historical archives and need special attention to be stored and used for research purposes effectively.

Considering of the life cycle of documents in the design of an information system points out the functional requirements for documents in the system. The life cycle model recognises the benefits of constant refinement of existing systems [Koulopoulos & Frappaolo 1995, p. 33, 57] and takes into account the time as a one dimension of a document. The life cycle of a document is even longer than the life cycle of the organisation because if the organisation dies the remaining documents still keep on living, some documents for some time but some documents "for ever" in special repositories.

Archival documents

Data as information must be useful but the usefulness and importance of archival documents is not always known in advance. Only the time and context of data creates its usefulness for research. For example, scientific documents are to be saved but it is not known on beforehand when and by whom the documents are needed. Some may remain totally useless, some may be valuable for centuries. For example, the CERN Archives have custody of the 'Pauli Archive', a private collection of scientific books, reprints, correspondence and manuscripts of the late Professor Wolfgang Pauli (1900 -1958). The Pauli Archive Collection also includes his Nobel Prize 1945 and other scientific awards and medals. Many books have been published under the auspices of the Pauli Committee, the latest ones on 1998.

Considering the use phase of a document, the cope of use and media preferred in different work roles Taylor [1986, pp. 38-40] has studied different classes of professionals and their use of information. The three roles of professionals were scientist, engineer, and manager. Scientists prefer paper as media because they need source data and produce documents of their research over long time periods. Engineers work within time constraints with need for reliable answers to find out satisfactory or good enough solutions. They do prefer informal sources of information and this means that they do not want or need paper documents. This may explain the unwillingness for proper documentation of their work. Computers offer them fast and easy access to good enough answers and electronic documents to be used. Managers tend to use assistants and secretaries as filters to information. They prefer evaluated and already aggregated data for their decisions, and try to avoid the overload of irrelevant information and documents. Managers rely on verbal media and human judgement, and these are hard to be put into documents. This example illustrates the need to distinguish between different types of professionals having differing needs for documents and document management.

2.4.5 Roles of people in document management

Bielawski and Boyle [1997 p. 305-306] separate two groups of people dealing with document management systems: end users and document management experts. An end user uses the system without being a document management expert. These two roles should be separated to let them do the work under their expertise. Suitable and economical document management should be the common goal for the representatives of specialists on different domains.

Before computers, document management in organisations was the responsibility of record managers or archivists. According to Dollar [1986] document management experts and computing experts should find and create a common understanding and a common language to the views of the other partner in the new electronic document management environment. The effort should be in the interest of both partners because record mangers must understand and accept the larger role, which they can play in the information management arena in their organisations. As well the computing experts may lack the ability to fully understand and accept the supportive role of their work. On the other hand too complex systems have created such users' resistance that some solution must be found to produce more user-friendly systems. This common effort can be seen in (Figure 2).

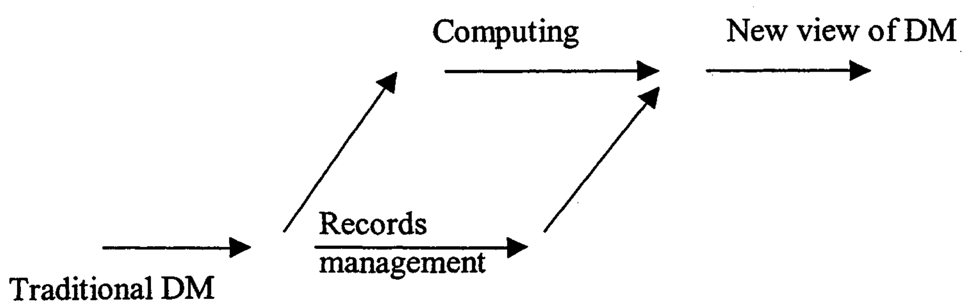


Figure 2. Development of new document management.

Sometimes information management functions include electronic document management but forget the traditional document management and try to reinvent "the wheel". This happens, when the already existing source of knowledge, the archivists and record managers, is forgotten in building new solutions [Dollar 1992].

Lack of compound views has caused limitations to current systems. For example, software tools currently do not automatically capture all of the contextual information of electronic records. This is an area where document managers should work with information system designers and software developers to ensure that this functionality is included in future systems [Dollar 1986, p. 75].

2.4.6 Electronic document management systems

According to Koulopoulos and Frappaolo [1995, pp. 248] implementation of an effective electronic document management system is as much a policy of adopting a new perspective of the organisation as it is to understand the technology. The basic objective of any new information system is the automation of tasks and processes to increase the productivity of the organisation.

The Electronic document management system offers potential benefits [Bielawski & Boyle 1997; Desktop management 1997] for users and document processes. Benefits for users are for example faster document creation and update processes, naming and identifying documents quickly and easily, and improved and customised access to documents.

Benefits for documents and processes:

- Lower cost of document creation and distribution.
- Reduced cycle times in document centred processes.
- More complete regulatory compliance.
- Enhanced document control and security.

- Refined managerial control and reporting.
- Providing a framework in which individuals can understand their responsibilities for using and maintaining information systems.
- Consistent practices and procedures lower the adaptation level of new staff.

If a fully implemented and fully utilised electronic document management system seems to be powerful tool, why is it not used in every organisation or company? There are five reasons from the technical point of view [Widegren, 1998]. The system is very expensive to buy and that is not enough because when buying you usually get an empty shell or a toolkit. To configure the system for every special organisation requires an enormous mount of time and effort. One reason is that user interfaces are not very user friendly. The maturity of some products is poor and none of the vendors has a market share greater than 8%. The market of vendors is insecure and it is difficult to say which company will survive in the long run. All systems do not suit all types of activities because of the nature of the functional operations.

Organisational and human factors include for example to gain an appreciation of the entire organisation [Koulopoulos & Frappaolo 1995, p. 249]. From an organisational point of view the major problems in implementing an electronic document management system are to convince the users, to get people willing to learn the new system, and to track present working procedures. It can be very difficult and time consuming to investigate and reveal errors in these working procedures. The benefits of using the system are seldom seen immediately and this includes the cases where people are not willing to use the system.

2.5 Metadata

The term metadata refers to data about data, in case of documents to data about documents. When a critical document is registered in a document repository, the necessary metadata has to be captured to ensure the accessibility of the document and other essential information related to the document. Metadata of a document has to reflect the content and context of the document. The metadata describes data itself and data systems that may include the structure of databases, their characteristics, location, and usage [Dollar 1992, pp. 59, 87]. When a document is transferred in computing systems it may lose the signs of the author, department or some other relevant data if not put into the document itself or into the metadata.

Metadata has traditionally been important in archives and libraries. The role of an archivist or record manager was vital in organisations with relevant archiving and records management systems. The recording of the metadata and using it for allocating documents were on the responsibility of the record manager. A person needing to find an important but ancient document went to the archivist and explained and described what he or she wanted. Detailed questions about the context and content of the wanted document were needed. When the archivist got a clear and complete understanding of the document, it was easy to find it using the expertise of the archivist. Creating the understanding of the wanted document through a discussion may happen implicitly just using tacit knowledge.

Currently, when a person creates an electronic document he or she as an author has to store all this information into the metadata of the document or to the document itself. This in order to enable efficient retrieval of the document later when needed. If the metadata is not regarded important and it is ignored, it may be impossible to find the document later.

Bearman [1994] defines six layers of metadata in a reference model for business acceptable communication and to support the effective management of any record or document over long periods of time. This model defines the functional requirements for evidence in record keeping. The whole model is not needed in detail for this research but the model offers one possibility to develop a metadata model for a document repository.

The layers are presented in Table 1 with examples showing the potential metadata fields needed for each layer.

Table 1. The layers of metadata with examples.

Layers of metadata	Examples of the metadata of a document
1. **Registration layer**	Unique identifier of the record and of the domain, standards, privacy, terms, and language.
2. **Terms & Conditions layer**	Restrictions of access, use or disposition, conditions of use, identify different views to different users, data of a license, retention and disposition conditions.
3. **Structural layer**	Identification of each file that make up the record, file modality, data encoding standard, application, software, and hardware dependencies, representation standard, content structure metadata.
4. **Contextual layer**	Transaction context, identification of originator, and recipient, person, system, instruments that is responsible for generating the record.
5. **Content layer**	Content.
6. **Use History layer**	Use type identification as viewed, copied, edited, etc., the date and the time, who or what used the data, identification of evidential consequences of a particular use.

Registration layer declares the data that follows to be a record, assigns values indicating the provenance of the record, and provides terms by which the contents of the record can be discovered. Terms & Conditions layer invokes controls over access to, and use and disposition of a record. It also identifies restrictions imposed on access and use and where to resolve them. Structural layer consists of metadata about data structure designed to permit the record to remain evidential over time and to be migrated to new software and hardware dependencies as necessary. Contextual layer identifies the provenance of the record and provides data that supports use as evidence of a transaction. Content layer contains the actual data engaged in the transaction. Use History layer documents evidentially significant uses of the record subsequent to creation. Typically these include indexing, redacted releases, and recorded disposition or destruction under record retention authority, nut other uses, for example, for eyes only viewing, may be recorded. This last layer occurs at the end of the physical record to permit adding of entries without having to open the record.

For example, on the content layer are metadata fields, which describe the content of the document. The end user writes the description of the content in short. This helps the writer to remember the document later and the receiver to make orientation if this is the wanted document or not without uploading the document itself.

2.6 Product Data Management

According to Stark [1992, pp. 3-4] engineering data of a product is difficult to manage because:

- The amount of data can be huge.
- It is manipulated by many computer programs and often on different computer platforms.
- Many people use it in different distributed functions.
- It is on many formats.
- It often has several different definitions.
- It exists in many different versions.
- It has multiple relationships and meanings.
- It may need to be maintained for many decades.

Computer-aided engineering, computer-aided design and computer-aided manufacturing demand produce enormous amounts of data. This insists efficient use of bandwidth especially in a distributed work. Large companies can produce thousands or even millions of drawings, which hold hundreds of terabytes of data. One three-dimensional CAD model may take up to several megabytes [Stark 1992, pp. 26-29].

A product life cycle can be divided into four phases: conceptual, design, manufacturing, and operation [Hameri & Nihtilä 1998b, p. 199]. In the *conceptual* phase, the first customer contacts are made. A detailed offer including the main technical specifications is prepared and the project is planned. The *design* phase consists of the detailed research and design work resulting in the necessary documentation for *manufacturing* of the product. In the manufacturing phase, the parts are produced or procured and the product is assembled, installed, tested and commissioned. The *operation* phase consists of the use, maintenance, and service of the product. The last and final *disposal* phase could be added. The importance of it has increased with the awareness of environmental protection interests.

On the research and design phase, the problem is to bind together the top-down and bottom-up approaches when there in the middle exist undefined and unknown areas. Multi-level process representations facilitate linking high-level abstractions of process objectives with specific operational-level tasks [Osborn 1998, p. 39]. Multi-level process representations can map strategic intent to the practice of real work.

2.6.1 Tree structures for product data

A product data management system should offer a possibility to structure the data needed to research, design, and manufacture large and complex products like paper mills or aeroplanes. A tree structure is commonly used in the systems to organise product data. It is simple, understandable and has several possibilities to evolve during the life cycle of the product. Where document management emphasises archival schemas based on alphabetical naming and titling [Couture & Rousseau 1987], the product management instead emphasises a tree structure for the classification and organising the documents related to a product [Stark 1992]. The aim is the same: to manage the information carried by documents.

A tree structure is used because it offers a similar basic structure for different breakdown structure purposes [Buckley 1993, p. 9]. According to Bachy and Hameri [1997] different breakdown structures are needed, for example, project, product, assembly, and organisation breakdown structures. The product breakdown structure, PBS comprises all configuration information of a product. This information includes the complete configuration of the product, instructions of manufacturing, machining, quality control, etc. for each level and branch of the structure. It includes also technical description of the elementary parts, i.e. the leaves, of the product.

2.6.2 Workflows

A *workflow* is defined as a set of tasks, characterised by resources, events, associated information, responsibilities, decision criteria, procedures to be used, and standards to be applied [Stark 1992, p. 54]. A workflow system:

- assigns tasks to individuals informing them of the resources to be used and the procedures to be followed,
- initiates the associated actions,
- maintains status information,
- reminds users of standard operating procedures,
- checks that standard of information is accessed,
- distributes data and documents to the individuals as needed,
- requests a review or promotes the design when the task is finished,
- initiates the next step of the process,
- enforces promotion rules to be used,
- when the responsible person is absent, automatically passes the work to the most suitable replacement person or to the next highest authority, and
- manages the review, approval, communication, and archival of information.

The notions of a workflow and a life cycle are related but the distinction between them has to be made. In the concept of a life cycle of a document the essential point is the documentary view. In the workflow the users of the system have central role. One workflow as a process may consist of many life cycles of documents.

2.6.3 Configuration management

Configuration management, CM is a discipline to manage product data and process to maintain the integrity of the product during its whole life cycle [Buckely 1993, pp. 3-5]. This applies technical and administrative direction and surveillance over the life cycle of items. This to identify and document the functional and physical characteristics of configuration items. Audit of the configuration items is to verify conformance to specifications, interface control documents and other contract requirements, control changes to configuration items and their related documentation. Configuration management records and reports information needed to manage configuration items effectively, including the status of proposed changes and the implementation status of approved changes [Buckley 1993, pp. 169-170; Kozman 1995]. Configuration management is to maintain the integrity of products by finding the balance between the amount of too little and too much discipline.

The term "baseline" was originally used as an engineering surveying term. In that context, it was simply an established line the direction and end points of which were fixed so that further extensions into unmapped areas could be made. In the configuration management sense, a baseline is a document, or a set of documents, formally designated and fixed at a specific time during a configuration's life cycle [Buckley 1993, pp. 17-18]. By establishing baselines, it is possible to extend the orderly development of the system from specifications into design documentation.

Risks of not to have configuration management according to Bielawski and Boyle [1997, p. 21] are several. From the users' point of view there exists risks like non user-focused products, poor information organisation, and difficult document control when response could be resistance to the whole system. From processes viewpoint potential risks are online distribution without document control, information overload, and poor technology infrastructures such as networks.

2.6.4 Engineering data management systems

It is preferred to have a computer based logically integrated information model in distributed and large-scale projects to manage the product data [Hameri 1995]. This means that the existing different systems used by participating departments and suppliers ought to be integrated into one logical system. Effective configuration management enables users to retrieve correct information in a unified and controlled way.

Engineering data management systems (EDMS) are also referred to as product data management systems or product information management systems. Stark [1992, p. 2] regards the latter too limited; they overemphasise the product data management and neglect the objectives of managing the process data and managing the flow of work through the processes that use engineering data. The product data management shortened as PDM seems to be most used term in industry and commerce.

An engineering data management system aims at bridging the gap between product and design data while enabling concurrent engineering in a company [Hameri 1997, p. 154; Hars 1998, p. 16]. The system helps engineers to manage both data and the product development process with all product-related information during the whole life cycle of a product. The system provides procedural control of product data by facilitating approvals and notifying team members of the status and progress of the project.

Concurrent engineering means parallel working instead of sequential working. The fundamental conditions of concurrent engineering are good communication and sharing of data. These points emphasise the latest and updated information to be available. Because the complexity is increasing the relevant amount of rules, regulations, and disciplines for processes is needed [Stark 1992, Buckley 1993]. As a result production processes have increased in volumes and decreased in throughput times [Hameri & Nihtilä 1998a]. Efficiency and effectiveness of processes are required because only limited and available recourses can be used. Large scale and one-of-a-kind projects insist using concurrent engineering instead of traditional sequential working habits.

A successful implementation of engineering data management system is based on two points. The first one is to clearly determine and understand the working habits of the company. This does not seem obvious because at least according to Stark [1992, p. 23] in many companies only few people can really describe the engineering workflow and even fever know why it takes this shape. The second point is to take into account the cultural change, which is unavoidable, because implementation of a product data management system changes the old working habits.

To success in the implementation the idea of the system has to be sold to the future users of the system. The user interface seems to be a key for productive usage of the system [CIMdata 1998, p. 20]. Early and on-going support and involvement by top management are also essential for the success.

2.7 Summary

This chapter as a literature survey has concentrated on special characteristics of a project in a large-scale environment. A project can be used in different scales to manage a huge multi-project environment with several sub-level projects. A large-scale project has to be divided into smaller projects to manage the whole process and anyhow every small scale follows the main principles of a general project progress.

In this work the term **document management** is seen as an umbrella, which covers both the traditional records management, **and** the electronic document management. Electronic document management includes only management of electronic documents. Here it is preferred to use the term document management including the traditional view because an organisation is seen in a holistic manner as a whole functioning organism.

A project has been studied to create understanding of the environment where the end user is working. Currently computers form a significant part of everyday work. For an end user there are potential benefits like easy and fast communication and distribution of documents and information. On the other hand, there are threats like resistance of the aimed users and the speed of changes. These new modes of work demand new skills and new working routines, which can be difficult to obtain and implement in the organisation. WWW can be used in a large-scale and distributed project for effective communication and to document management.

The aims for electronic document management and product data management were discussed. Functions of data management systems and document management systems have some similarities and some differences [Stark 1992, pp. 153-154]. Exact similarities seem to be that both can manage the workflow, provide system management, generate reports, and provide external interfaces. Furthermore, those both offer functions to store and retrieve, manage, distribute, and archive data and documents respectively. Data management system functions can control data access but so can also document management system. Data management system functions provide index or catalogue facility, define attributes and relationships, and maintain audit trail, configurations, and engineering changes. While document management system functions provide index facility, scan and capture existing documents, link to references, and create new documents. Furthermore, document management system functions display documents and graphics, modify documents, manage documents pages, and print and plot documents.

3. THE METHODS

The research method used in the study is the case study method. The first section discusses the method and the second section introduces the data gathering methods used in the study.

3.1 Description of the case study research

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context especially when the boundaries between phenomenon and context are not clearly evident [Yin 1994, p. 13]. In general it collects and describes detailed and intensive data about an event or of a small amount of dependent events. It is typical that a case study is carried out in its natural environment. The reliability of findings can be achieved with usage of several [Holme & Solvang, 1991 pp. 93-94] methods and sources for collecting the data, including participant-observation, direct observations, interviews, documentation, archival records, and physical artefacts [Yin 1994, p. 80].

In the presented study, the case study method has been augmented by action research goals. In a case study, the researcher is in most cases an observer. In action research instead, the researcher is actively involved in some changes in the collaborative organisation. The collaboration of the researcher and the organisation is expected to benefit both the organisation and the researcher [Koch et al. 1997]. This was the case also in the presented study.

The research data was collected mainly by the participation in the ALICE-EDMS project at CERN. The first discussions about the research possibility were in Mars, the visit to CERN in May and in August 1998 the researcher entered the field and started the study at CERN. The general background of the research project is given on the Appendix 1.

3.2 The data collection techniques

The study is mostly based on qualitative data. In qualitative research the aim is to describe the existing world as it is in a holistic way. This is the aim also in document management to see the organisation as a whole. The absolute objectivity of the researcher is the ideal aim [Yin 1994] and effort but in a qualitative research the possibilities for that are limited.

The data was collected mainly by the participation in the ALICE-EDMS project, by 6 demonstrations, by using the TuoviWDM/EDMS system and from documents. The sources of data can be divided into confidential and public sources as well as to personal and institutional sources [Holme & Solvang 1991, p. 140]. The sources used are combined into a dichotomy with examples of the data in Table 2 as follows:

Table 2. Sources of data.

	Personal sources	**Institutional sources**
Confidential sources	Diary Written personal notes and remarks Transcriptions Private email Group email Personal interviews and discussions Observations	Participation Internal working papers Non-public reports Not yet approved reports Cost Estimate ALICEDB login of TuoviWDM/EDMS
Public sources	Memoirs WWW-pages	Brochures Reports Technical Design Reports, TDRs WWW-pages Circular letters Rules to create drawings Minutes of the ALICE - EDMS meetings Minutes of the EDMS - ALICE meetings Minutes of the EDMS-PC meetings

Participation in the ALICE-EDMS project

The researcher's assignment was to attend the different meetings, document the ALICE-EDMS and EDMS-ALICE meetings, carry out the advised activities, and to mediate between different experts according to the proceeding of the development work. Furthermore, the main task was to carry out this research with commitment to develop document management at ALICE.

Participation-observation was the source for the data of the meetings. The presumption was that the researcher participates at least one year at ALICE and in the ALICE-EDMS project. The researcher was a member of the DM group, which included six members. A major task of the researcher was to document the meetings. There were 11 ALICE-EDMS meetings during 1998 and 22 meetings during 1999 making 33 meetings all together. The dates of the meetings with the EDMS numbers are given in the Appendix 2. The EDMS number refers to the minutes of the meetings in the database.

Participation-observation of the researcher was well known among the group. The meetings of the DM project played a vital role in the development work. One task of the researcher was to mediate between the different partners of the EDMS effort and development people. This insisted to have interviews and discussions on several items of the document management subjects with different partners. These discussions were made to achieve a wider and better view of the environment and of others' experiences of the TuoviWDM/EDMS system and other matters about the EDMS. Interviews and discussions took place as planned and agreed interviews and as prompted less formal talks. The researcher participated ALICE weeks to get a general view of the ALICE experiment and its communication.

The researcher was called to attend the Configuration Management Meeting in January 1999. The participants were responsible among other things for configuration management in their own experiments or projects. The purpose of this meeting was to divide opinions and experiences to gain some useful insight to the configuration management. The researcher attended also an introduction for summer students in Tuovi team. This situation was to gain insights to the computing developers' culture. One other aim was to hear the future development plans and real actions for the TuoviWDM in order to get facts instead of fictions.

Demonstrations

Demonstrations of the TuoviWDM/EDMS were arranged to find out the user needs and to reveal the existing technical problems. The members of the DM group attended the demonstrations. The number of persons in the group was six and so very suitable for the purpose. During the six demonstrations there were unexpected problems because the access rights were not configured right on beforehand but those revealed in practise the unstability of the system.

Virzi [1992] has revealed that approximately 80% of the usability problems can be found after only five subjects, it is persons testing the system. Important usability problems are more likely to be found with fewer subjects than are less important problems. A researcher who chooses to run a small number of subjects will identify most of the major usability problems and some proportion of the less important problems. Virtzi's method presents the subjects, tasks, and the procedure of the demonstration. The prerequisite is that the end user has not to be a computing specialist to retrieve or to save one document with the EDMS.

The six demonstrations were arranged within two weeks in September 1998. The duration of each was approximately 1 h 40 min. Tasks to be proceeded were presented in a half-structured formula in order not to forget any basic functions. In general there were to main tasks, to submit a small and a large document, it is a document with an image. If there were clear questions how the person should do, a straight answer was given but otherwise they went on with trial and error and with think-aloud procedure method.

Testing

During the testing it was important to keep the role of an average end user and let this guide observations of the usage of the system. Testing included to write the minutes of the meetings on an ALICE template and submitting those into the system. Test-setups of the DAQ Coordinator, the administrator, and the researcher included testing to reveal and solve the remaining pending problems, which depended on the connection between TuoviWDM and CADIM. One of the researcher's tasks was to interview the other testers.

Transposition of the documents can be taken as a part of the test setup to ensure the proper functionality of the system. Content-loading may have three elements, which are to gather and organise the document sets, to determine and record all the required attribute information for each document, and to load the documents into the EDMS [Bielawski & Boyle 1997, p. 253]. Once the uploading has reached the critical point, the task can be done with batch loading application or given to clerical staff to be accomplished.

The documentation convening the interface testing followed the instructions of Haikala and Märijärvi [1997]. They divide testing to the documentation of testing and to the reporting of errors. The documentation should include detailed descriptions from the testing itself and from the reporting the errors and bugs. Descriptions of found errors should include for example explanation of the error, evaluation how severe the error was, when the error was made and how it was found, and how it was corrected.

Document study

In this research document study served to find out documents and document types of the organisation as well as the relevant workflows. Document survey is a prerequisite method for every archivist and record manager and document managers work [Couture & Rousseau 1987, p. 67]. Mazza et al. [1996] calls this same activity with a name document study. The study gives access to the activities and to the documents, and document management helps to analyse situations, and diagnose problems. The document study is intended to [Couture & Rousseau 1987, p. 67] understand the organisation and the nature of its activities, mission, goals, components, and operations, identify the personnel involved in document management on a full- or part-time basis.

4. THE CASE ENVIRONMENT

This chapter presents the case study environment. CERN is an international research centre and ALICE is a one large-scale project of LHC. The document management organisation at CERN will be presented and the procedures in use are viewed. After these background descriptions the EDMS itself accompanied with the TuoviWDM interface are studied.

4.1 The ALICE experiment

CERN was founded in 1954 and at present there are 20 Member States, Finland being one of them. CERN is the world's largest particle physics research centre and its mission is the fundamental research of matter and confirmation of theoretical laws of nature. The Laboratory sits aside the Franco-Swiss border west of Geneva at the foot of the Jura Mountains. Some 7000 scientists, half of the world's particle physicists, use CERN's facilities. They represent some 500 universities and over 80 nationalities. CERN plays an important role in high technology education and as a significant test-bed for industry as well.

In LHC different particles will be accelerated and collided in four separate experiments recording what happens. This recording is the job of particle detectors placed around the collisions. For the LHC the particle detector stations are ATLAS; A Compact Solenoid Detector, CMS; Compact Muon Solenoid, LHCb; the Large Hadron Collider Beauty experiment, and ALICE. The purpose of the ALICE Project is to design and build a dedicated heavy-ion detector to record the data of the collisions of heavy lead nuclei.

ALICE as one of the LHC experiments

There are four experiments in the LHC and this means constant battle of limited recourses. To compare the situation there is Table 3 with very general subjects to look at, budget, duration, and number of people, manpower, and participants. The comparison is difficult because commensurable figures were not available from official public sources. The data was catered by queries to key persons who were responsible for coordination and integration in the experiments.

Table 3. Comparison of the LHC experiments.

Experiment	**Budget** MCHF, year of data	**Duration:** planning, construction, usage in years	**People involved**	**Manpower per year**	**Institutes/ Countries**
ALICE	115 (1998)	10, 4, 15-20	Scientists 968	Construction about 250	115/28
ATLAS	475 (1995)	10, 9, 15-20	Physicists 800 All 2000	2400 full time equivalence	146/34
CMS	440 (1995)	7, 7, 15-20	Scientists 1822 All 2140	Construction about 500	147/31
LHCb	86 (1997)	7, 5, 15-20	Scientists 449		47/14

The ALICE Collaboration proposes to build a dedicated heavy-ion detector to exploit the unique physics potential of nucleus-nucleus interactions at LHC energies. The aim is to study the physics of strongly interacting matter at extreme energy densities, where the formation of a new phase of matter, the quark-gluon plasma, QGP is expected. It will be ALICE's task to record what happens. The energy densities will be 300 times higher than at CERN's present day experiments and the lifetime of ALICE experiment is expected to be from 15 up to 20 years. The ALICE experiment covers the whole life cycle of the detector and the ALICE project is only the research and design phase of that life cycle.

The ALICE experiment is distributed collaboration of 968 participating scientists from 115 institutions in 28 countries all over the world. This demands co-operation, communication and modern information technology to enable such a task. The total cost estimate for ALICE is about 115 MCHF. The goals of ALICE are main milestones such as the Technical Proposal in December 1995, Muon Arm addendum in October 1996, Approval of TP in February 1997. Other goals are Technical Design Reports from mid 1998 to early 1999, construction beginning in 1999, installation in 2003/2004, and start-up of the LHC in June 2005.

The organisation of ALICE

The formal organisation of ALICE consists of the Collaboration Board, the Management Board, and the Technical Board. The Collaboration Board is the governing body, which defines the scope of the ALICE project and takes decisions concerning modifications and relative priorities during its execution. Each institute has one representative in the Collaboration Board but the right of vote is restricted to institutes with at least three members. The MB supervises the progress of the experiment along the lines defined by the Collaboration Board and it must endorse the MB decisions.

The ALICE Technical Board assesses all technical aspects of the ALICE detector as decided by the Collaboration Board. The design, co-ordination and technical execution of the experiment are discussed and agreed upon in the TB. Technical decisions, having important implications for the ALICE detector must be presented to the Collaboration Board for endorsement. The Technical Board, chaired by the Technical Coordinator, is composed of the Project Leaders including Sub-project Leaders. Ex-officio members are the Spokesperson and Deputies and the other Coordinators. The Technical Coordinator can enlarge the composition of the Technical Board to include other members of ALICE having important technical responsibilities.

In addition to the previous formal organisation also other functional organs are needed. The Finance Board is responsible for dealing with all subjects related to the costs and resources of the Collaboration, evaluation of contributions, relations with funding agencies, contract policy, and administrative things. The Resource Coordinator chairs the Finance Board. The Physics Board co-ordinates and assesses activities concerning physics topics of interest, including the simulation and optimisation of the physics performance of ALICE. It co-ordinates conference contributions, publications and internal ALICE notes. The meetings of the Physics Board are open to all Members of the Collaboration.

Technical Design Reports for sub-systems of the detector

CERN's Research Board approved the first Technical Design Report for ALICE collaboration on the 3rd of November 1998. Technical design reports are 'blueprints' that describe detector sub-systems precisely how those will be built. Technical Design Reports are prepared for each sub-system of a detector including introduction, research and design, prototypes, test results, description of the detector performance, the installation and organisation. This all to define, for example, the responsibilities, schedules and costs of each sub-system.

The ALICE Project includes several detector sub-systems, which are resource-consuming sets of activities. The sub-projects in ALICE Experiment Project are:

- Inner Tracking System
- Time Projection Chamber
- Particle Identification
- Photon Spectrometer
- Zero Degree Calorimeter
- Forward Multiplicity Detector
- Muon Spectrometer
- CASTOR
- Trigger
- Data Acquisition
- Detector Control System
- Offline Software and Computing

4.2 The organisation for document management at CERN and at ALICE

There are named bodies and members of the personnel who are responsible for records and archiving at CERN. Those are the Director-General, The Archive Committee, the CERN Archivist, Divisional Records Officers, the directors and division leaders [Operational Circular no 3]. The general principles include among other things that any record that documents the results of scientific endeavour is archival material. The archiving is mentioned to involve the preservation of documents, requiring organised record management and the application of defined standards at the moment of creation of a document. This last point shows the importance of preserving electronic documents as a part of archival material.

In September 1998 the Archivist retired after nearly 30 years work and her assistant left CERN to continue her studies. The team for the Archives work had to be rebuilt in 1999 and the new Archivist arrived in January 1999. All Division Leaders appointed divisional records officers in 1998. [CERN Annual Report 1998, pp. 281-282]

Divisional Records Officer is a person who assist in locating and collecting of the archival material of their respective Division, Collaboration or area of activity at CERN. A Divisional Records Officer is nominated by the Division Leader or Collaboration and works in close collaboration with the CERN Archivists and with the Archive Committee. The person has the authority to implement a record management and archiving plan within the division/collaboration. One task is to inform the CERN Archivist prior to any restructuring or cessation of activities in the division, or departure of staff who possess files of potential interest to the CERN Archives. They will be invited to attend meetings of the Archive Committee when archiving of their divisional and collaborations' files or archiving are under discussion. Their needs are discussed in DRO, Divisional Record Officers' forum convened by the Archivist, which happens once or twice a year.

ALICE belongs to the EP division, where is the Divisional Record Officer for it. ALICE has started at 1991 and for the moment there does not seem to be problems because the secretaries take care of all documents and records. The problems usually arise later when the amount of records and documents is so big that it becomes difficult to manage and so very visible or when losses of critical information are realised.

The Working Group on Electronic Archiving was set up at the end of 1997 with a mandate to explore the size and the typology of the electronic documents at CERN [CERN Annual Report 1998]. The purpose was to study current status, and to prepare a basis for an organised record management and archiving policy to preserve the historical, scientific, and economical value. During 1998 the Working Group carried out a series of studies of existing CERN information systems, with a view to evaluating their suitability for the long-term preservation for information.

4.3 Engineering data management at CERN

The idea to use hypertext for distributed engineering data management was proposed for the first time in October 1993 [Høimyr et al. 1993]. The main purpose was to find a way to manage distributed data in a heterogeneous environment like CERN. The system should be robust enough to cover the whole lifetime of an experiment. The aim was to integrate collaborative institutes and companies who were connected to the Internet and to provide them with tools to exchange information between the remotely located design teams. Basic principle was interface through the World Wide Web. Recommended data formats were HTML, ASCII, Postscript, and IGES. These standard formats were fixed already that time because the previewing of data is limited by the capabilities of the browsers. With the FTP protocol any file format of data can be transferred. Other recommended tools were MOSAIC and WWW servers.

In 1995 the Engineering Data Management System Task Force was established to study and find out a proposal to save and control further development of engineering data for the LHC project [Pettersson & Hauviller 1997]. The complete set of data describing LHC and its experiments will be large, complex, multidisciplinary and large-scale in time and size. That is why the EDMS was considered viable to fulfil the needs of managing the engineering data for LHC machine and experiments. It should be beneficial in terms of the working methods and in controlling the expenses of the project.

CEDAR, CERN Engineering Data Management System for LHC Detectors and Accelerator is one project continuing the work of the EDMS Task Force and its aim is to exist as a forum for further development of the EDMS. Other goals are to arrange needed training, create divided understanding about different views and opinions and to manage the resources for the CEDAR project. The LHC, a long-term and global one-of-a-kind project, could be affected by some basic problems.

The EDMS-ALICE co-ordination meetings linked the ALICE-EDMS project to the CEDAR project. The EDMS-ALICE meetings were to discuss the problems and progress of the ALICE-EDMS project with the EDMS Task Force. These meetings were aimed to be regular, once in five weeks. The minutes of the meetings were the researcher's responsibility. One level up was also the EDMS Project Co-ordination meeting for all participants of the EDMS system at CERN. The researcher was supposed to take apart also in these meetings.

4.3.1 The system for engineering data management

The main tool is the Engineering Data Management System, the EDMS at CERN. On hardware server-side there are a Central Oracle Cluster, CADIM server, and CEDAR server. Central Oracle Cluster stores all CADIM metadata and CEDAR server acts as Web server. On software server-side there are CADIM/EDB and TuoviWDM. On client-side there is Web browser with Netscape 3+ to be Java 1.1 compatible. Networking standard is Transmission Control Protocol/Internet Protocol. The expected lifetime of the EDMS system is equal to that of LHC and its experiments.

The general policy is openness. Information in the EDMS is freely available word-wide to all users and guests. One can access by logging in as "guest" and leaving the password blank. Access to non-open documents and use of certain functions are controlled by a system of privileges specified by the EDMS administrators, particular to each individual user.

Figure 3 describes the architecture of the EDMS at CERN in general. The arrows show the interaction possibilities between the different parts of the EDMS system. The biggest arrow on the left shows that the TuoviWDM and CADIM are able to exchange data which is not possible in the case of Library and CDD, CERN Drawings Directory systems. It is possible to retrieve data from Library and CDD but not to submit it. The big CDD box presents the CDD system itself with the narrow arrow pointing that only copies of drawings are available.

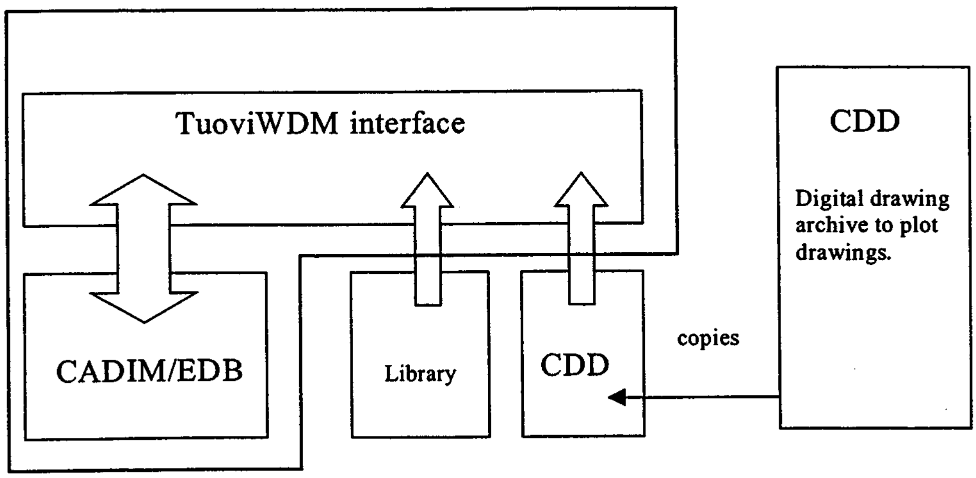


Figure 3. Architecture of the EDMS at CERN.

The EDMS includes, for example, product configurations, part definitions and other design data, specifications, CAD drawings, neutral CAD and geometry files, manufacturing process plans, routines and data acquisition etc. There are special requirements for the EDMS at CERN because of the complexity of the products such as accelerator or Collider, and the highly distributed worldwide user environment. Perhaps against this background it can very well be understood why Tim Berners-Lee invented the World Wide Web at CERN 10 years ago.

CADIM/EDB and CDD

CADIM/EDB, Computer Aided Data Integration Manager/Engineering DataBase is a commercial product by Eigner and Partner [CERN CADIM/EDB 1999]. The main objects managed by CADIM/EDB are items, bills of material, and any type of technical documents with files being managed in an electronic vault, and projects. Items are for example parts, components, and products. Different relationships are defined for these objects. These are project - item, item - item, and item - document relationships. There are also other objects available for example, engineering change request or variant. Following capabilities are included in the software electronic vaulting, restricted data access, product structure management, bill of material, product life cycle management, configuration management, workflow management, classification, viewing and interfaces to CAD.

CDD have been in use since 1982 as a digital drawing archive only for plotting. Plotting means a graphics printer that draws images with ink pens point-to-point lines directly from vector graphics files. CDD is a multi-platform utility, which manages engineering drawings made in any division at CERN. The aim of CDD is not to store the graphical drawing itself, but to store a reference and the information related to the drawing. CDD is based on an ORACLE database and suited for any type of drawing created on any type of platform. Since there are more than 25 different CAD systems used in CERN projects, the original drawing files are not to be stored in CDD, only the plot files of the drawings in the HPGL, Hewlett Packard Graphics Language format. HPGL format enables to view and plot drawings in good quality but because it is only a plot file, it is not possible to modify it. The preliminary plan is to integrate CDD or fully replace it by the general EDMS by the end of year 1999 and that is why no further major development of CDD will be done.

4.3.2 TuoviWDM

'Tuovi' abbreviation means product process visualisation and is in Finnish **tuo**te = product, and **vi**sualisointi = visualise. TuoviWDM is a Web data management tool that supports distributed design work by providing means to store and distribute files over the Internet. It allows to store, search, and retrieve files with a WWW browser and a single point access interface.

TuoviWDM can be used as an interface or as a stand-alone mode. It has been designed to store documents on a Web server and make them accessible through the WWW. The system can also connect to an external data vault. At CERN TuoviWDM is used as an interface to the EDMS to make its contents available in the WWW. In practise this connection means that for example the releases of both systems must be made on the same time.

Project structure as a tree and the main concepts

TuoviWDM uses a tree structure as the basis for organising documents [TuoviWDM User's Guide 1999]. The project structure is a tree of nodes where the root node represents the whole project, a branch represents a sub-project and a leave represents a document as seen in Figure 4 on the left side. A project structure may be created on-line or using special project management software, e. g. MS Project. The term sub-project refers to a node and all sub-structure underneath it. Documents are stored in the nodes of a project but they are not visible in the tree on the screen. Contents of a document such as text and graphics can be attached to a document as files. Each document can contain multiple files. Each project, node, and document is associated with metadata of its own. The metadata attributes of a node includes, for example, the owner, accesses rights, a short description, the scope, and the context of the node. The metadata attributes of a document include its status, type, owner identification, access rights and a description.

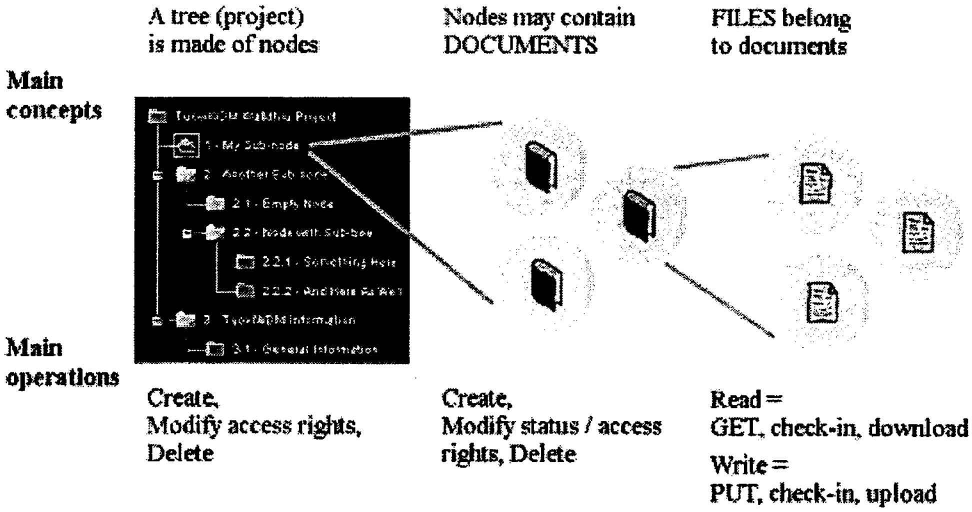


Figure 4. The world as seen by TuoviWDM. [TuoviWDM User's Guide 1999]

It must be kept in mind that the term document in TuoviWDM is used as a folder or a container, not in the meaning of a file. A file belongs to one document. The definition of a document does not seem to be stable and it is not always understood in the same way. In the subsequent sections the term Tuovi document referring to a folder will be used if the meaning of the team document is not clear or cannot be understood from the context.

Layout of the interface

The general layout of the TuoviWDM user interface presented in Figure 5 has two frames. The left frame is called the structure frame and it is intended for navigating the project structure. The right frame called content frame displays information about a selected node. The project structure may occupy one browser window and the document list another one. Each end user can customise the TuoviWDM interface according to one's preferences as in 5.

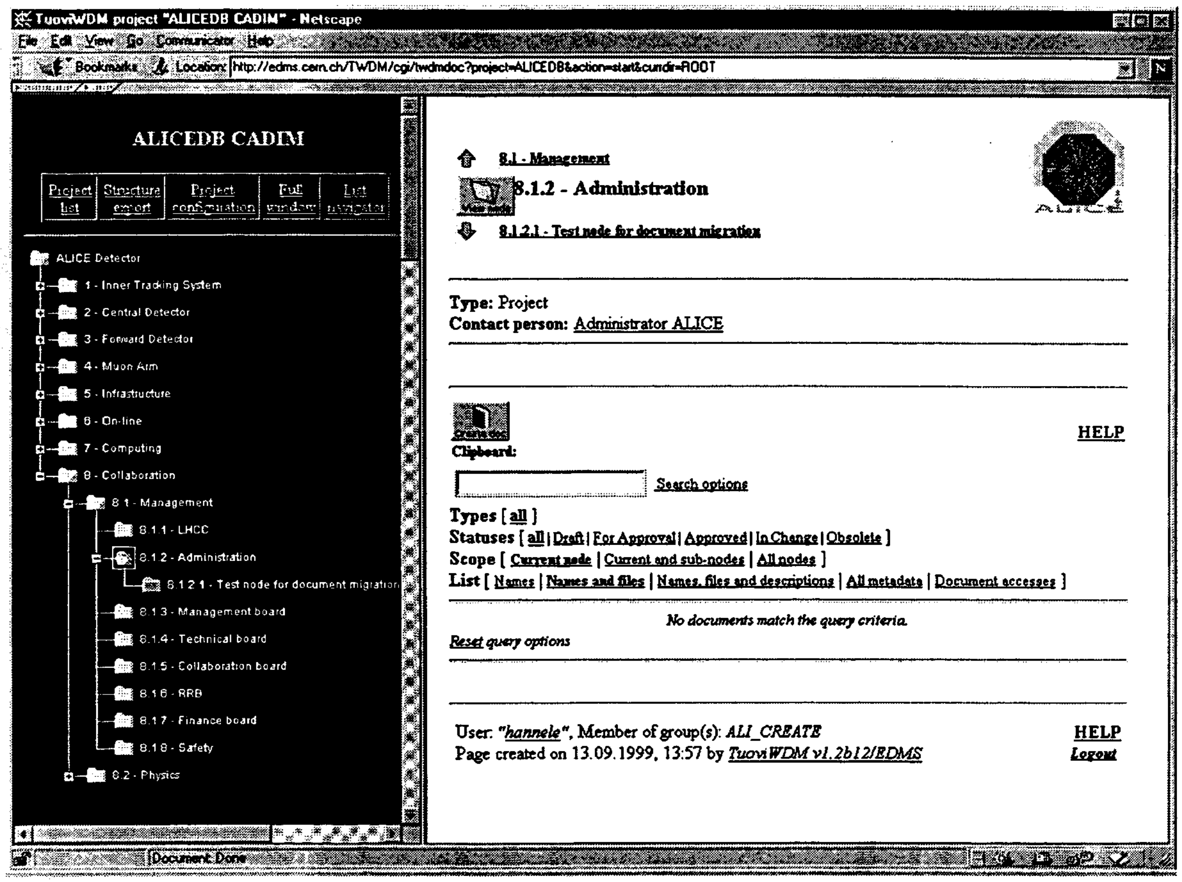


Figure 5. One TuoviWDM interface of the ALICE Project in the EDMS.

The folder icon colours in the structure frame help to locate the needed information. If one or more documents have been attached to a given node, its folder icon appears in bright orange. Nodes that do not contain documents are marked with yellow icons. An orange mark in the lower right hand corner of a yellow icon indicates that the node itself does not contain documents but that some documents exist further down in the sub-structure. An example is the folder icon of the node 8.1.2 Administration in Figure 5.

The functionality of the TuoviWDM system

The key functions of the TuoviWDM system can be grouped into project structure management, data and document management, file management, indexing and searching, administration and configuration. This basic set of TuoviWDM functionality is presented in Table 4. It is intended to provide means of working across geographical distances and applies basic document life cycle procedures.

End user interacts with the system through operations. The end user operations include creating and accessing documents and nodes and their metadata, writing and reading files attached to documents. Putting a file to the Web server is called upload or check-in while getting it out to computer for viewing or editing is known as download or checkout.

Table 4. The functionality of TuoviWDM.

Project structure management • Hierarchical structure, it is Product Breakdown Structure (PBS) • Online creation and modification of PBS • Integration to project management software, it is MS Project
Data and document management • Submission and retrieval of documents through WWW • Document description and attributes • Multiple file formats • Visual document status indicator • Creation and edition of documents as folders • Notification of changes to owner/group/list of arbitrary email addresses • Document access follow-up with history information • Document access control at owner/group/guest level, access rights
File management • Management of multiple renditions • World-wide access according to users rights to all documents in the system • World-wide upload of new/changed files according to users rights
Indexing and searching • Navigation according to the PBS structure • Document attributes and content indexed (PS, PDF, RTF, MS Word, MS Excel, etc.) • Gradually focusing queries • Queries based on document attributes • Full-text search on file contents To be continued

Continuing The functionality of the TuoviWDM system
• Project, node and document metadata • Sorting based on attributes • Search scope direction • Indication of nodes with/without documents
Administration • Creation of new projects from the Web • Basic set-up of document types, document statuses etc. from the Web • User authentication and access control based on users and groups • Online creation and modification of breakdown structures with access control • WWW-based administration of users and groups
Configuration • Parameterised display of information • Template-based presentation of documents and files • Customisation according to user standards

TuoviWDM is the official WWW interface for product data management at CERN. Integration of the TuoviWDM into all elementary data management systems is under development. It has been strongly recommended that the ALICE collaboration should start using TuoviWDM as the interface to the EDMS.

4.4 The baseline for the ALICE-EDMS and the TuoviWDM/EDMS interface

Ignorance of documents and data concerning the current Collider is evident and this data unquestionably is needed for the experiments of LHC and its research and design phase. The EDMS plan in 1997 [Pettersson & Hauviller] defined three goals for the ALICE-EDMS project. The first goal was to have a system for registration and distribution of drawings and files to be fully operational by the end of 1997. The second goal was to define ALICE's user requirements. The third goal was the participation of the EDMS people in regular discussions with the ALICE collaboration.

On the domain of 'Planning and Documents' there was to be three sub-projects: Resources & Planning, Document Handling, and Quality Management. The first sub-project was to develop resource planning and scheduling system for the ALICE Project to manage among other things work packages including all recourses. This project was priority number one because the resources are limited. The document handling project was priority number two. Proper document handling was not considered critical. The third subproject was the quality management project with the lowest priority. The reason for the low priority seemed to be the adequate quality management on the LHC level.

The first and the second subprojects had the researchers of their own who were ready to enter the site at CERN in August 1998. In the beginning these subprojects were treated in the same meetings named the ALICE-EDMS Project Management Meetings. During the winter it was considered relevant to separate these two subprojects but the name remained the same. In this research according to the different priorities, and to the points of view of these sub-projects it is relevant to rename the second subproject. The second subproject is in the focus of this research. It is referred to as ALICE-EDMS project or as the document management, DM project and people in the project as the DM group.

According to the computing expert of the DM group there in the beginning were two main problems. The first problem was the user interface and the second was the stability of the system. The interface to the EDMS was not yet at the level of quality and stability to be released to the whole collaboration. The attitude in the DM group was that it had itself at first to understand all the implications of the usage of the EDMS before releasing it to the collaboration.

The baseline of the TuoviWDM/EDMS interface

In the following the baseline of the TuoviWDM/EDMS will be introduced. The product structure consisted of 141 project nodes including some Tuovi documents. The presumption was that almost 100% of documents in ALICE were created in electronic format with the exception of the ALICE Week presentations, which were transparencies and most of them were created manually.

Figure 6 presents the content frame layout for the ALICE Project with TuoviWDM version 1.1a3. The frame shows the content of a node in the structure tree. The bad quality of the figure can be taken as an example of a lesson learned. The meaning of real time documentation is visible and inevitable.

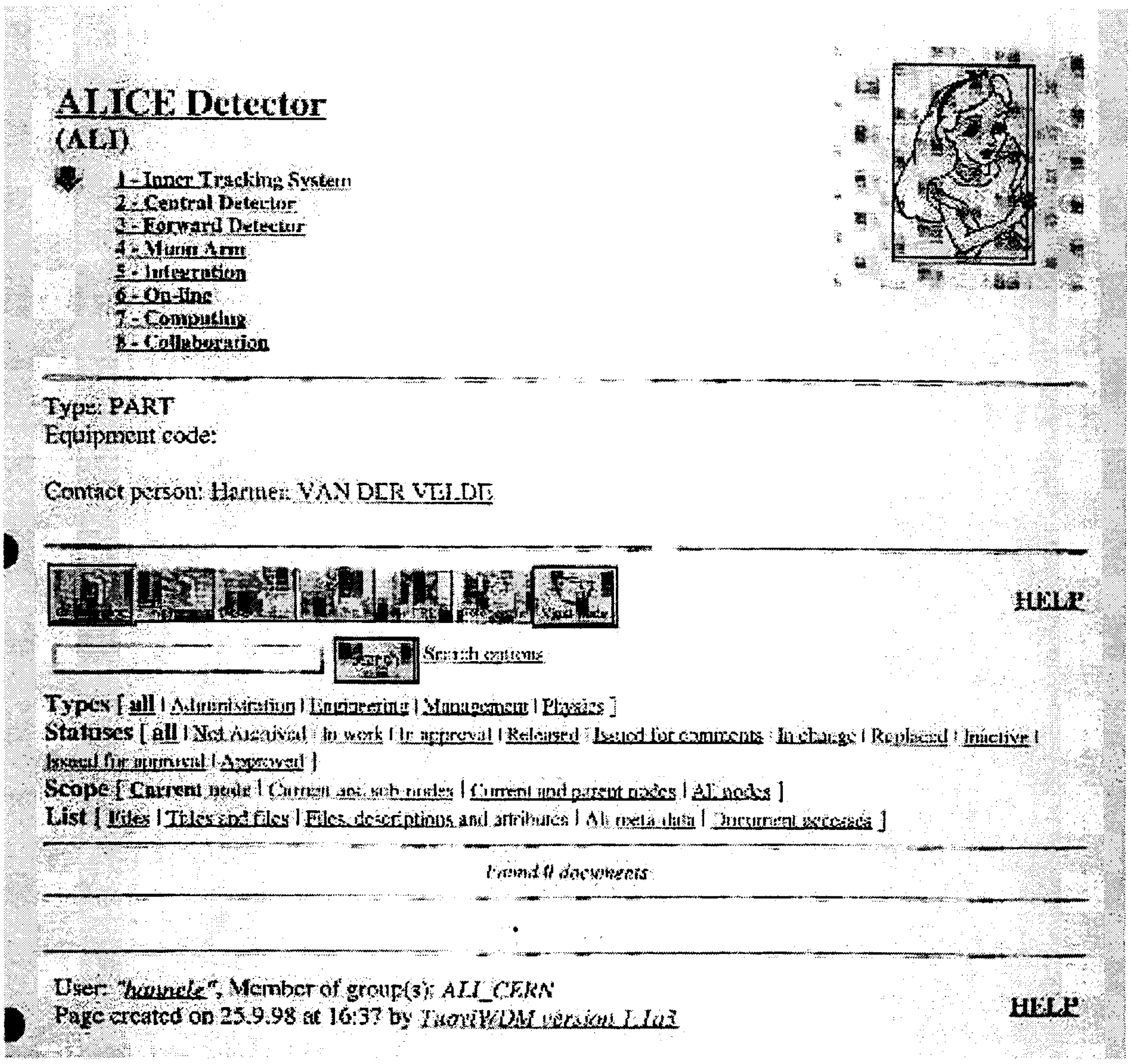


Figure 6. The baseline of the TuoviWDM/EDMS interface for ALICE.

The frame is divided into six parts by the horizontal lines. The first part lists the subprojects of the ALICE project and shows the ALICE logo on the right. The second part includes information about the node, for example the name of the contact person, in this case the administrator. The third part includes control buttons, a field of simple search and a link to advanced search, and attributes. After a search document list is shown in the fourth part and it indicates the number of retrieved documents. The fifth bar is to express the compact list of the retrieved documents but in the case example it is empty because there were no retrieved documents. The user data is given in the sixth part with a help link.

The control buttons in the third part could be used for creating a new document and for manipulating the existing ones. Some of the buttons turned inactive when access rights did not allow an operation in the active node. Search was possible with a keyword or search options. The attribute options of type, status, scope, and list offered a possibility to filter the document list and adjust its format. Retrieved documents were shown in a compact document list. The user data represents the username and access rights according to groups.

Metadata

The document numbering scheme of the ALICE project consisted of the abbreviation ALI, a relevant document type in abbreviation, two last figures of the year, and a running number, for example, ALI-INT-98-6. This numbering scheme included meanings and caused trouble for practice and computing because it could run out of numbers and had for example only digits for to express the year. It is worth remembering that the total number of the LHC documents may reach three millions. In that case the numbering scheme is of great importance if the documents should be identified uniquely for the whole life cycle of the detector, for example, in the maintenance phase of the experiment.

The initial main document types in the beginning of the TuoviWDM/EDMS were administration, engineering, management, and physics, and a hidden document type of CDD. Subtypes could be defined for the main document types. The sub-types included for example contracts, slides, and drawings. The CDD was needed to enable plotting of drawings at CERN. There was no other possibility to plot than to submit a drawing into the CDD system and plot via it. There were about 20 drawings with the type CDD. The initial combination of the different main types and subtypes is shown in Table 5.

Table 5. The combinations of document types and subtypes.

	Minutes	Internal Note	Slide	Publication	Contract	Drawing	Official Document
Administration	X	X	X		X		
Engineering	X	X		X		X	
Management	X	X	X				X
Physics	X	X	X	X			
CDD						X	

The DM project was intended to last one year. Releases of applications and configurations were made during that time. The starting point in August 1998 was the version 1.1a3. The administrator did the configurations of the ALICE database through the CADIM during the development work according to the presented ideas. The following release of the TuoviWDM 1.2/CADIM 2.2 was made in December 1998 including six modifications of the ALICE TuoviWDM/EDMS interface. The next release was in February 1999. In June 1999 there was the TuoviWDM 1.2/CADIM 2.3 update. The TuoviWDM production installation was split into two separate installations due to the large number of projects and the EDMS user group integration. This meant that the EDMS installation run only CADIM projects and the new installation was set-up to run stand-alone projects.

5. THE DEVELOPMENT PROCESS

The general phases of the DM project are presented in Figure 7 to show the activities of the first development period, which is in the focus of this research, started in August 1998 and lasted until the end of June 1999.

In July 1999 started the next period of the DM project. This period included implementation and integration of the ALICE database into the EDMS system. From that on the meetings of ALICE-EDMS got more participants from the EDMS Task Forces in order to enforce effective communication of the progress of the test setup in this implementation period. The release of the system to the ALICE collaboration was on 23rd of September 1999.

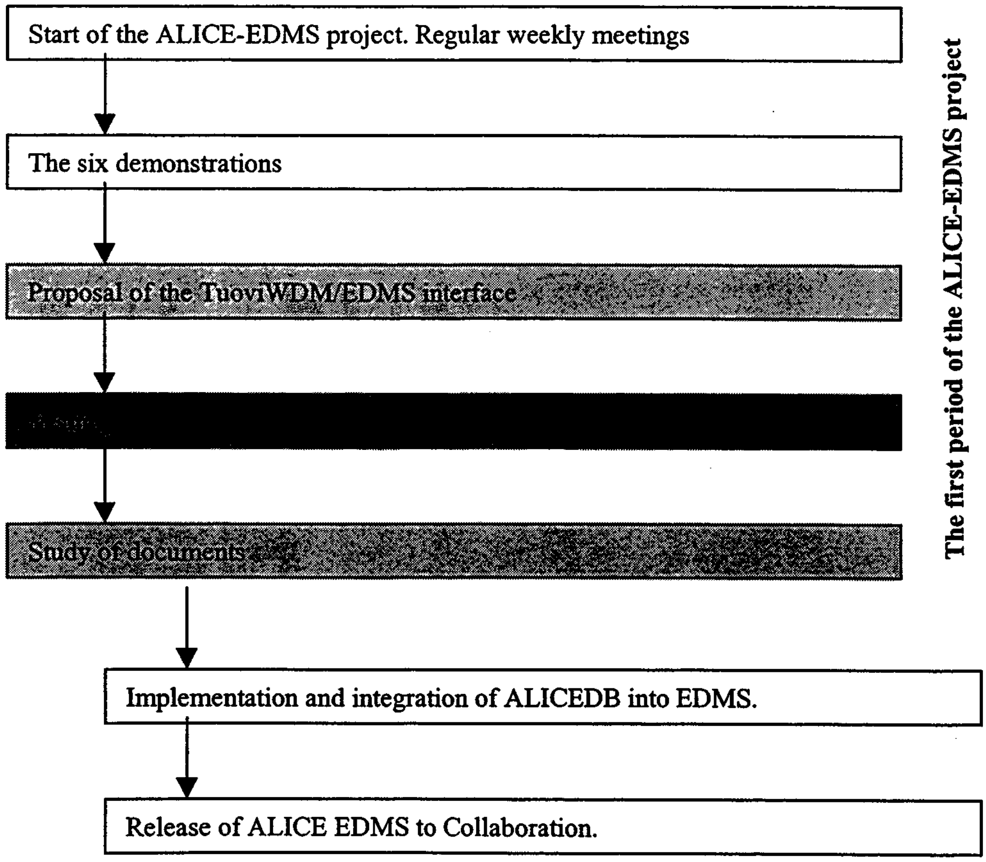


Figure 7. The main activities of the first period of the ALICE-EDMS project.

The researcher attended nearly all meetings making the notes and documenting the meetings. The six demonstrations were arranged and carried out together with the administrator as well as the proposals of the interface for the weekly meetings. Analysing the tapes of the demonstrations was on the researcher's responsibility and so to contribute as an interpreter of presented oral expressions and invisible needs for the system. Testing meant usage of the system using with real data.

The phases of the first period will be described in sections 5.1 - 5.5. More detailed data can be seen from the Appendix 3, The Study and Proposal of the TuoviWDM/EDMS interface at ALICE. The results of the first period will be introduced in section 5.6. Finally, in the evaluation of section 5.7 the problems in the development process will be discussed and some suggestions will be given.

5.1 The ALICE-EDMS project

Discussion of the needed document management had in general started in year 1997. Earlier at ALICE there had been two meetings concerning document handling to have some kind of a system to collect and store the data. Negative experiences of other experiments caused concern and suspicion at ALICE. In general the pressure from the EDMS Task Force to initiate the collecting the research documents and existing design data from the participating institutes over.

In August 1998 when the ALICE-EDMS project started, the goals were redefined. The goals were to create a plan for the EDMS system, to organise the registration system for the documents, and to take the system into use. Concerning the use, there were two sub-goals. One was to have users before Christmas 1998. The other was to expect about 50 people to have personal user identification usernames and passwords while the others to use a generic login name and password for submitting documents.

Real actions were taken in August 1998 when the ALICE-EDMS project started with meetings under the name ALICE-EDMS Project Management. There were six regular participants as members of the DM group five males and one female. The six regular participants were:

- Engineering and Integration Coordinator, a physicist
- Resources Coordinator
- DAQ Coordinator
- Administrator of the TuoviWDM/EDMS system at ALICE
- Doctoral student for sub-project of the resources and planning
- Researcher for the document management subproject, Document Manager

Participants presented the view of physicists, the economical management, computing expertise from data acquisition knowledge, and the other participants as graduated student and student. In the beginning also other participants were called but they did not attend the meetings. During the year only one change occurred among the regular participants.

The first main idea in the ALICE project was the belief on human communication. This meant that there was unwillingness to put conflicting views into the system, for example, email messages, which would be saved as history data. The other experiments had used the system as a negotiating forum and there had been some personal conflicts. This was to be taken as a warning to ensuring good personal relationships in spite of the huge distances. The regular ALICE week with meetings and presentations four times a year was intended to be the forum for communication and where to refresh face-to-face relationships.

The second main idea was the trust on people. This meant the approach that responsibility was awarded along with power and people were expected to use the power with care. The strategy included the usage of common resources as much as possible with the aim of creating synergy of collaborating work. The intent was to find out what other groups in the high-energy heavy ion physics domain were doing at CERN and benefit from shared knowledge and prototype systems at CERN.

The common commitment of the participants for weekly meetings was good because the participation was from 73% up to 90% among the regular six partners of the group. The meetings were usually on Fridays and those lasted on an average 1 hour and 45 minutes. The participants of the DM meeting were interested in the item and willing to spare of their limited time resources. The discussion was nearly always kept strictly to the subject. Clear decisions were rare because the DM project meetings played rather a forum for the discussions and opinions.

5.2 The six demonstrations

Demonstrations of the TuoviWDM/EDMS were aimed at starting to use the system, studying the interface, and revealing the existing technical problems. The study and proposal of the interface were based on TuoviWDM 1.1a3 version presented earlier. The ALICE-EDMS meeting decided that this kind of an attempt is needed and all participants of the group were willing to participate.

The administrator and the researcher arranged the demonstrations. Each demonstration took place in the own room of the person. The intent was to test the real-life environment and using the system as part of everyday work. The access rights were not configured correctly and this caused some problems. For example the author name as default according to username became wrong. The administrator played the role of an adviser. The researcher was the silent observer taking care of the tape recorder and making notes in writing of the situation as a whole.

5.3 A proposal for the new TuoviWDM/EDMS interface

The TuoviWDM interface of the EDMS system was studied carefully in the DM meetings because the user interface is a key to acceptance and productivity of the system with the proper functionality. The aim was to find out conflicting actions or visualisations of functions as well as possible points of misunderstanding. It had to be found the balance between the needed functionality and simplicity. The six demonstrations generated suggestions to develop interface towards simplicity.

The administrator and the researcher worked as a team in preparing a proposal for some changes in the interface. By the collaboration the intent was to get both the technical and the interaction aspects to be taken into account. The administrator with better technical computing skills and equipment created the images for the proposal. The researcher analysed the tapes and pointed out the needs and opinions to be visualised in the proposal. For example, where and in which order the fields of the metadata in the frame should be. The team working in practise meant discussion pros and cons, it is for and against items expressing different viewpoints. The overall responsibility of the proposal was on the researcher.

The proposal was prepared step by step starting form the baseline. The evaluation and suggestions concerned the ALICE document page, the search, the structure and the metadata. Transparencies were prepared for the weekly meetings of the DM group to visualise the proposal for comments in order to develop the outlook and the respective functions. The process of study and presentations continued as long as the presentation was acceptable for the proposal. This took from September till the end of October 1998.

There were two structures: the project breakdown structure of the Project Management Planning system and the project breakdown structure in the EDMS. Those structures ought to be the same but it was not the meaning to extract Project Management product breakdown structure from the EDMS structure. The Planning system had nothing to do with the EDMS system because those subprojects were decided to have separated.

The page for of the document metadata needed much consideration. There were many points, which had to be taken into account but anyhow keep things clear and simple for the end user. Such were, for example, the order of the metadata fields and how clear or self- explaining the titles of the fields were. The aim of the proposed grouping of metadata fields was to clarify the outlook and functions of the interface for an end user. The previous and the respective proposed metadata fields are in Appendix 3 Table 1 to show the rearranged order. There were also discussions about the meaning and usage of words and some changes were made. For example, expression 'In work' was considered to be wrong because the term in common use was 'Draft' and so on.

The proposal of the interface was presented orally to the Tuovi interface in November 1998. The user comments and the remaining technical problems were also discussed. The presentation included transparencies but no user needs of ALICE defined in writing. The proposal was presented to the EDMS-ALICE meeting on December 1998.

5.4 Testing

There was pressure to use the batch load for the transpose of all documents from the ALICE web server into the system. But the ALICE-EDMS group with DAQ Coordinator ahead insisted to use the TuoviWDM/EDMS. The goal for ALICE was to use the transition from the simple web system to the EDMS as a test period. To practise and to improve the EDMS system, the participants of the DM group had to test it, find the errors, report them to the EDMS team and check that the tool was improving from one version to the next. There was a decision of the DM group to use the actual data as a test case. This was anyway considered to be better than any artificial test that could be invented because this meant valuable real-life experience about the system.

The system got steadier after the release of Tuovi 1.2 and CADIM 2.2 on 1st of December 1998. After that it was considered to be the right time to start testing. It was decided to include several activities. The first one was to put the minutes of the ALICE-EDMS project meetings as relevant test data into the system and test it in reality. This included to use the templates of ALICE project and to gain experience of them. The second part was to start the test set-up to transpose documents from web-server into the EDMS. This part of the test setup included three different activities. The first part consisted of test setup of DAQ Coordinator, Administrator, and Researcher to test the system, the second was the DAQ test setup, and the third was test setup in the secretariat.

The minutes of the meetings

The first activity of the test setup was to put the minutes of the ALICE-EDMS and the EDMS-ALICE Co-ordination meetings on an ALICE template. On the 15th of January 1999 the researcher got the ALICE template to be used for the minutes. The template itself was heavy, about 100 KB. There were for example nine choices for titles and it is not obvious that so many were needed. The minutes from year 1998 were transposed into the templates and submitted into the system. From that on the minutes of the meetings were written down right after the meetings on ALICE template and submitted into the EDMS system. One task was to create the agreed file formats from the original Word to be also HTML and PostScript formats to ensure printing possibilities. This was taken as a test in two ways. The first was to test the TuoviWDM/EDMS system and the second was to test the expressed main idea that only ready documents are to be put into the system.

Test set-up from January to March 1999

Test setup of Administrator, DAQ Coordinator and Researcher took place from January to March 1999. The DAQ Coordinator tested the system with Administrator in January. DAQ Coordinator transposed some documents with several files and revealed several errors sending the error messages to Administrator. Administrator and Researcher tested the system for two days in February 1999. Administrator sent the error messages with relevant descriptions to the EDMS support, which was established recently. The test setup caused an avalanche of error messages. Most of the problems according to the administrator were based on the connection and disintegration between TuoviWDM and the CADIM/EDB.

There was a notification test on the same time. It included using the automated system but it pointed out to be irrelevant. The receiver of the automatic notification got three emails per an ordinary creation of a document. The receiver of the messages did not consider this test as relevant because his email was full of unnecessary automatic notification emails. It was decided to prefer the manual notification as long as there is a proper and configurable choice available.

The DAQ test set-up

DAQ Coordinator of the ALICE-EDMS meetings was from the data acquisition and this part of the test setup was strengthened by a test effort to transpose DAQ web documents into the system. In April 1999 the tester transposed 62 documents into the EDMS on DAQ node.

The opinions of this tester were considered important because one aim was to test the stability of the system. Researcher made an interview of the tester. The tester's opinion was that the system was stable, reliable, and easy to use. The nuisance was to retrieve the web documents with complicated operations. There should be some smooth operation to transpose them. It may be relevant because TuoviWDM is a WWW- based system and in the transposing phase should be convenient if there are many documents to be transposed.

Test setup in secretariat

When the TuoviWDM/EDMS interface was satisfied and the system was stable enough, the test setup in secretariat started in July 1999. The two secretaries started to submit web documents. Secretaries submitted about 20 documents into the EDMS. After that the system was considered to be stable and reliable enough to transpose all documents on a batch load into the system.

The secretariat had in use document types of internal note, minutes, ALICE week presentation, publication, and official document. These types were derived from the functional needs of the ALICE project starting from 1992. Those were considered to be more relevant to the end user than the TuoviWDM/EDMS document types. The change from TuoviWDM new document types to the used in secretariat was implemented during the test setup.

The administrator had left in June and the EDMS implementation was planned to happen on the same time. The leaving administrator caused a problem while the exchange of students and fellows is a rule. ALICE got implementation support form the EDMS Task Force, two software engineers. They were appointed to the implementation and integration for two weeks time. They revealed in the very beginning that there still existed integration problems between ALICE database configuration and the CADIM/EDB.

Batch load meant that the second period of the ALICE-EDMS project had started. Batch load turned out to mean that all submitted documents were to be deleted from the database and submitted in batch. Batch load succeeded with 373 documents while the remaining problematic documents had to be submitted manually. Batch loading was done in August and September 1999 keeping the release to the ALICE collaboration on ALICE week as a goal.

5.5 The study of documents

The researcher carried out a study of paper documents at the secretariat of ALICE while the web documents were studied earlier. The document study was to find out the facts of paper documents. The facts were needed about the documents, the document types, the life cycles, and the amount of work needed to scan the paper format documents into electronic format to be put into the EDMS system. The study was focused to the documents at the secretariat because it could be seen as one main knot of the document flows and distribution in ALICE project.

In the document handling system, the drawings were archived separately from the other documents. The technical drawings did not come via the secretariat. There was one drawing on the ALICE web page but it was the most important engineering drawing offering the basic parameters to research and design a detector.

5.6 Results of the development activities

The main results of the development activities were the documentation of the meetings, the demonstrations, modifications to the system, and the proposal of the interface, the testing revealing technical problems, which resulted to solve the problems and got the system stable and the study of documents.

Documentation

Documentation of the development meetings was one wanted result of the researcher's work. All meetings except three were documented. The meetings played a vital role as a forum to discuss and share opinions about the general effects and results of the system to the collaboration. Minutes of the meetings tried to capture reasoning and basics of the decisions.

A CEDAR document under the name 'Guidelines for Organising Document Management in a Project' [Hameri & Lahti 1998] was released in December 1998. This was a user document to offer guidelines or a checklist on tasks which should be considered, defined and documented before the projects can fully exploit the EDMS at CERN. This paper was not written in an end user friendly manner. It was anyhow used as a guide and included items discussed in the ALICE-EDMS meetings. The researcher rearranged the order of the items to reflect the TuoviWDM interface outlook. Then this rearranged basic paper was used for the DM guidelines at ALICE.

Demonstrations

The results of the six demonstrations were tapes of each demonstration, preliminary list of user expectations, a list of configuration items, and a list of technical pending problems. These resulted on their part to be taken into account when the following activities were planned and carried out.

The administrator made some configurations to the ALICE's database and outlook right after the demonstrations. The technical problems revealed during the demonstrations were collected to a list in order to express real problems, which were hindering the usage of the system. At that time there was no EDMS support and some problems remained to wait for the next release and the following one.

In the release December 1998, some suggested modifications were implemented to the TuoviWDM/EDMS. The changes in the ALICE interface were following: 'Advanced search' option to search for documents on arbitrary attribute, 'Advanced search' dialog was parameterised so that rows could be turned on and off. If number of documents found by a query exceeds some defined amount, only the number of documents is displayed along with a link to show or hide the compact document list. 'Document accesses' listing mode was parameterised so that one could select the actions to show in the history list. The document status was displayed at document creation time, if there is only one life cycle in the project. Additional buttons 'subscribe/unsubscribe', delete document' and 'Version history' were displayed at the bottom of the document metadata page if the user had the appropriate rights on the document.

Proposal of the interface

The results of the proposal of the interface can be visualised by making a presentation of the baseline and the proposal of the content frame, see Figure 8.

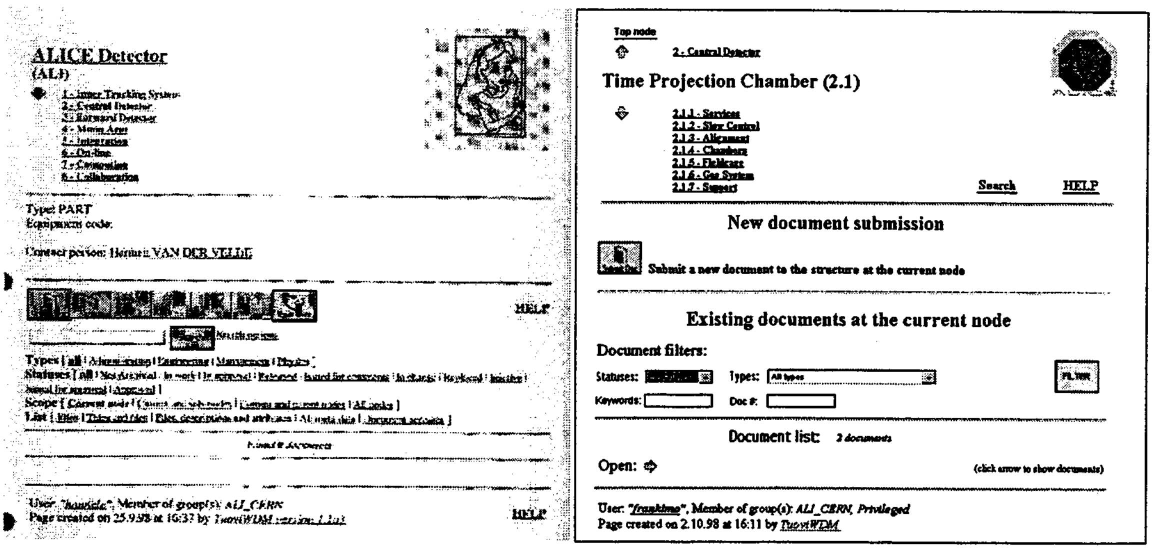


Figure 8. The baseline and the proposed outlook of the TuoviWDM interface.

The ALICE logo was changed to the new one, which was proposed and agreed after a competition to find a better logo for ALICE. The next part was removed to dismiss unnecessary data and this part got most of the rearrangement. Submission of a document got a part of its own with only one button for submission of a new document and the header was added to clarify the meaning of the part. The next part got a header "Existing document at the current node" and the attributes were formulated to document filters to have drop-down menus. Search link was added also to the first part besides the help link. The Document list part was to present at first the number of retrieved documents. This to offer to the end user a possibility to reformulate the query if needed to reduce the amount of retrieved documents.

Testing and the EDMS support

The EDMS support was established in December 1998. Before that the only support channel was to send error messages to persons, whom were known. This might not be very effective neither to the end user nor to the receiver of the message. The method was to guess who might know about this problem.

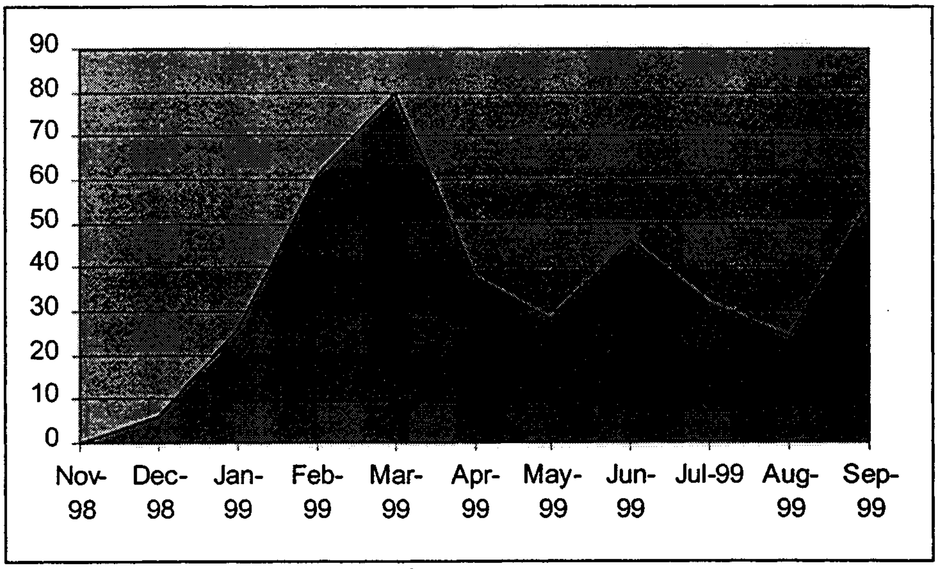


Figure 9. Number of requests per month in the EDMS support Remedy database.

According to Figure 9 the testing of ALICE could be seen in figures of every month. The proved error messages to the EDMS support in the Remedy database shows in January 19, in February 8, and in March 5 error messages from ALICE. It should be remembered that the sample does not include all error messages from ALICE because the testing was continued separately without collecting the data about errors anymore.

Study of documents and their life cycles

The study of paper documents was made in autumn 1999 in secretariat. The number of studied folders was 31 making 2,55 meters. The language of the documents was English in all but one document, which was in Russia. There were no originals or signed minutes for the meetings. The outdated and old files were destroyed and there seemed to be no procedure for archival purpose.

The number of registered documents had grown from starting year 1991 in document types as follows: Internal Note 324, Minutes 78, ALICE Week 17, Publications 92, and Official Documents 3 making 514 registered documents all together. Publications showed steady growth because the Technical Design Reports were prepared and accepted. These documents are published on the ALICE web page.

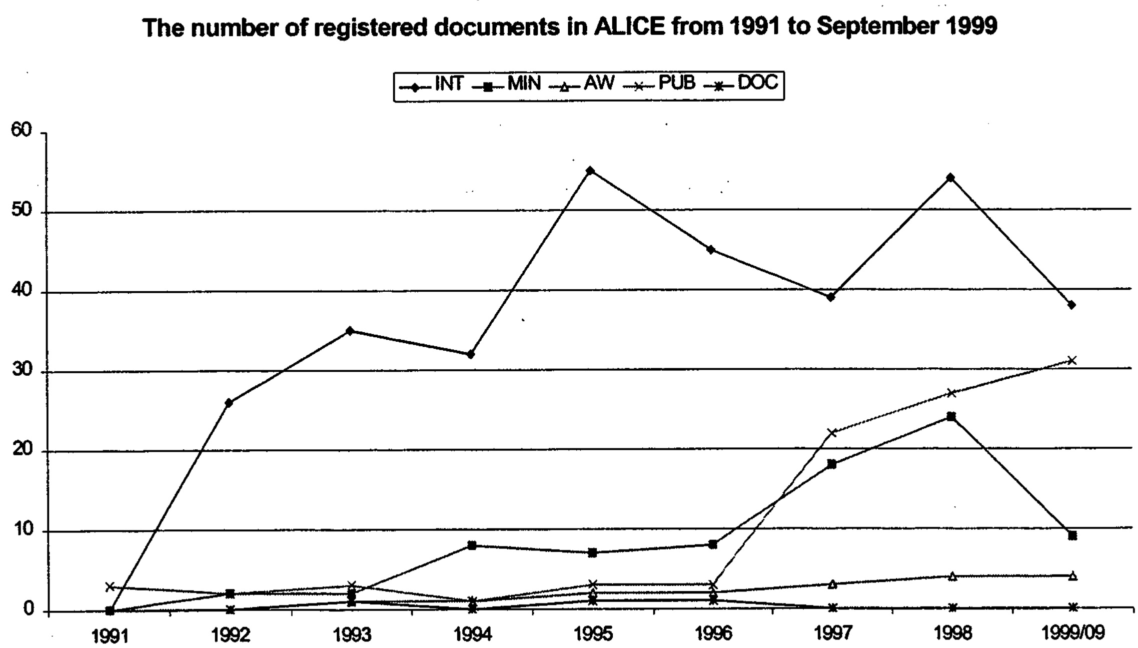


Figure 10. The number of registered documents at ALICE.

The collection of the old ALICE week material from the year 1991 till 1998 does not have a greater value of interest. This material is anyhow worth saving and paper copies are available. Material of one ALICE week may grow up to 5 centimetres bunch of paper. The more the format of presentation is electronic the more interest it seems to arise.

On autumn 1998 the secretary asked one person per institute to be responsible for the material of ALICE week presentations and to collect all material of that institute. This method to collect the material did work better and the amount of electronic format material has been increasing. From year 1999 there has been aim to get all the material in the electronic format as far as possible and to publish it on the ALICE web pages. For June 1999 the amount of received ALICE Week material in electronic format was in general 60% while DAQ and Off-line reached the amount of 100%. The scanning of only paper format ALICE Week documents begun at secretariat in March 1999.

The current workflow of drawings was modelled with simple transition diagram see Figure 11 to define and present the results of the analysis to get feedback. Example of the state transition model was a drawing representing the workflow in general. It can be divided into informal and formal procedures. All the actions before submission to the formal EDMS procedures are part of the informal life cycle.

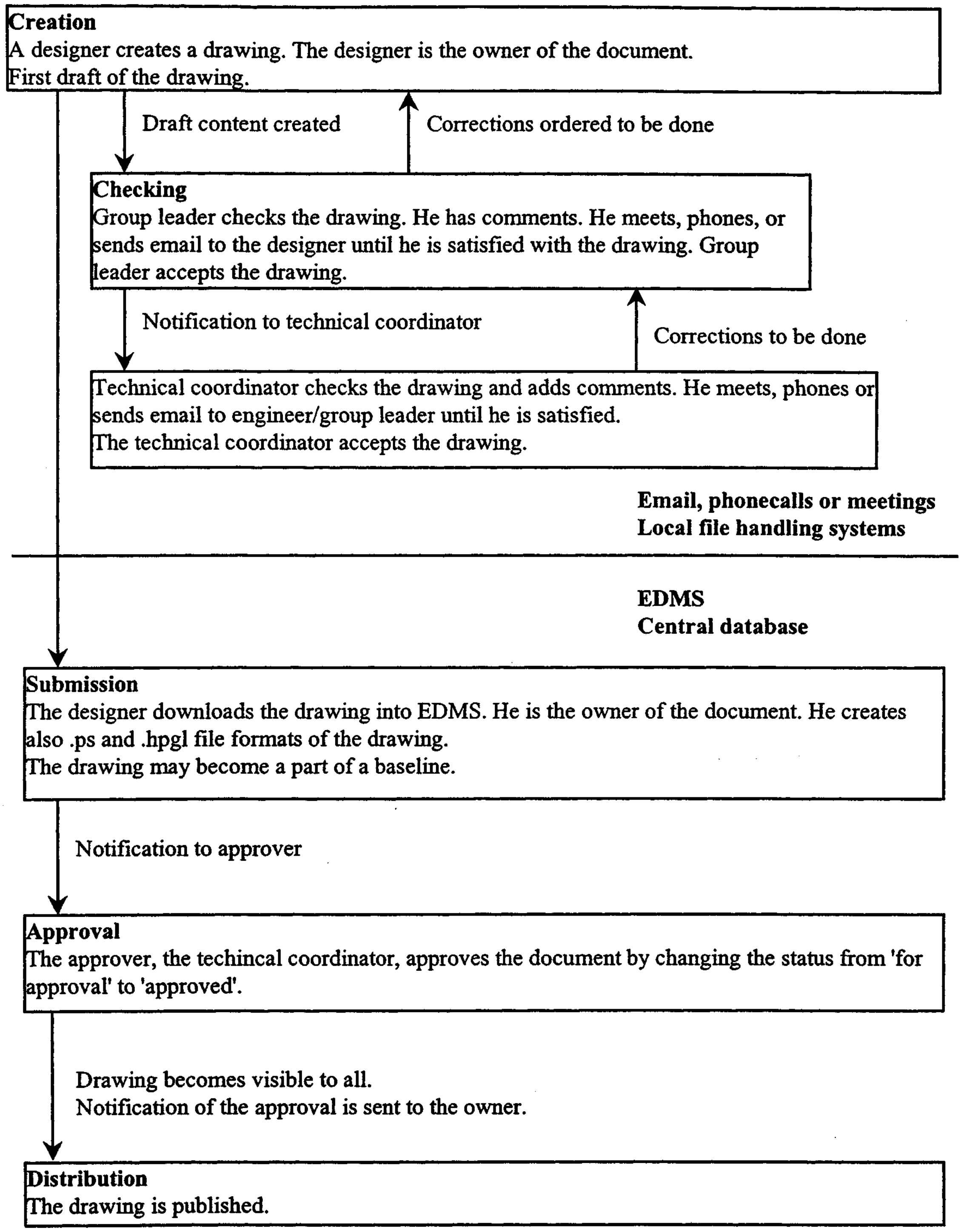


Figure 11. State transition diagram of an engineering drawing.

The life cycle of a drawing has several phases. After the designer has created the drawing starts the informal procedures to negotiate and get satisfied with it. There is great rely on human personal communication through email, phone calls or in meetings.

Explanations clarify what is wanted and why in order to accept a drawing, which takes into account the views of all partners. The informal procedures of negotiating phase are to be kept in local file handling systems. When the Technical Coordinator has accepted the drawing it is submitted to the EDMS system and its central database for formal procedures. These include the submission, approval by the approver and till the end distribution of the drawing. When a drawing is approved and in the EDMS system there may arise need to change it somehow. To keep track of the changes and make proper documentation of it is called configuration management.

5.7 Evaluation

The process of the development work did include some problems. The method of the development work was to proceeded step by step in an incremental way. Following a rearranged paper 'Guidelines for organising document management in a project' when planning and preparing for the implementation could speed it up. This is needed to study systematically all needed aspects and to document the decisions.

The separation of the first and the second sub-project caused unnecessary work because two different structures had to be maintained. The ideal aim of both sub-projects was to ensure and save information in documents but in this case the potential advantage was lost. The explanation might be that the role of the researcher as a student was not appropriate to give lessons or training. On the other hand, the distinction between document handling and document management of the end user's point of view was not clarified to the researcher in crystal earlier than spring 1999. Anyhow, the distinction of roles and responsibilities of an end user and of a document manager might be the key to sell the idea of proper document handling to the end users and so tackle the existing negative attitudes and resistance in organisations.

One problem of the DM project was caused by changes in the participation. The administrator left in June 1999 and the successor fellow started from July 1999 but only for three months. This caused a flea of knowledge because the occupation system is based on the division between regular staff and changing students. Fellows are named for two years and this causes problems for the continuation of basic functions.

When the administrator left the result was that the EDMS Task Force supported the implementation period at ALICE. When the real implementation and integration started it was found out that there still were problems with the configuration to the CADIM/EDB. These insisted to do rehearsal on some subjects of DM meetings in order to get basic aims clear, which seemed to be unnecessary task to do. The conclusion could be that if there had been an EDMS representative in the meetings once a week during the ALICE-EDMS project, the straight and clear answers of technical computing matters could be got immediately when the subjects were under discussion and consideration in the DM group.

On the other hand it might worry to have a participant of the EDMS Task Force in the DM group. It seemed to be pressure from the EDMS Task Force to get something done at ALICE. This could have aroused implicit resistance. One explanation could be that because the main approach was to have the view of an end user as a leading star it was considered to have enough computing experts in the group already.

An example of a realised concern could be the new ALICE interface, which was created by the support person from the EDMS Task Force in September 1999, see (Figure 12). This new TuoviWDM/EDMS interface did dismiss the prepared proposal although it was presented on July 1999 in order to be taken into account when implementing the ALICE configuration to the TuoviWDM/EDMS system.

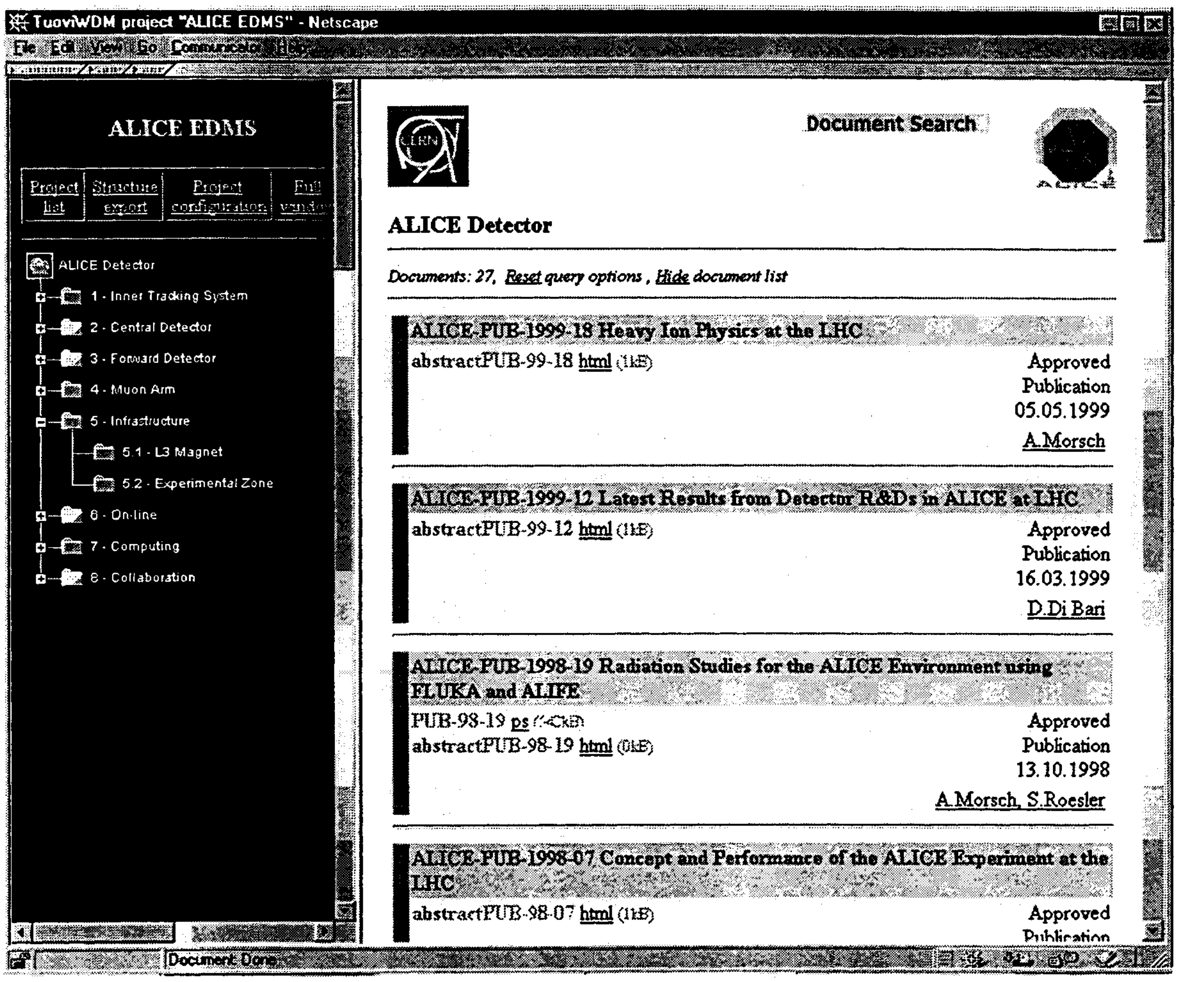


Figure 12. The new TuoviWDM/EDMS interface for ALICE in September 1999.

The baseline of the product structure consisted of 141 nodes in a complicated tree. There were strict recommendations at that time to use pure product structure but there was a constant question of one participant in the group: "Where do I put my minutes?" The strict recommendation did not take into account the reality of a project. The minutes of a project meeting are to record the important decisions and it was essential to have a node for relevant minutes. For example, the minutes of a Technical Board meeting records the changes to critical drawings. The EDMS Task Force reviewed its recommendation in autumn 1998 so that also project nodes were allowed in the structure. This can be seen from Figure 5, the nodes from one to five are product nodes and the remaining from six to eight include project related files. This was important because one perquisite was to have only one structure for the documents at ALICE.

The research data of test setup was just a sample and not systematically catered. Obstacles for this were for example, the missing history of a Tuovi document. It seems to be so that in April 1999 the EDMS Task Force made a decision of a policy not to keep data of document accesses. This meant that all data of the documents submitted until that was unexpectedly disappeared without any notice.

The communication of error messages revealed a problem to an end user, how to make a proper error message. On the TuoviWDM help page should be clear advice to an end user to whom and how to make a proper error message. The four points in an error message are essential to tell. At first what was the exact text itself in the received error message after a failure. The second point is the project or database where the sender was working when the occurrence happened. The third is the description what the sender was doing. The last relevant thing to tell the access of the person into the system, as a guest or person's own username. This all could order avoid end user's misleading and confusing error messages to the support. If the meaning is not to get computing people angry and annoyed, the guidance should be given on the help function.

The conclusion might be that the EDMS support was a needed establishment. It was needed to an end user that could just remember the name of the support, EDMS.support@cern.ch, and to the EDMS support personal when the messages came into one point. There it could be evaluated who could be the right computing expert to whom forward each error message.

At ALICE it would be proper to appoint a person formally to bear the responsibility of the documents. The appointment of a named person is relevant because most of the other experiments have them and this formal appointment might have good consequences when the named person becomes visible to the archival hierarchy at CERN. This means that the person gets the latest information and training arranged being able to disseminate and adopt it at ALICE as a part of everyday work. The person will also know whom to turn to for advice and help, when problems arise.

6. IMPLICATIONS FOR RESEARCH

In the following implications for the document management development in large-scale engineering projects will be discussed.

6.1 Critical documents

There were two main ideas in the development of work. The first one pointed out the great trust on human communication aiming to leave the negotiation phase out of the EDMS. This can be called also as a workspace. This seems to match with the findings in literature. All documents do not have equal value to the organisation. Some documents contain more important data and information than the others. To save the limited resources it seems to be relevant to make exact distinction between the most important, it is critical documents, and the other documents. This relationship between a document type classification and the relevant system to be used is presented in Figure 13. Based on this distinction it would be useful to use the sorting attribute of relevance in the metadata.

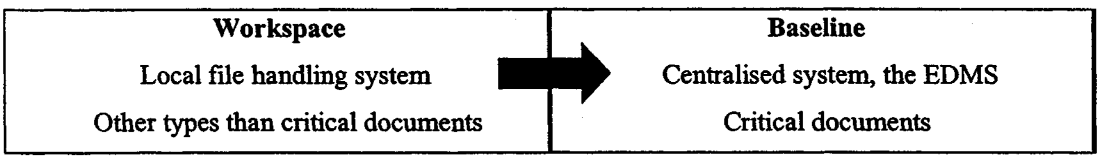


Figure 13. The relationship between document type and system.

The Pareto rule 20 – 80 seems to match on documents in general. It would be useful to concentrate on the critical 20% of documents and leave the remaining 80% out of the EDMS system. These critical documents should be submitted to configuration management in order to ensure the integrity and consistency of the documents including drawings.

The state transition diagram in Figure 11 shows what the principle 'Only ready documents into the EDMS' meant with drawings. The discussion of a document in the local file handling system, is made using point-to-point mode. This means that if conflicting opinions of two persons do exist the discussion outside the TuoviWDM/EDMS goes on as long as the common understanding of the subject has been found.

Users of the system

One implication of the research is found from log in statistics. The time series start from January 1998 to show the distinction to time before and after the research started in August 1998. The distinction is made based on guest users and named users. The amount of named users who mostly were the members of the DM group was quite steady while the amount of guests show four peaks in Figure 14.

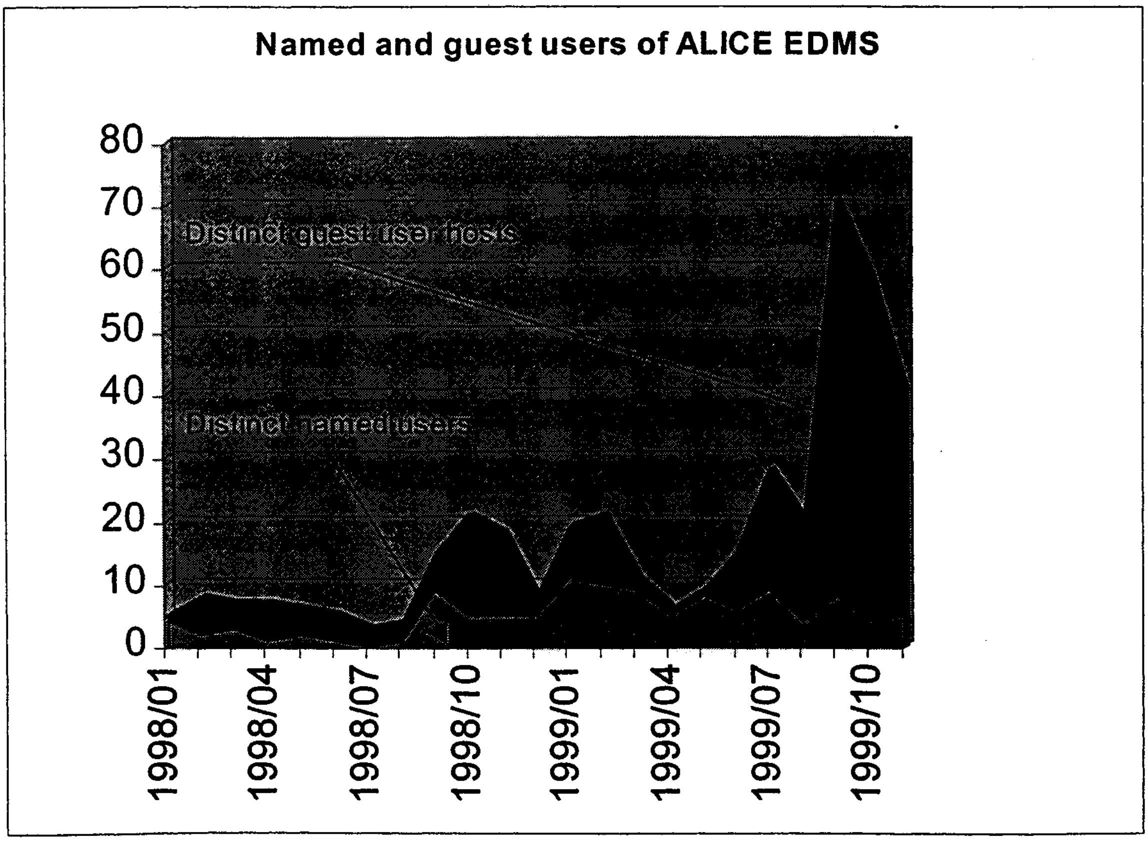


Figure 14. Distinct and named users of the TuoviWDM/EDMS.

The first drop between the first and the second peaks is time for close up at CERN during Christmas but it seems to be regular drop in nearly any diagram. The second drop has at least two explanations. The DM meetings had a break from the middle of March till the end of April 1999 when there were no meetings at all. The other explanation might be time of waiting for the next release of the next TuoviWDM/EDMS system. The problem was that the TuoviWDM and CADIM connection did not keep the selected document type properly. After the selection of right document type, for example minutes of a management meeting, it was not kept. When retrieving the same document afterwards the document type turned out to be the first one on the selection list. The EDMS Task Force was not able to solve the problem until the release in June 1999. Problems arose also when a competing web interface of the EDMS Task Force was presented.

Commitment

The commitment of the top management was essential. Two of the participants of the DM group were from the top management of the ALICE organisation. The Engineering & Integration Coordinator is responsible for the integration of the sub-detectors, safety, infrastructure, experimental area, services, machine interface and the installation of the detector. The person presented the view of integration of all parts concerning the physical detector and the view of a physicist as an end user of the TuoviWDM/EDMS. The Resource Coordinator chairs the Finance Board and he is responsible for the management of the common resources for the Collaboration. The DAQ Coordinator is responsible for whole computing sub-project with the respective responsibility. Their participation and commitment to the DM project from August 1998 to October 1999 expressed the importance of the DM project for the whole ALICE project.

While the commitment of the ALICE project was evident, there did not seem to be much commitment from the EDMS Task Force. As Table 2 in Appendix 2 shows that there were only five EDMS-ALICE meetings when there should have been a meeting every fifth week. These meetings were abandoned after April 1999. Proposal for rearrangement of all meetings was presented on August 1999.

Integration of the product and document management

Document management offers still relevant principles to guide document handling and document management. Product data management offers to the integration the structure in a tree form and disciplined configuration management. In the ALICE-EDMS project the practical need to have both product and project data in the same structure was enabled and taken into use. This integration could be taken into use more widely by offering the participants more possibilities to use the potential system in full-scale.

6.2 Distinctions between functions and roles

The end user has different needs for documents when creating and using documents than for example, the document manager. This means different roles from document's point of view. This distinction between roles is clarified in Table 6 with distinction of terms document handling and document management.

The distinction between document handling and document management

The word handling is based on the verb to handle, work with hands to act in a directed and certain way. For example creating a document with a Word application insists to follow precise step by step procedures. To manage means to oversee and make decisions about something to use it to best advantage. In document handling the duration of action is like step by step, one act after another while document management must consider all processes and even their relationships. Handling means short term activity while management must have long term view. The end user proceeds according to predefined rules and work flows having responsibility and duty of the documents and files belonging to his or her own work. The scale of document handling is small on documents, which are focused to current tasks. This is the reason when the view to document handling remains partial on the department level.

Table 6. The distinction between document handling and document management.

Viewpoints to documents	Document handling	Document management
Basic verb	To handle	To manage
Basic noun	Handling	Management
Activity	To act in a certain way when managed or directed	Direct and treat with care and use to best advantage
Duration of action	One act	Process
Duration of activity	Short term	Long term
Actor	End user	Record/document manager
Regulations	Rules and work flows	Top management policies
Responsibility for	Some documents and files	The whole
Scale	Small	Large
Timing	Current	Prehand
View to documents	Partial	Organisational

Document management is proceeded by records manager or document manager according to the top management policies, which should take into account the organisation as a whole. Document management is like glue of different processes, which assess the information and knowledge into storage of an organisation. Document management must have an organisational and a large-scale view to all documents in its approach. The end user makes document handling and the document manager makes document management.

Before a release of any new system or application the needs and requirements of document management should be planned and discussed thoroughly with the end users. This insists that document management persons with generalistic views and computer specialists with narrow computing views communicate with each other. If the adjustments to systems are made afterwards it seems to be nearly impossible, very complicated, or demand extreme recourses. These extra efforts could be avoided by open-minded approach to the same interest: information.

An administrator and a document manager's different insights on work

The roles of an administrator and a document manager seem to express different views of work, see (Table 7). In this case study the roles of an administrator and a document manager had some features, which point out some distinctions in the roles and in the professional attitudes presented in Figure 6. An administrator is usually a person with education and training for computing tasks, which create expertise on computing and relevant hardware and software. The work of administrator requires to be a pedant and concentrate on every detail so that, for example, complicated computing systems integration is right and works well. An archives and records manager usually has a long-term experience of practical work with relevant education and training. This creates a holistic insight to the processes and life cycles within one organisation. A computer is seen as a tool, which should help the work without special computing skills needed.

Table 7. Distinction of the insights of an administrator and a document manager.

Insight	Administrator	Records manager or Document Manager
1. **Expertise on**	Computing	Archives and records management
2. **Great trust on**	Machines, computers	Organisation, people
3. **A computer seen**	As the intrinsic value	As a tool to get something done
4. **Interest in**	Facilities of computing	Manual and automatic systems
5. **Perspective**	Information technology tools	Functional efficiency of the systems, usefulness
6. **Focus on**	Details	Whole
7. **View**	Fragmented	Holistic
8. **Attitude to login**	As a guest avoiding traces in history	With the username being aware of the rights and corresponding responsibilities
9. **Attitude to end users**	Underestimation	Relevant
10. **Content of a document**	'That is not my job.'	'That is my job.'
11. **Computing skills**	Good	Limited
12. **Purpose of work**	Take care of computing as a tool.	Ensure long-term availability of information.
13. **Task**	Offer available computing tools and facilities to users.	Functionality of the system, transform end user needs' into computing procedures.
14. **Work**	To administer and modify hardware and software applications according to relevant needs.	To study true workflows and corresponding documents and documentation.

These features were observed from real life experiences, some of which will be given as examples. One example pointed the differing attitudes to login. Computing experts in general seem to want to avoid any traces of their login into a system. CERN is a research institute with a policy to keep all possible data public and in practice this means that guest user login group is required. The result is that guest user access in a document history is seen as unnecessary and not wanted data. In this case study it came up in a discussion of the real document history. The administrator said that he prefers guest access while the document manager said that 'I do not enter the archival repository with someone else's keys and so I use my username.' This meant that the activities of a records or document manager can be seen also afterwards and the awareness of the responsibilities according to named rights is high.

The attitude towards end users and their needs could be taken as an example, too. One system developer 's comment of an expressed end user expectation was nullifying. This attitude seems to be common among computing people because they concentrate on computers as machines with high intrinsic value. If end users do not take available systems into use, if they do not find those helpful to their work, the basic aim for computers and computing work is lost.

The representatives of the two roles were studying a template as a possibility to link it and the metadata fields. The basic idea is that if there are commonly accepted rules for using template but they are not obeyed, anarchy in computing systems will be the dominant state. In this case, for example no retrieval offers right responds and potential advantage of structuring documents is lost. Templates with clear accepted rules could offer one possibility for well-guided document creation.

These two roles were observed in real life situations. Anyhow, those might be summed up from a philosophy's point of view in a more general level because same features of behaviour have been observed on different people's attitudes. The attitude of an average records manager, or document manager is to share the knowledge with others in the same organisation. This is seen as a willingness to solve problems in a reconstructing and integrative manner with end users. A scornful attitude of computing professionals to end user's needs seems to be the average one. These differentiating approaches to share knowledge, sharing and withholding insist to create a new shared view to information. These two professions need each other for the new approach, which may create advantage of synergy forces for both.

7. CONCLUSIONS

The focus of this research was on integration of document management and product data management and on the development of document management from the end user's, information technology tool, and documents' point of view. An end user's point of view meant studying and testing the TuoviWDM/EDMS system for document management of a product. Those points of view meant also studying documents and their life cycles during the research and design phase of a detector. TuoviWDM is a WWW-based data management system, which was used as an interface to Engineering Data Management System at CERN.

Document management and product data management in a large-scale engineering project can be integrated to be document management of a product. Document management offers the basic principles and life cycle model. Product management offers the structure for documents and disciplined configuration management to manage the huge amount of documents and their relationships. This ensures the up-to-date information and documents available when needed.

In large-scale and one-of-a-kind industry document management of a product plays a vital role, because huge amounts of data has to be collected and stored. The traditional record management principles with the life cycle model still hold with modification to the electronic format of a document. This means that the planning and definitions of document management functions in a computing system have to be done before the implementation of the system, not afterwards. This also means that traditional record managers with a holistic view to an organisation have much to offer in this document and product data management integration.

In practice the structure is the integrative form and a link between product and project. One structure includes documents of a product but it also includes documents of a project respectively. To integrate these properly on the long run configuration management is needed. It is in charge of that the pits and pieces fit together when the installation takes place. The other task for configuration management is to trace the changes so that information of a single item is retrievable from storage when needed during the whole life cycle of the item or during the life cycle of the product, in this case a detector.

The target organisation is based on collaborative work in an international research institute where the problems are connected to communication and information storage as well as distribution of information. Main problems related to the integration seem to be related to human. The main effort sould be to create common understanding of the distinction between document handling and document management. Document handling is done by an end user and document management is done by document manager. It is not document manager's job or aim to interfere an end use's papers or files. Those belong to the end user's responsibility. After papers and files are registered according to the importance and classification they became critical documents of an organisation.

This study pointed out that there are certain phases of a development work. Those are participation-observation in the development group meetings including documentation, and six demonstrations. Those resulted to development activities like studying user needs and expectations, a proposal of the interface including metadata, test set-ups, and study and analysis of documents.

End users' needs for the interface should be studied as the bases of the development work for document management of a product. Study can be done with limited amount of demonstrations and interviews. The aim is to find most of the problems of the interface and the functions. This is to create a presentation for the discussions in the organisation, which can be in a small scale meetings or larger scale presentations to achieve opinions and feedback of the potential users of the system. The aim is to get people to start to use it and to offer a forum where to save and disseminate created knowledge in form of documents and files.

The metadata of a document is needed in the integration to store iformation. Metadata has its expression for people and to computer to 'understand' it. The metadata of an electronic document expresses the information of the content, context, and structure of a document. In traditional paper format this information was in the document itself or in the minds of people who took part in the life cycle of that specified document. In a large-scale project this is not anymore possible because so the most of the information is lost and not accessible to the rest of the organisation.

Document management of a product is not adding any value for the organisation as a separate function. This means that it is tightly compound to all other activities and if this is not understood, document management alone is useless. Any computing system should be adapted to the needs and requirements, which the end users of the organisation for their work have, not the other way around.

Based on the research it can be stated that the development periods and activities can be speeded up in order to achieve the implementation period faster. Anyhow time is needed for the organisation to adapt to the new way of working. Further development of the usage of TuoviWDM/EDMS is needed to satisfy and fulfil the needs of proper document management of a product. It might be successful to concentrate on the critical documents of a product and to proper management of them. An interesting research item could be the critical documents during each phase of an engineering project.

REFERENCES

Bachy, G. & Hameri, A-P. [1997]. What to be implemented at the early stage of a large-scale project. International Journal of Project Management, Vol. 15, No. 4, 211-218.

Bearman, D. [1994]. Toward a Reference Model for Business Acceptable Communications. [Referred 9.2.1999]. Available in www-format <URL: http//www.lis.pitt.edu/~nhprc/prog6-5.html>.

Berners-Lee, T. [1989]. Information Management. A Proposal. CERN, CERN-DD-89-001-OC, March 1989, May 1990.

Berners-Lee, T. [1999]. Weaving the Web. The Past, Present and Future of the World Wide Web by its Inventor. Orion Business, London.

Berners-Lee, T., Caillau, R., Luotonen, A., Frystyk Nielsen, H. & Secret, A. [1994]. The World-Wide Web. Communications of the ACM, Vol. 37, No. 8, 76-82.

Bielawski, L. & Boyle, J. [1997]. Electronic Document Management Systems. A User Centered Approach for Creating, Distributing, and Managing Online Publications. Prentice Hall, London.

Buckley, F.J. [1993]. Implementing Configuration Management. Hardware, Software, and Firmware. IEEE PRESS, New York.

CERN [1999]. European Laboratory for Particle Physics. [Referred 12.9.1999]. Available in www-format <URL: http://www.cern.ch/>.

CERN Annual Report [1998]. Report of Activities in the Divisions. Volume II.

CERN CADIM/EDB [1999]. CERN CADIM/EDB Support. [Referred 12.9.1999]. Available in www-format <URL: http://cadd.cern.ch/cedar/support/>.

CIMdata Inc. [1998]. Product Data Management: The Definition. An Introduction to Concepts, Benefits, and Terminology. [Referred 24.2.1999]. Available in www-format <URL: http://www.cimdata.com/homepage.htm>.

Couture, C. & Rousseau, J-Y. [1987]. The Life of a Document. A Global Approach to Archives and Records management. Vehicule Press, Montreal.

Desktop Management [1997]. Guidelines for managing electronic documents and directories. [Referred 20.11.1998]. Available in www-format <URL:http://www.records.nsw.gov.au/erk/edm/desktop1.htm>.

Dollar, M.C. [1986]. Electronic records management and archives in international organizations: a RAMP study with guidelines. United Nations Educational, Scientific and Cultural Organization, PGI-86/WS/12, Paris.

Dollar, M.C. [1992]. Archival Theory and Information Tehcnologies. The Impact of Information Technologies on Archival Principles and Methods. Publication of the University of Macerata, Ancona.

Eisenhardt, K.M. [1989]. Building Theories from Case Study Research. Academy of Management Review, Vol. 14, No. 4, 532-550.

Ewusi-Mensah, K. [1997]. Critical Issues in Abandoned Information Systems Development Projects. What is it about IS development projects that make them susceptible to cancellations? Communications of the ACM, Vol. 40, No. 9, 74-80.

Haikala, I. & Märijärvi, J. [1997]. Ohjelmistotuotanto. Suomen Atk-kustannus, Espoo. In Finnish.

Hameri, A-P. [1995]. Configuration management in project driven manufacturing - Guidelines to better performance. International Journal of Manufactruing System Design, Vol 1, No. 4, 343-349.

Hameri, A-P. [1997]. Project management in a long-term and global one-of-a-kind project. International Journal of Project Management, Vol. 15, No. 3, 151-157.

Hameri, A-P. & Lahti, M. [1998]. Guidelines for organising document management in a project. CERN, EDMS no 100447.

Hameri, A-P. & Nihtilä, J. [1998a]. Computerised Product Process – Measurement and Continuous Improvement. Research in Engineering Design.

Hameri, A-P. & Nihtilä, J. [1998b]. Product Data Mangagement – exploratory study on state-of-the-art in one-of-a-kind industry. Computers in Industry, No. 35, 195-206.

Hameri, A-P., Nihtilä, J. & Rehn, J. [1999]. Document viewpoint on one-of-a-kind delivery process. International Journal of Production Research, Vol. 37, No. 6, 1319-1336.

Hameri, A-P., Nikkola, J. & Onnela, E-L. [1996]. Life-Cycle of an EDMS - A Road Map. Technical Note EST-ISS/96-01. CERN, Geneve.

Hars, A. [1998]. Better Control with PDM. Byte, International Edition, Vol. 40IS, February, 16-18.

Helsinki Institute of Physics [1999]. Annual Report 1998.

Holme, I.M. & Solvang, B.K. [1991]. Forskningsmetodik. Om kvalitativa och kvantitativa metoder. Studentlitteratur, Lund. In Swedish.

Salminen, A. [1999]. Methodology for Document Analysis. To appear in Encyclopedia of Libraray and Information Science. Kent, A. (ed.) Vol./Supplement. Marcel Dekker Inc., New York.

Sprague, R.H. [1995]. Electronic Document Management. Challenges and Opportunities for Information Systems Managers. MIS Quarterly, Vol. 19, No. 1, 29-49.

Stark, J. [1992]. Engineering Information Engineering Systems. Beyond CAD/CAM to Concurrent Engineering Support. Van Nostrand Reinhold, New York.

Sutton, M.J.D. [1996]. Document Management for the Enterprise. Principles, Techniques, and Applications. Wiley Computing Publishing, John Wiley & Sons, Chichester.

Taylor, S.T. [1986]. Value-Added Processes in Information Systems. Ablex Publishing Corporation, New Jersey.

TuoviWDM 1.2 User's Guide [1999]. [Referred 18.11.1999]. Helsinki Institute of Physics. Available in www-format <URL:http://edms.cern.ch/TWDM-WWW/guides/en/User.html>.

Virzi, R.A. [1992]. Refining the Test Phase of Usability Evaluation. How Many Subjects Is Enough? Human Factors, Vol. 34, No. 4, 457-468.

Widegren, D. [1998]. Engineering Project Support in a Distributed Design Process using WWW and Internet. Master's Thesis Work, Computer Systems for Design and Manufacturing, Royal Institute of Technology, Stockholm.

Yin, K.R. [1994]. Case Study Research. Design and Methods. Sage Publications, Thousand Oaks, London.

APPENDIX 1.

Research Project Report

Management of projects related documents in a global large-scale ALICE project

European Laboratory of Particle Physics (CERN)
& Helsinki Institute of Physics (HIP)
& Jyväskylä University

Introduction

Large Hadron Collider -Project consists of four experiments and one of them is ALICE, A Large Ion Collider Experiment. This research project description covers document management of a product at the ALICE project. The aim is to organise project document hierarchies and practices to manage project related documents by the engineering data management system, EDMS. The interface to this EDMS system is TuoviWeb Data Management system, TuoviWDM. Users, documents and document workflows, together with the functionalities of the system were in a special focus of this research work.

Research method

The research method was a case study research compound to action research methods. It included working closely with the ALICE project management and participating in the ALICE-EDMS project meetings. Understanding of the domain was achieved by mediating between the project group, the users, the document system developers, and support people. The research work was carried out in close contact with ALICE project management and Tuovi and EDMS personnel. Literature survey was made, too.

Scope

The first objective was to create understanding of CERN and ALICE as organisations and environments as well as of the TuoviWDM system and the EDMS system. The second objective was to create understanding about document management at ALICE and to study user needs and requirements. The third objective was to organise document hierarchies and practices in order to manage projects related documents with the TuoviWDM/EDMS system and to suggest improvements for TuoviWDM interface to be used at ALICE.

Tasks

Tasks to create understanding of CERN and ALICE were introduction to facilities at CERN and introduction to TuoviWDM and EDMS used at CERN. CADIM courses were needed to understand the EDMS. One task was participation to the ALICE-EDMS and EDMS-ALICE meetings as well as to the EDMS PC Meetings.

Users' needs and requirements were investigated by demonstrations and the users' requirements for the interface of TuoviWDM were created. Proposal of the interface was prepared together with the administrator at ALICE and improvements were presented to the developers of the TuoviWDM and the EDMS.

Organising electronic document management with Tuovi/EDMS was the third task. Test setup by down loading documents from current web pages into Tuovi/EDMS was made. Guidelines for electronic document management at ALICE project were prepared and Tuovi/EDMS was made available for ALICE users.

Schedule

The researcher worked at ALICE from 1st of August 1998 till 31st of December 1999.

Resources

CERN, HIP, and Jyväskylä University in Finland contributed to the presented research. Hannele Saloranta-Rönkä worked as the researcher of the ALICE-EDMS project. The project contact persons were the following:

- The Jyväskylä University, Finland, Vesa Ruuskanen, professor
- The Jyväskylä University, Finland, Airi Salminen, professor, supervisor
- ALICE project management, Lars Leistam, Engineering and Integration Coordinator
- ALICE project management, Hans de Groot, Resources Coordinator
- HIP, Ari-Pekka Hameri, Program Manager, Dr. Tech., thesis supervisor
- The Jyväskylä University, Finland, Hannele Saloranta-Rönkä, BSc., M.Sc. thesis work.

Related research

Bachy, G. & Hameri, A-P. (1997). What to be implemented at the early stage of a large-scale project. International Journal of Project Management, Vol. 15, No 4, 211-218.

Hameri, A-P. (1997). Project management in a long-term and global one-of-a-kind project. International Journal of Project Management, Vol. 15, No 3, 151-157.

Hameri, A-P. & Nihtilä, J. (1997). Distributed New Product Development Project Based on Internet and World-Wide-Web. A Case Study. Journal of Product Innovation Management, Vol. 14, 77-87.

Hameri, A-P. & Nihtilä, J. (1998a). Computerised Product Process – Measurement and Continuous Improvement. Research in Engineering Design.

Hameri, A-P. & Nihtilä, J. (1998b). Data-Based Learning in Product Development. Elsevier Science. Vol. 14, No 3, 223-238.

Hameri, A-P. & Nihtilä, J. (1998c). Product Data Management – exploratory study on state-of-the-art in one-of-a-kind industry. Computers in Industry, No 35, 195-206.

Hameri, A-P., Nihtilä, J. & Rehn J. (1999). Document viewpoint on one-of-a-kind delivery process. International Journal of Production Resources, Vol. 37, No 6, 1319-1336.

Puittinen, R., Silander, M., Tervonen, E., Nikkola, J. & Hameri, A-P. (1997). Universal access to engineering documents. In the Sixth International World Wide Web conference, Santa Clara, CA, April.

Phases of the study	05/98	06/98	07/98	08/98	09/98	10/98	11/98	12/98	01/99	02/99	03/99	04/99	05/99	06/99	07/99	08/99	09/99	10/99	11/99
Introduction to facilities at CERN	■																		
Decision to start the research and pre design		■	■																
Entrance to the case study environment				■															
The meetings of ALICE-EDMS project					■	■	■	■	■	■	■		■	■	■	■	■		
Introduction to TuoviWDM and CADIM courses					■		■			■									
Planning and process of 6 demonstrations					■	■													
Study and Proposal of the interface						■	■	■										■	■
Writing the theoretical part									■	■	■	■							
Proceedings of test setup									■	■	■				■				
Collecting and analysing the data													■	■			■	■	■
Preparing the Report to the case study organisation															■	■			
Stylisation and rewriting of the master's thesis															■	■	■	■	■
Literature survey	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Figure. The process of the research and the master's thesis. [Graduphases.doc]

APPENDIX 2.

The meetings of the ALICE-EDMS and the EDMS-ALICE

Table 1. ALICE-EDMS meetings from 08/1998 to 10/1999.

	ALICE-EDMS Meeting	**EDMS no**		**ALICE-EDMS Meeting**	**EDMS no**
1.	07.08.1998	101373	7.	19.03.1999	102391
2.	04.09.1998	101376	8.	07.05.1999	102836
3.	18.09.1998	101378	9.	21.05.1999	102837
4.	02.10.1998	101379	10.	28.05.1999	103067
5.	09.10.1998	101446	11.	04.06.1999	103069
6.	16.10.1998	101450	12.	25.06.1999	103437
7.	23.10.1998	101518	13.	09.07.1999	104150
8.	06.11.1998	101519	14.	16.07.1999	103792
9.	13.11.1998	101520	15.	26.07.1999	103793
10.	20.11.1998	101521	16.	30.07.1999	104151
11.	04.12.1998	101054	17.	06.08.1999	104152
1.	08.01.1999	101798	18.	20.08.1999	No minutes.
2.	15.01.1999	101799	19.	27.08.1999	No minutes.
3.	29.01.1999	101800	20.	03.09.1999	No minutes.
4.	05.02.1999	101692	21.	01.10.1999	
5.	12.02.1999	101661	22.	08.10.1999	
6.	26.02.1999	101681			

Table 2. The EDMS-ALICE meetings.

	EDMS-ALICE Meeting	**EDMS no of the minutes of the meeting**
01/98	23.09.1998	
02/98	28.10.1998	101370
03/98	11.12.1998	101371
01/99	05.03.1999	101754
02/99	09.04.1999	102537
03/99	14.09.1999	

APPENDIX 3

THE STUDY AND PROPOSAL OF THE TUOVIWDM/EDMS INTERFACE AT ALICE

LIST OF FIGURES

LIST OF TABLES

1. THE STUDY AND PROPOSAL OF THE TUOVIWDM/EDMS INTERFACE AT ALICE

The TuoviWDM interface of the EDMS system was studied carefully because the user interface is a key to acceptance and productivity of the system with the proper functionality. The aim was to find out how the system works and how to use it, to find out conflicting actions or visualisations of functions as well as possible points of misunderstanding. It had to be found the balance between needed functionality and simplicity.

The six demonstrations generated proposals to develop interface towards simplicity. The characteristics of two users were advanced, three were expert, and one was beginner. The tasks were the same because a half- structured formula was used. Anyhow there were unexpected problems because the system was not stable and because the access rights were not configured correctly on beforehand. The computing environments were different because every demonstration was made on the person's own computer in his or her working room. The platforms were different because Macintosh computers and PCs were used. The product to be studied was the TuoviWDM version 1.1a3 interface to the EDMS.

1.1 Preparing the proposal

The administrator and the researcher worked as a team when making the study and the interface proposal. This to get the technical and interaction aspects to be taken into account. The administrator with better technical computing skills and hardware created the images for the proposal. The researcher analysed the tapes and pointed out the needs and opinions to be put into the proposal. For example, where and in which order the fields of the metadata in the frame should be. Team working in practise meant discussions for and against items. The overall responsibility of the proposal was on the researcher.

1.2 The baseline

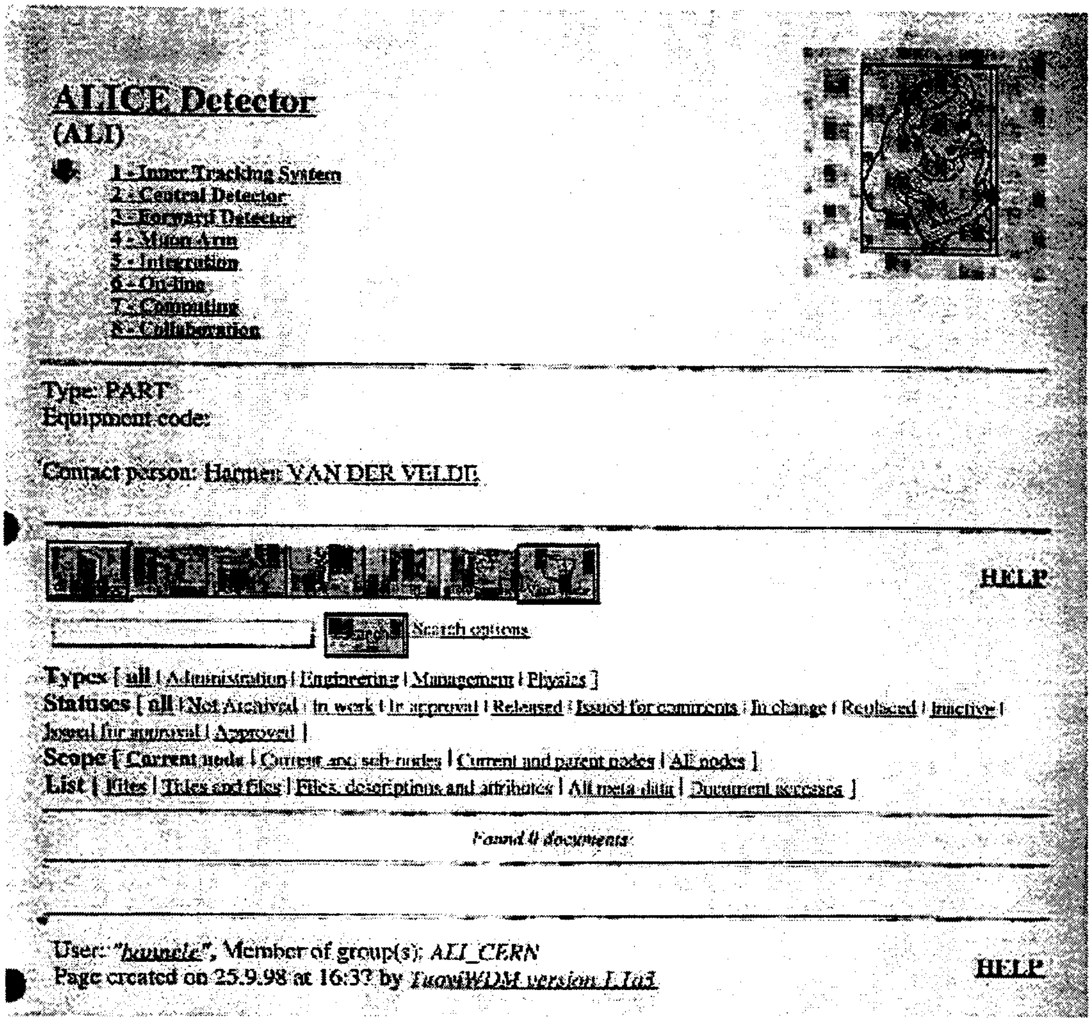


Figure 1. A baseline of the ALICE page from September 1998.

The state and the settings of the TuoviWDM/EDMS interface baseline for ALICE detector is given to clarify the starting point of the ALICE-EDMS project. The interface of TuoviWDM/EDMS was studied in two sections. At first the structure and then the right or content page. The document metadata was treated in division to identification scheme, document types, and file formats. Document approval process, document life cycles and statuses, and user groups and access rights, configuration management, version management for documents, and change notification policy were also treated.

1.3 Presentations of the proposal

The proposal of the TuoviWDM/EDMS interface was presented orally with paper copies of created transparencies to the responsible person of the Tuovi development team on 25th November 1998. The mutual presentation did cause problems. It is not easy to transform oral expression into user needs and development initiatives. Speech may be so flexible form of expression that the common understanding may not be the same. This could have avoided if the proposal was made both in writing and orally. It might have been easier to make a distinction between at that time current outlook if it had been presented with the proposal outlook side by side, previous and new. Documentation of the proposal was not made in detail at that time. An example of an ancient paper printout after scanning can be seen in Figure 1. Processing of a bad paper copy does not get the quality of the image to get better.

2. THE PROPOSAL OF THE INTERFACE FOR ALICE

2.1 The new ALICE document page

The ALICE interface proposal consisted of ALICE document page, the search, and the outlook and functionality of the interface shown in Figure 2. ALICE document page was suggested to be outside the TuoviWDM/EDMS system on ALICE's web page. The ALICE document page would present the concepts of the ALICE EDMS system. This was needed because the term document is used as a comparison to a folder or a container. On this ALICE document page there would be three choices: to search, to submit a document with a Java version or with a light version meaning that no frames are used. This possibility to choose between technically heavy or light possibilities was caused by the old technical hardware in some distant participating institutes. On ALICE document page there would be links to the general help, ALICE EDMS tutorial and to the table of acronyms.

The search pages would include the simple and the advanced search to enable the basic functions in as simplified manner as possible. Complicated actions would be minimised or simplified to the extreme that an end user does not get confused and the search was considered to be among the most used functions. The search could be guided with pre-programmed buttons that the new system could work about the same way than the search on the ALICE's web pages. This means for example that all internal notes could be reached with only a one click of a button or by document name, author, document identification number of by keyword.

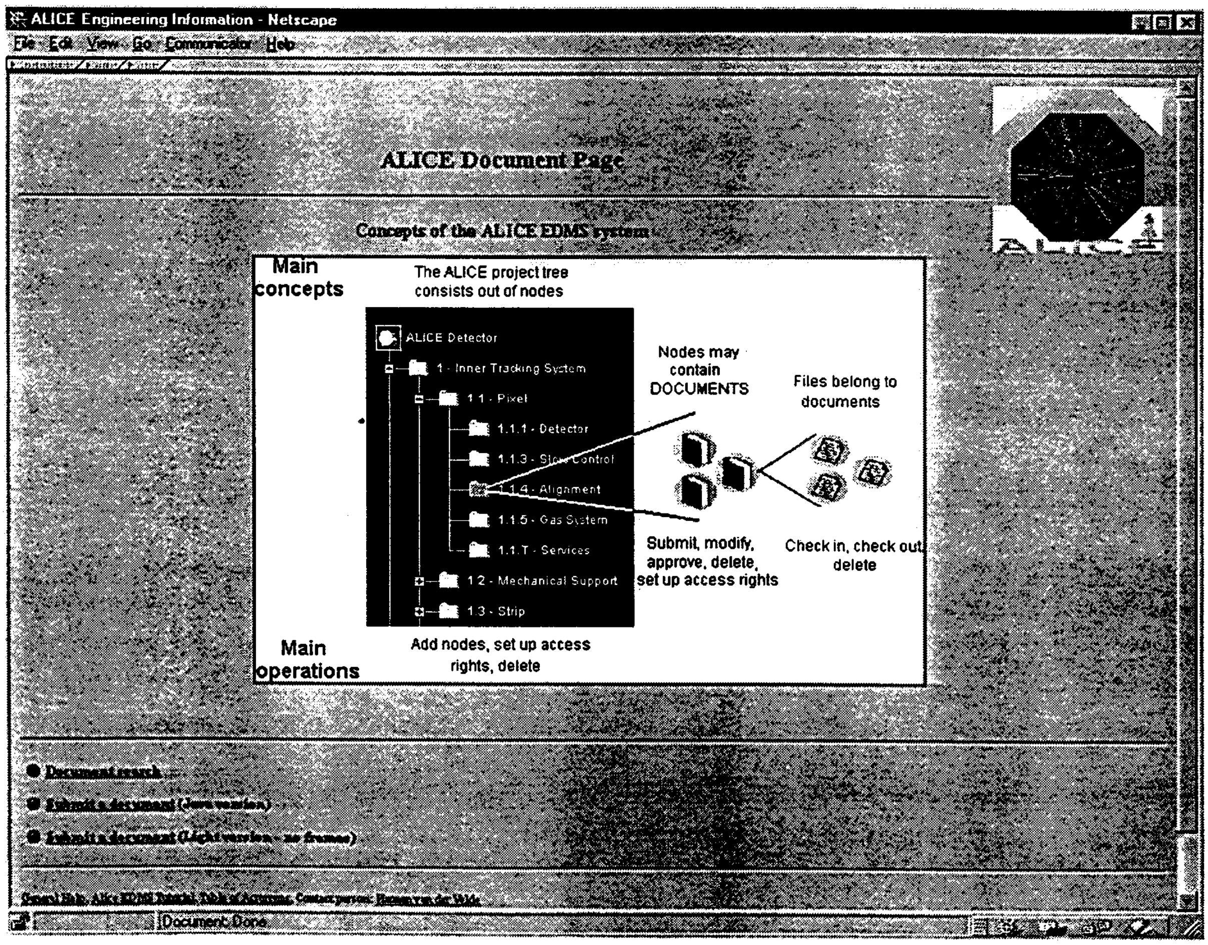


Figure 2. The proposed ALICE Document Page.

It must be kept in mind that in TuoviWDM the term document is used as a or a container, not in the meaning of a file, see Figure 2. A file belongs to one document and a document has a metadata of its own.

2.2 ALICE Project structure in the EDMS

Product structure consisted at the starting point of 141 nodes. It had been decided to have only three hierarchical levels. There were strict recommendations at that time to use pure product structure. Anyhow there was a constant question of one participant in the group: "Where do I put my minutes?" In the early stages of the project, complete definition of the product (or project) breakdown structure (PBS) is impossible, and it tends to evolve over time. Experience has shown that the first PBS heads for to be outlining project breakdown structure rather than a final product breakdown structure. However, it is extremely vital to define even a rough PBS quickly in the beginning of the project to enable early and disciplined start for the project. As the project progresses the PBS evolves and is finally frozen when the production is started.

In the EDMS the PBS of ALICE project is a tree of sub-systems and project items as its branches (nodes) and documents as its leaves. The PBS is built by breaking down the ALICE project according to its natural decomposition into ALICE Detector. It consists of the natural parts, which are Inner Tracking System, Central Detector, Forward Detector, Muon Arm, Integration, On-line, Computing, and Collaboration.

Project structure of the ALICE EDMS is presented in Figure 3. On the left hand frame is the outlook of the tree from august 1998. The background colour is black. The right hand frame presents the tree from autumn 1999. The proposed background colour was white with resemblance to a paper.

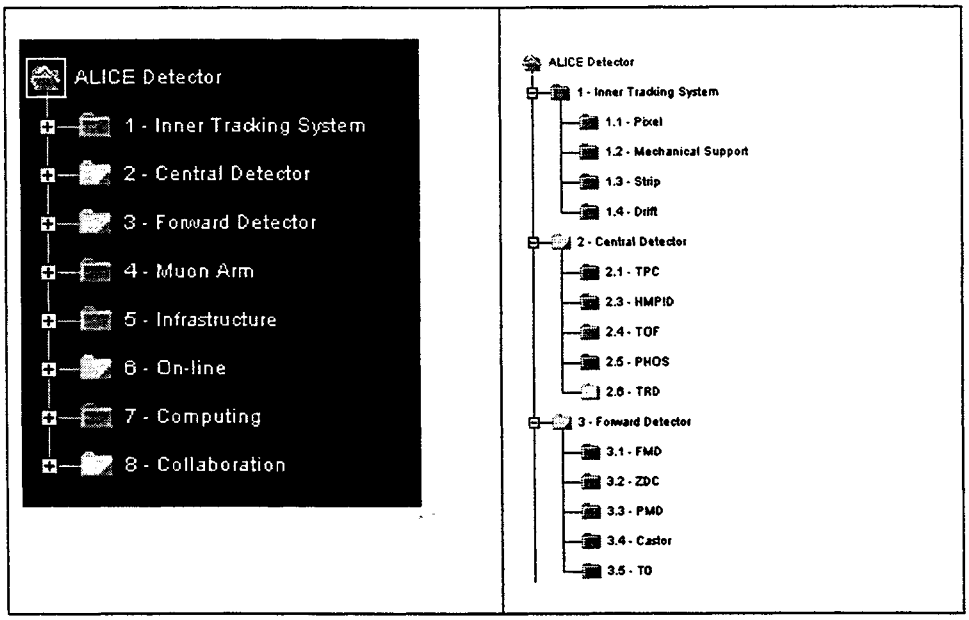


Figure 3. The outlooks of the PBS.

The strict recommendation to use a product breakdown did not take into account the reality of a project because a node for example, for the minutes of the important meetings was missing. The Technical Board documents the agreed changes in its minutes. This practical attitude brought the EDMS TF to consider the need to manage all project-related documents in the same structure. In autumn 1998 this new view was taken into account in the Guidelines for organising document management in a project (Hameri & Lahti 1998). The product breakdown structure for ALICE was shaped to enable also minutes and so the structure became a project breakdown structure. This was important because one perquisite was to have only one structure for the documents. The node 8 -

Collaboration included two sub-nodes. The first was Management and the other Physics. The Management node could include sub-nodes like Administration and nodes for different Board at ALICE.

This resulted to have both product breakdown and project breakdown in a same structure. In Figure 3 the nodes from one to five belong to the product itself and its sub-systems while the nodes from six to eight belong to the project. Anyhow there could be problems to find relevant node to submit a document, which belongs to several sub-systems of the detector.

Documents like schedules, work breakdown structures (WBS), cost breakdown and other documents are stored in a same kind of a structure but in the sub-project called Resources and Planning. In ALICE it is not meaning to extract PBS from the EDMS for that purpose. The Planning system had nothing to do with the EDMS system. Anyhow, it was decided in the ALICE-EDMS group that the structure of the Project Management Planning system should be the same than in the EDMS. The postdoctoral student was responsible for that sub-project management.

Suggestion

Figure 3 expresses the names of the nodes on the left hand and names of the sub-nodes on the right hand frame. The names of the nodes are words with some understandable meaning. The names of the sub-nodes are acronyms. Those are words formed from the initial letters or groups of letters of the word in a name or phrase (Webster 1997). For example the node 2 includes TPC, HMPID, TOF, PHOS, and TRD. This kind of use of acronyms may be very practical when everybody knows what the subject is.

2.1 TPC	Time Projection Chamber
2.2 HMPID	High Momentum Particle Identification Detector
2.3 TOF	Time-Of-Flight
2.4 PHOS	Photon Spectrometer
2.5 TRD	Transition Radiation Detector

It could be more users friendly and clearer if in the end of a line was added also the whole name in complete words. When the user is more familiar to the system and detectors, it would be easy to forget the rest of the lines. A proper and extensive list of acronyms on the ALICE web page or at the CERN page could be one solution. Currently there are some pages but those are out of date and no one is responsible for them.

2.3 Layouts of the proposed views

2.3.1 Overview of the content frame

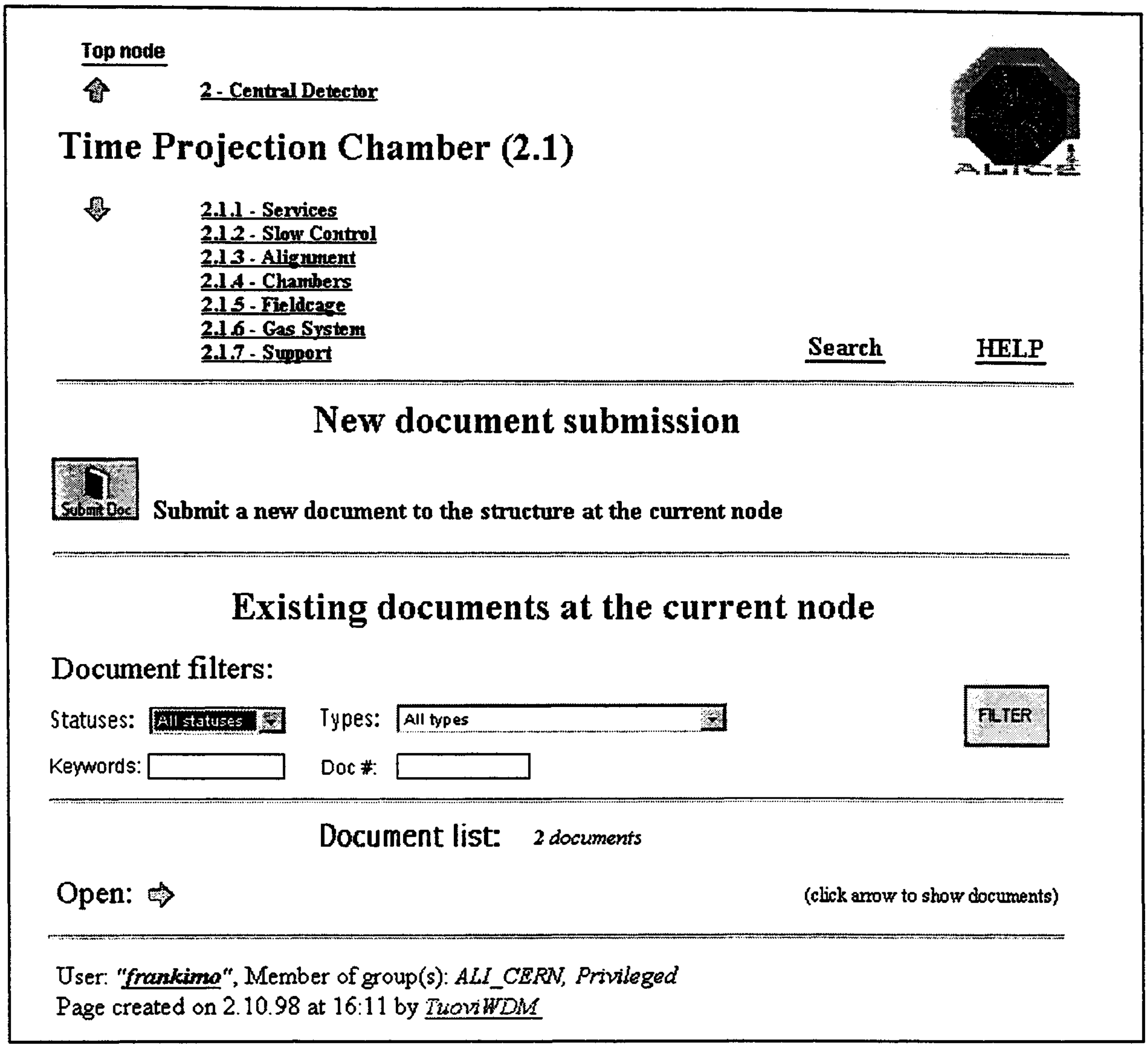


Figure 4. Right frame of TuoviWDM with headers and new layout.

The ALICE logo was new one. Search link was added to the first part besides the help link. Submission of a document got the header to clarify the meaning of the part a part and only one button for submission of a new document. The next part got a header "Existing document at the current node" and the attributes were formulated to document filters to have drop-down menus. The Document list part was to present at first the number of retrieved documents. This to offer to the end user a possibility to reformulate the query if needed to reduce the amount of retrieved documents.

2.3.2 Search pages

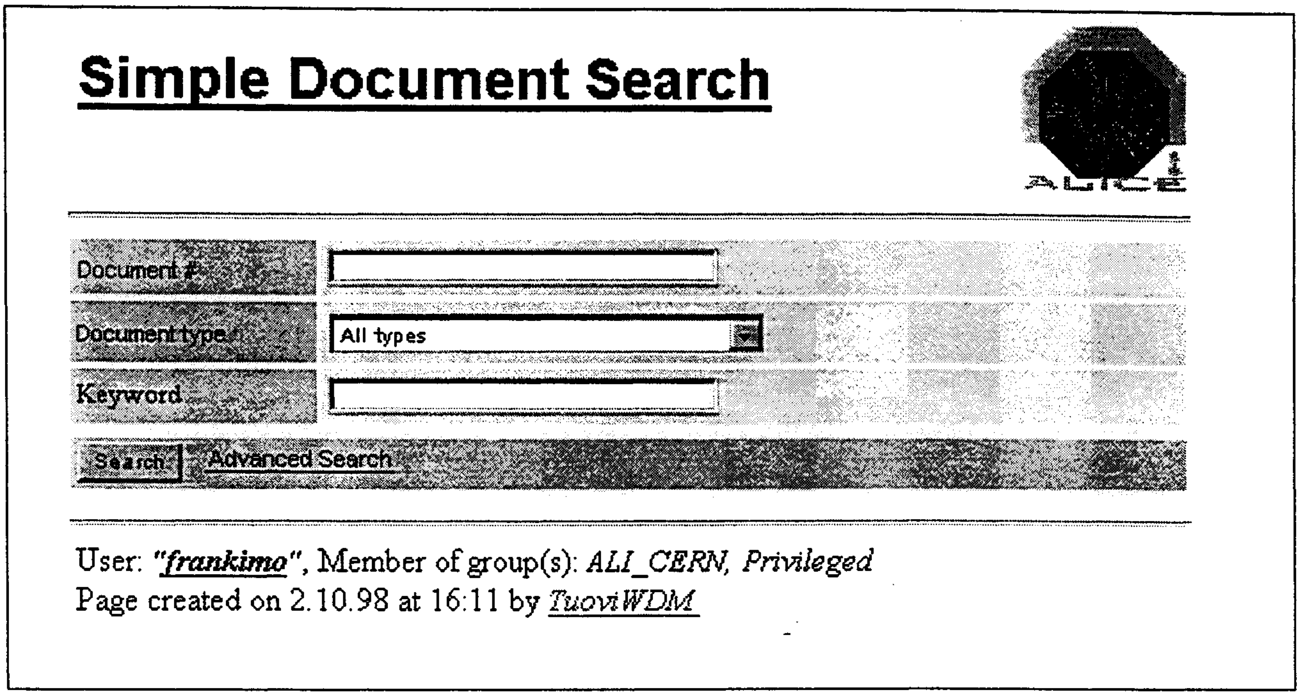


Figure 5. Simple document search in TuoviWDM.

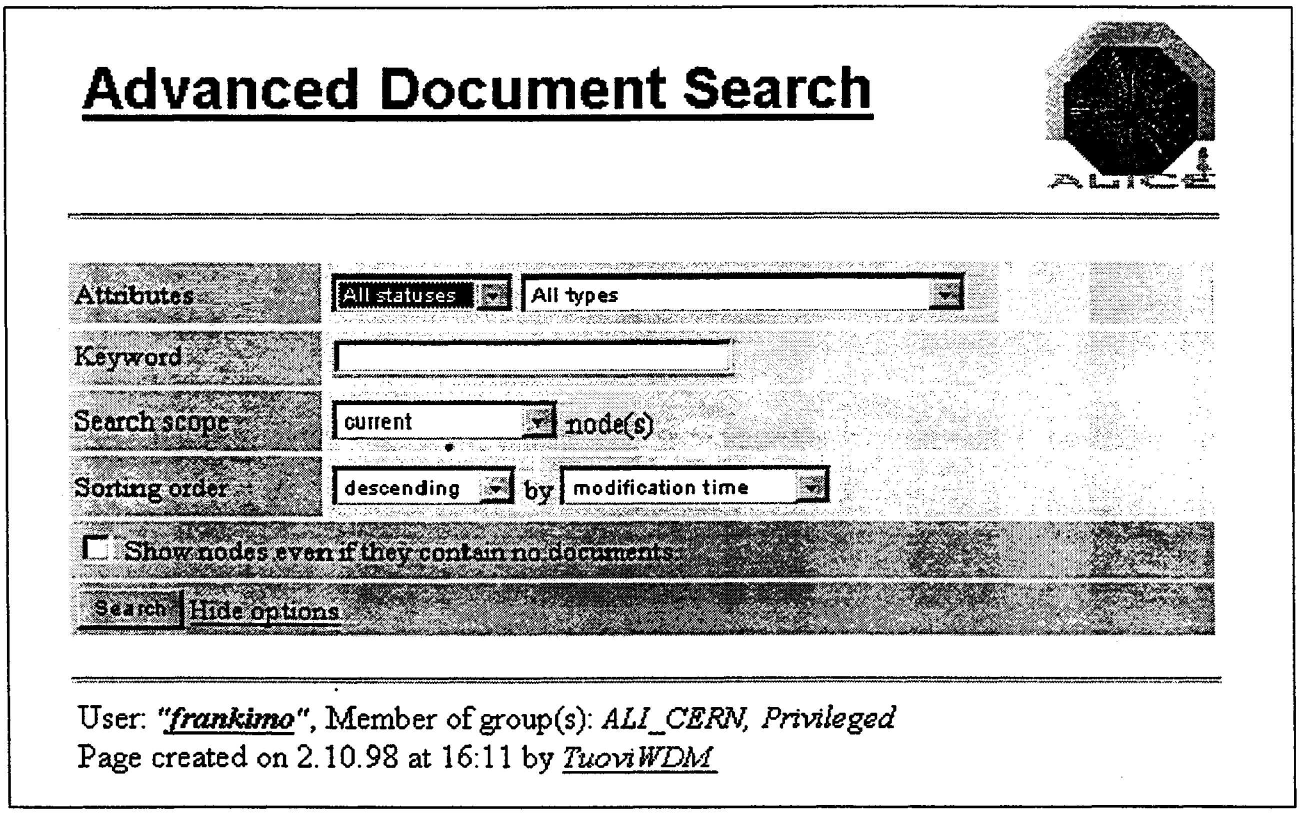


Figure 6. Advanced document Search.

In the baseline, see Figure 1, the field of the third part can be used for keyword searching. In the proposal the simple search got a modified outlook, see Figure 5. The advanced document search page presents the attributes of statuses and types. Also search scope and sorting order could be selected from a drop-down menu, see Figure 6. Both simple and advanced search was to have page of its own.

2.3.3 Metadata views during creation

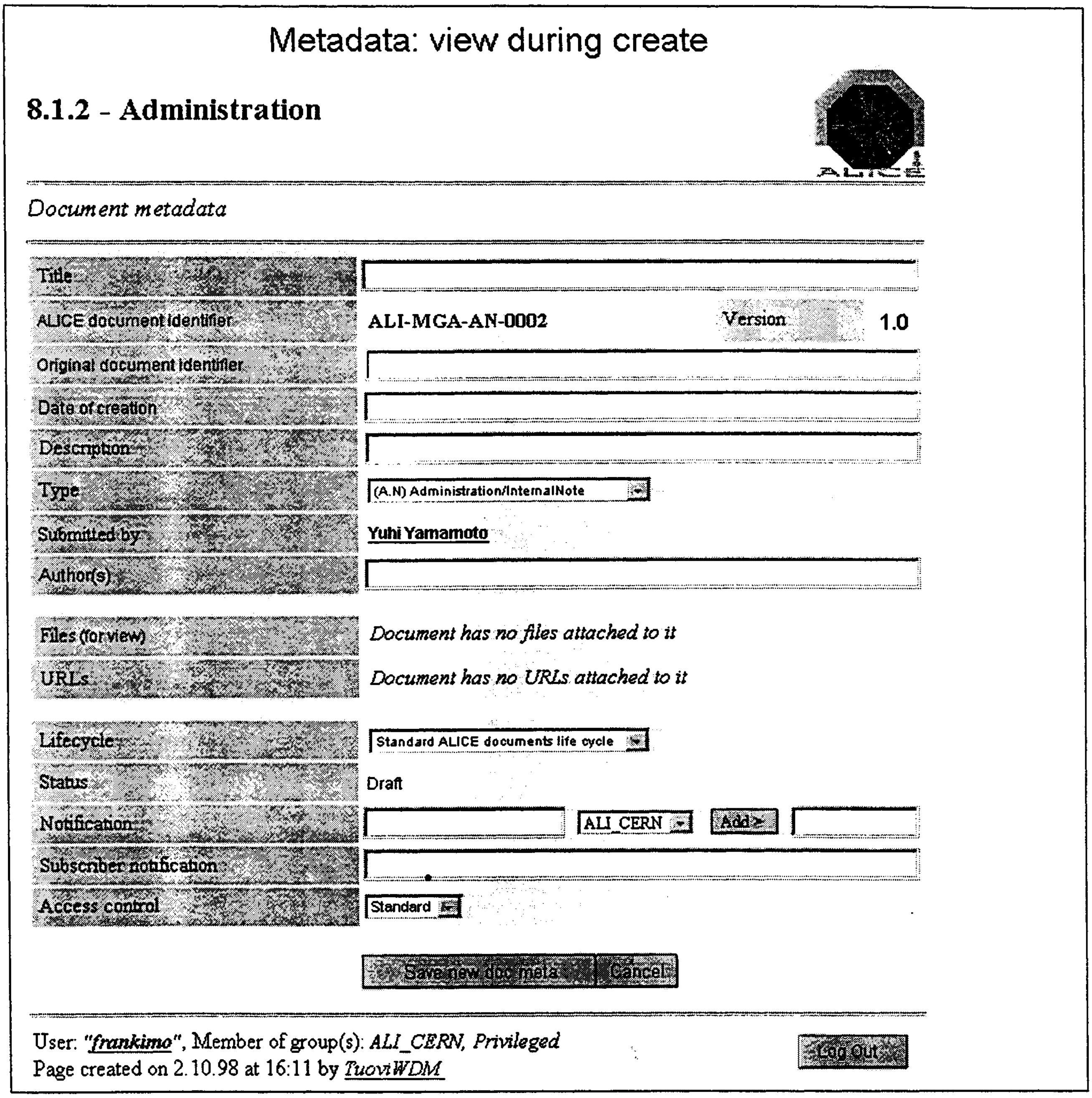


Figure 7. Tuovi document during metadata creation.

Figure 7 presents the general outlook for the document metadata and its fields. The fields would be the same during creation, after saving, and during modification of metadata. The outlook of the field indicates what data could be filled in. For example the second metadata field, ALICE document identifier was not modifiable. It was created automatically by the system identification generator to ensure unique identification number. The visible buttons on the end of the page explicitly were to show which operations were enabled to the user in each phase. The log out button was insisted to exist. This to enable document handling and management of one user through different roles, for example, as an administrator and as an end user.

2.4 Metadata of a Tuovi document

The Tuovi document metadata needed much consideration in the ALICE-EDMS meetings during autumn and winter 1998. Many points had to be taken into account but anyhow to keep things clear and simple for an end user. Such were for example the order of the metadata fields or layout from the end user's point of view. Under consideration was also how clear or self- explaining the titles of the fields should be.

The order of the metadata fields in the baseline and in the proposal is presented in a simplified form in Table 1. It shows that only the fields Title and Version remained on the same place, it is in the beginning. Code was divided into two fields, ALICE document identifier and Original document identifier. The date of creation was relevant to have next. Description was to be lifted from the eleventh field to the fifth field. A user seeks for a document at least according to the description. Author field was removed from a third field to be in the seventh field because the document itself was considered more important than the author of it was. Relevant seemed to be to lift the fields of Files and URLs to be next and so help the user in main operations.

The fields of Life cycle and Status were removed down to meet the Notification and Subscriber notification fields. Access control matrix was not wanted to be visible to an end user. The predefined life cycles would do the same definitions according to the access rights and type of a document.

Table 1. The baseline and the proposed order of metadata fields of a Tuovi document.

The baseline order of fields	The proposed order of fields
Title	Title
Version	Version
Code	ALICE document identifier
Author	Original document identifier
Author email	Date of creation
Created	Description
Modified	Type
Lifecycle	Submitted by
Status	Author
Type	Files
Relevance	URLs
Description	
Files	Lifecycle
URLs	Status
Notification	Notification
Subscriber notification	Subscriber notification
Access control: Document I File	Access control
Owner	
Group	
Others	

The aim of the proposed grouping of metadata fields (see also Figure 7) was to clarify the outlook for an end user. The starting point was the procedure to submit or download a file. The leading idea during the 6 demonstrations was to observe what an end user does as main operations and in what order. The narrative story was an average physicist who wanted to submit a file. This story was very descriptive and offered for example the terms in use in physics.

The metadata of the TuoviWDM/EDMS proposal will be presented in the following order:

- Identification scheme
- Document types

- File formats of a document
- Document life cycle and statuses
- Document approval process
- User groups and access rights
- Configuration
- Version management for documents
- Notification

2.4.1 Document identification scheme

The document identification scheme links documents to the project structure according to unique identification (ID) number. This in order to ensure that the documents can later be retrieved. When a document is submitted into the EDMS system it always gets a unique identification number (EDMS #). That is only a running number without any meaning. This ensures that every document gets a unique number. The numbering convention passed a significant change during the autumn 1998 when the old numbering, which had much inbound meanings, was radically changed. The EDMS TF decided to allow all experiments to run their own file registrations schemes and not intend to have one and only for CERN.

The ALICE identification scheme includes the following metadata fields: a title, ALICE document identifier, version number, and original document identifier. Other fields are date of creation, description, submitted by, and author, see Figure 7.

Some problems were caused because of the three different identification (id) numbers (#), which were obligatory EDMS number, ALICE document identification number given by secretariat, and institute document identifier known by CADIM as External reference number shown in Table 2. Those all were considered to be essential for retrieval and the view of an institute was forgotten from the EDMS view.

Table 2. The different identification numbers.

CADIM	EDMS #	ALICE	EDMS #
	Project #		Secretariat # = Original document id #
	External reference #		Ext. ref. # = Institute id #

For example, at ALICE project the amount of participating institutes is about 120. When an institute creates a document it naturally takes into use an identification number of the institute (Institute #). This id number of the institute must be kept in the metadata to trace the document even with the original institute number. The information technology tools allow searching a document based on the EDMS id number and various document attributes over the whole project structure.

The numbering scheme of ALICE project consisted of format abbreviation ALI, relevant document type in abbreviation, two last figures of the year, and a running number. One example was ALI-INT-98-6. This numbering scheme included meanings and caused trouble for practice and computing. It is worth remembering that the total amount of LHC documents may reach amount of 3 million. In that case the numbering scheme is of great importance if the documents should be identified uniquely, for example in the maintenance phase of the experiment.

2.4.2 Document types

The document types are used for separating different types of documents. The type defines also which approval process and lifecycle policy is needed for the document. In the daily use of the EDMS the document type is a practical way to search for documents. The document type is derived from the functional needs of the project, not from the applications used for creating them.

The document types at ALICE and in TuoviWDM/EDMS

Main document types in the beginning of TuoviWDM/EDMS were administration, engineering, management, and physics with a hidden document type of CDD shown in Table 3 with the sub-categories. These are the basic document types offered by TuoviWDM but those can be configured according to project needs. The CDD was needed to enable plotting of drawings at CERN. There is no other possibility to plot than to submit a drawing in to the CDD system and plot via it. There were about 20 drawings with the type CDD.

Internal note was (INT) written by the author(s) and submitted to Physics Coordinator for approval. Once he had approved the document, he informed both the author and the secretary and she gave the INT ALICE number (e.g. ALI-INT-98-40). The secretary asked the author to provide her with a file of the note, which was transferred to the web.

Minutes (MIN) was a category for all minutes of meetings. For example, workflow of a Meeting of Management Board (MB) proceeds in different phases. At first the MB meeting is held and decisions made. The secretary of the meeting writes the minutes and sent it for comments and approval to spokesperson and participants of the MB meeting. There was discussion in emails as long as the common agreement of the decisions on writing was found. These negotiations were very few but sometimes needed. After the informal agreement the minutes were submitted for formal approval by spokesperson. The document became approved and was given to the secretariat, which transformed it to the ALICE web. The document came visible to the relevant people according to the access rights. Examples of the most important minutes of the meetings are Collaboration Board, Management Board, Technical Board, chaired by Technical Coordinator, and Physics Board, chaired by the Physics Coordinator. This was very general description of the process for minutes of a meeting and suited most of the meetings of ALICE. For Publications (PUB) the process was the same as above, except that approval had from the spokesperson before the publication is presented at a conference.

Table 3. Document types in TuoviWDM and at ALICE.

Document types in TuoviWDM	Document types at ALICE	
(A) Administration	INT	Internal Note
(A.C) Administration/Contract	MIN	Minutes of the meetings
(A.M) Administration/Minutes	AW	ALICE Week presentation
(A.N) Administration/InternalNote	PUB	Publication
(A.S) Administration/Slides	DOC	Official Document
(E) Engineering		
(E.D) Engineering/Drawing		
(E.M) Engineering/Minutes		
(E.N) Engineering/InternalNote		
(E.P) Engineering/Publication		
(M) Management		
(M.M) Management/Minutes		
(M.N) Management/InternalNote		
(M.O) Management/OfficialDocument		
(M.S) Management/Slides		
(P) Physics		
(P.M) Physics/Minutes		
(P.N) Physics/InternalNote		
(P.P) Physics/Publication		
(P.S) Physics/Slides		

Alice weeks (AW) - slightly different category as these are the slides from the presentations given during ALICE Weeks. The secretary collected both paper copies of the slides and computer files when available. Then the documents were transferred to the web. There was no approval system for this category. The ALICE Weeks are arranged 4 times a year. During the week will be held plenary sessions and other presentations. So these weeks are important in order to let the other participants on the ALICE project and its sub-projects know what is the state of the progress. The material of these presentations is collected after the week and it is needed to ask for it from 4 to 5 times while 70% replies and sends the material presented.

Official documents (DOC) were the category for official documents, right at the beginning of ALICE. However, these official documents are usually now produced as minutes or Internal Notes. The approval system would be submission to the spokesperson and approval by him before publication on the web. The Electronic Document Handling (EDH) system at CERN will not be used in the future. So far, there are no contracts or tenders involving ALICE and very limited amount of confidential papers.

The combination of different types in each category is shown in Table 4. For example, one combination included different types of minutes of a meeting and management.

Table 4. The combinations of document types.

	Minutes	Internal Note	Slide	Publication	Contract	Drawing	Official Document
Administration	X	X	X		X		
Engineering	X	X		X		X	
Management	X	X	X				X
Physics	X	X	X	X			
CDD						X	

The secretariat had in use types internal note, minutes, ALICE week presentation, publication, and official document, which were derived from the functional needs of the ALICE project from the beginning in 1991. Those were considered to be more relevant to the end user than the other classification. The change form TuoviWDM'document types to document types used by secretariat was implemented into the TuoviWDM/EDMS during the test setup at secretariat in July 1999.

2.4.3 File formats of a Tuovi document

The formats in web application are HyperText Markup Language (HTML) and PostScript (PS). The original MS Word file is not transposed in to the application. The files were distributed on the web pages where the natural format is HTML. The relevant files in original file formats were saved by the secretariat, which took care of the ALICE web page.

The problem is that different software applications use several different file formats. The native formats are often incompatible with the other software applications. The standardised official file formats of the project guarantee that documents can be distributed between the users via WWW and that those are accessible through out the collaboration. In the EDMS there were commonly suggested formats for files so that access to documents would be assured even in the long run of time. The ALICE-EDMS project established a policy on universal file formats to support fluent communication and long-term access to the information.

File formats available are so numerous that some principles were to be defined. In the EDMS there were commonly suggested formats for files so that access to files would be assured even in the long run of time. The native version has to be stored to ensure that the file can be changed if needed. Thus, there is a need for creating different file formats for different purposes. The needed formats depend on the Tuovi document types and needs of the project. The recommended formats were:

- Native format, always, whatever it might be.

- Printable formats, such as PostScript.
- Viewable formats, such as HTML, PDF or HPGL.

The most common software tool used at CERN for office and administrative documents is MS-Word. For scientific documents it is Latex, for engineering drawings made by CAD/CAM programs as Euclid, it is HPGL.

2.4.4 Tuovi document life cycle and statuses

Document status indicates the succeeding phases during its dedicated life cycle as shown in Figure 8. A life cycle is a part of the release procedure, which defines who, has the rights to promote the document from one status to another or demotes it back to preceding status in the lifecycle. In the standard life cycle model the user has normal access rights.

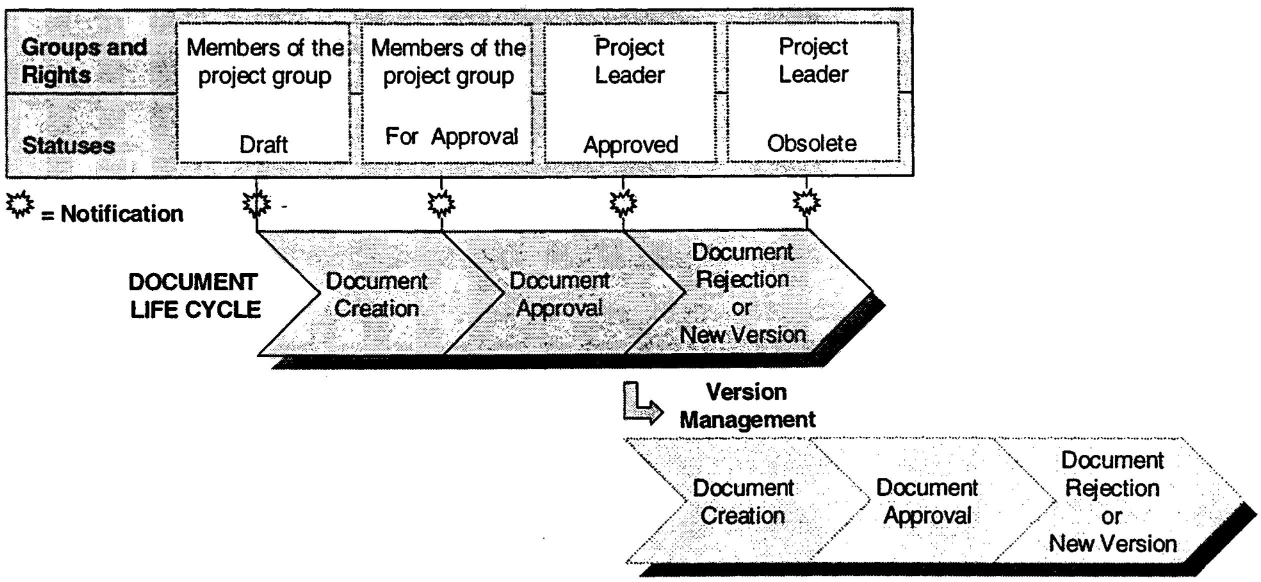


Figure 8. An example of the document life cycle and approval process. Modified from Hameri & Lahti 1998.

The first step for creating a document is to create a document as an empty container or a folder with the metadata needed. The first status of a document is defined to be 'Draft'. Then a user has to attach all relevant files to the document. A project leader of the participating institute puts forward or submits a document for approval, this means promoting the status from 'Draft' to 'For Approval'.

Table 5. The first and the defined statuses.

The previous statuses	The defined new statuses
• In work • In approval • Released • In change • Replaced • Inactive	• Draft • For Approval • Approved • In Change • Obsolete

2.4.5 Document approval process

The document approval process is a part of the release procedure. It is to make sure that each document passes through a formal approval process before other documents based on it are created. All documents have to go through approval process because documents, which are not approved, will not be seen.

The approval process may vary according to the document type. The approval process has to be 1) **released** for unofficial documents, like notes and memos and 2) **strict** for drawings and contracts. Drawings and contracts have to be approved because of the nature and importance of documents. The document approval process has an effect on several EDMS parameters. Among those are:

- Document statuses
- User groups and user access rights
- Versioning

The participating institute of ALICE project may use their own approval procedure to the degree that the item does not interfere interfaces among other institutes. In every institute the project leader is the responsible person to submit for approval. At the moment ALICE Project has only one approval procedure but for example restricted documents need another approval procedure to be created. The suggestion for general approval process in the EDMS was accepted in ALICE-EDMS group. ALICE wanted to use suitable terms according to physics domain. This modification to the model was to change the terms and those were implemented for ALICE in the release of December 1998.

The approver is a person having relevant access right to change the status from 'For approval' to be 'Approved'. The approval rights can be connected to the technical roles of the project participants. If the change has an impact on the product design, it has to go through the Technical Board acceptance process. The right to do status change depends of the working group, which the person belongs to. According to the roles of the group, the rights to make different transactions differ. Document statuses in the beginning of the DM project are shown in table 5 on the left-hand frame and the statuses from December 1998 release on the right hand frame.

Possible actions proceeding status 'Approved' are 'Obsolete' or 'Draft' again because an approved document cannot have changes without being a new version. The order of statuses in this phase stems from the archival principles at CERN in order to keep track of the document versioning. Versioning will be explained later.

In the DM project there were discussions of the meaning and usage of words. For example, expression 'In work' was considered to be wrong because the term in common use among physicists is 'Draft'. When the document was ready to be approved, the status had to be promoted into the status 'For Approval'. After that the following status was 'Approved'. Possible actions preceding this status change were 'Obsolete' or 'Draft'. In order not to confuse the end user, who just wants to use the TuoviWDM/EDMS system as a tool, all exceptional usage of terms was considered to be avoided as far as possible.

This simplified document approval process was considered to be relevant for ALICE use. The other automated approval processes seemed to be too complicated and so useless. At ALICE the purpose of the system is not as a workplace but to submit ready documents into the EDMS system.

2.4.6 User groups and access rights

Access rights are used for restricting access to the system. In general, strict access right policy tends to cause extra work for the project participants and system administrators and hinders information flow in a project. The more loose policy the project can have the better the EDMS system can serve users. Anyhow the restricted documents and large access rights demand to use required safety procedures like authentication and authorisation.

The user groups of the TuoviWDM/EDMS system are related to the working groups of the project. A common way of enabling better maintenance was to define roles for the project participants. Instead of associating document promotion right to a certain person the right was to tie it to the organisational status of that person. If the person was replaced with another person during the project, it was not necessary to search all documents and nodes of the project but it was enough to update only the role. This approach took notice of the scale and nature of ALICE collaboration.

Approval rights were given to a limited amount of persons. The approver may approve documents in the same group with different rights while the role of the approver determines the rights. The basic approach of access rights in ALICE was confidence in people. The spokesperson would treat the misuse of these rights.

The access rights include the possibility of a guest user among other user rights as shown in Table 6. One example of the approach in the development work is that what you see you can use it. This meant that when the user according to the access rights received a document, it was not proper that such buttons of functions were shown, which anyhow were not enabled to that user. It was more than misleading to see a button with a text 'Delete file' if one could not according to the lack of access rights do that. The guest users have the minimum of access rights but the guest users are preferred because that is compatible to the common public policy of CERN.

Table 6. Access control matrix for ALICE Project

ALICE group	Grade	Normal documents				Restricted documents		
		Only Search & Read approved documents	Subscribe to notification, modification, etc.	Submit & Modify, Search & Read draft documents	Approval	Search & Read	Submit & Modify	Approval
World as guest	1	Yes	-	-	-	-	-	-
Registered ALICE users	2	Yes	Yes	-	-	-	-	-
Creators	3	Yes	Yes	Yes	-	Yes	Yes	-
Approvers	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Administrators	5	Yes	Yes	Yes	-	Yes	Yes	-

In the first phase there were four groups: World, All ALICE users, Creators and Approvers. This division did forget the restricted and confidential. Later it was realised that also the groups and access rights for all users including administration have to be defined. The aim was to create complete understanding whom and with which rights uses the system. One forgotten viewpoint was archiving. If the life cycle of a detector is to be about 20 years, it is needed to have a role in which it is possible to search and retrieve documents but not to modify them without being the administrator of the system.

2.4.7 Version management for documents

Document versioning is used to keep track of the document changes as it evolves. The version management policy defines when a new document version or even a new document should be created. Common practise is that an approved document cannot be demoted back to a draft state but that a new document version has to be created and approved. Version management is needed to ensure the availability of up-to-date information. A new document will be created to serve as a container for new files, which belong together. For example, project minutes should be stored in separate documents but the written memo and the presented slides of the same meeting should be in the same document.

A new Tuovi document version is going to be created when a major change in the file is needed. Major changes are all changes, which involve the interfaces between two or more sub-projects. Minor change of a file does not conclude for a new version. The owner of a file has the right to make minor corrections like spelling error or a less important change of the file. A major and minor change is seen from the version. A major change upgrades the first figure and major change the figure after dot. For example if there is just minor change 1.2 becomes 1.3 and if there is a major change 1.2 becomes 2.0.

The difference of a minor and major change can be difficult to find. For example, to change a one character of a number in a file can be problematic. The importance of the change has to be evaluated according to the environment where the number exists. If the number is for a date and clear misspelling, it could be a minor change without new approval process. If the number is in an excel sheet of a cost estimate, it might be a major change. The responsibility of the evaluation between major and minor version is on the owner of the file as long as there are not defined principles to follow.

2.4.8 Change notification

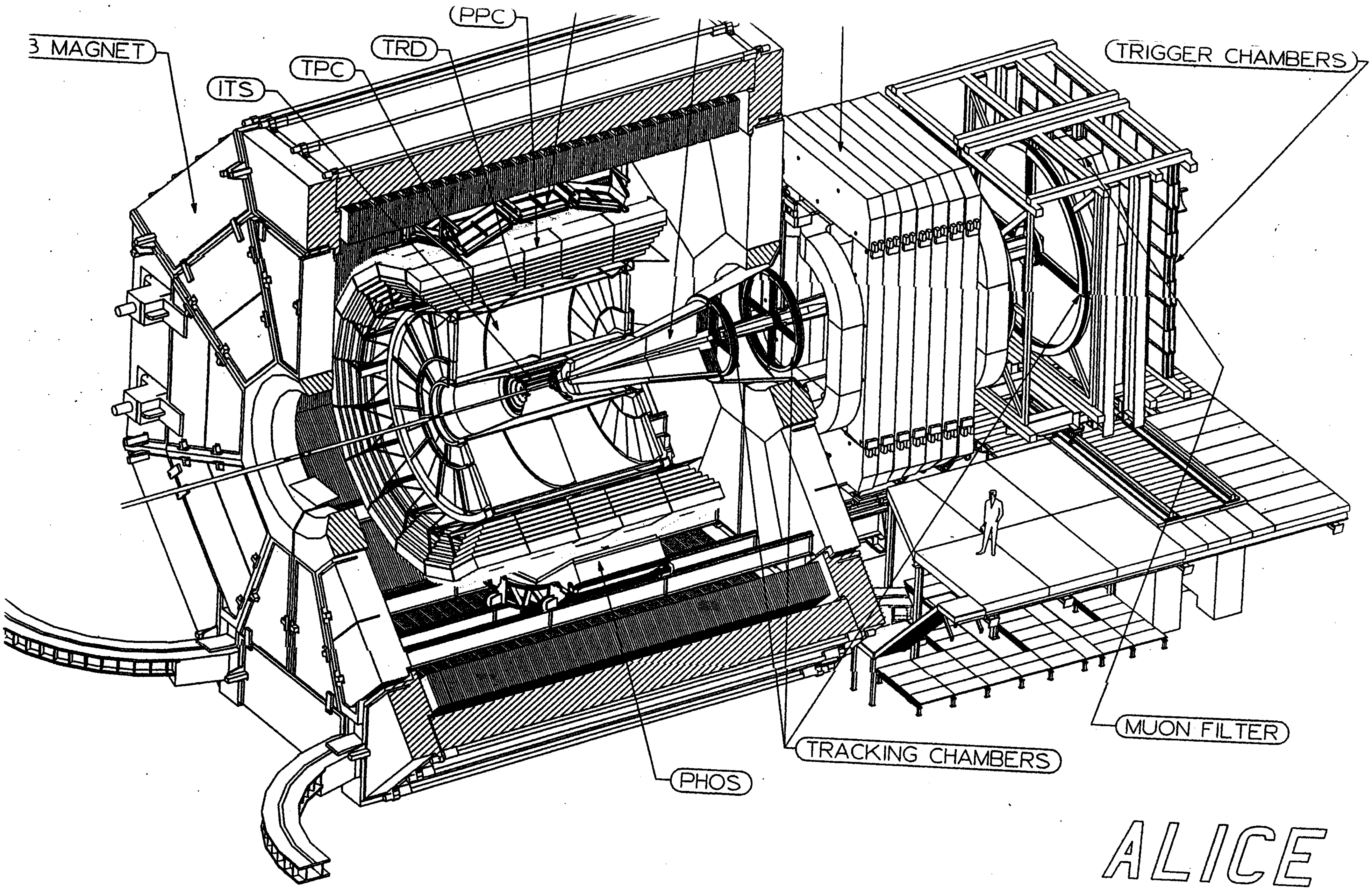
In a large and distributed project like ALICE, changes have to be properly communicated to avoid conflicts and misunderstandings between project participants. The change notification policy is needed to define the rules for the use of change notifications. Notifications may lose their meaning if used too much. Only urgent messages should be sent immediately, while minor changes should be grouped and distributed periodically.

With manual notifications the creator of the document sends the notification to known persons or to the mailing list of the relevant group. The manual subscriptions of a document creation and change are going to be replaced by automatic EDMS notifications when the system is mature enough.

3. CONFIGURATION MANAGEMENT

The Technical Board, consisting of project leaders, is responsible for approving the product configuration and controlling design changes. The board ensures that the proposed changes do not violate interfaces between the different subsystems. It also makes sure that the impacts of the proposed change are properly analysed before accepting it and informs project participants. The requests for changes are submitted via Engineering & Integration Coordinator. At ALICE there will be large emphasis on people's responsibilities. This means that the change requests will be documented in the Minutes of Technical Board Meetings, which should keep the meetings once a week. In the ALICE case the TuoviWDM/EDMS system is thus not meant to be used to manage changes in the product, it is configuration management.

Anyhow there should be defined some rules and regulations how the requests for change are manually going to be processed in order to manage the changes and their history properly. A common form on a template would be needed to include all relevant items as fields. This could avoid unnecessary requests and make the relevant ones more considered before submitting them. The request for a change could be available in the TuoviWDM/EDMS and no empty fields would be accepted before submitting the request. There should be a person nominated as the EDMS project co-ordinator to maintain and support the TuoviWDM/EDMS system and its services as the project evolves.


3 MAGNET
ITS
TPC
TRD
PPC
TRIGGER CHAMBERS
MUON FILTER
TRACKING CHAMBERS
PHOS

ALICE