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# Extended World Wide Web support for software development projects

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## Abstract

Software-development projects produce a huge variety of highly interconnected design documents. Serving as working material these documents need to be continuously actualized and revised. Using the World Wide Web (WWW) as an infrastructure for maintaining this document space can increase substantially cooperation, information retrieval and end-user participation. Nevertheless, practical usage for both setting up and opening up the document space requires additional tool support. This is the subject of the article. It presents concepts and tools for cooperative work on and navigation support through the document space elaborated in the context of a cooperation project with a hospital. The article closes providing a first evaluation of their usage.

**Keywords:** WWW, cooperation, documentation, information retrieval, software development projects

## Introduction

It is well known that in software development projects a huge variety of highly connected documents needs to be maintained. Numerous people are involved in writing and working with these documents. Due to the simple and wide-spread use of the World Wide Web (WWW) for presenting documents and supporting information retrieval it seems natural to exploit WWW technology for documentation purpose in software development projects.

The benefits - also apparent in several teaching projects of the Software Engineering Group of the University of Hamburg where the WWW was used as a medium for both storing and representing the documentation of software development projects - are obvious. In comparison to traditional methods of storing project documentation e.g. in a file the permanent availability of all distributed documents in the WWW is clearly an improvement in quality. Besides, the topicality and the completeness of all documents is essential for the work in a project where a number of persons work with each other and on the same documents. Since the interdependence of the design documents the hypertext-structured documents of the WWW result in a fine support of document's relationships (see [12]). Additionally, for teams having to cope with heterogeneous work settings

the platform-independent concept of the WWW makes it easy even to involve end-users in the design process if the required technology is present.

Therefore, while starting a new cooperation project with a hospital a WWW group for accompanying the project from its start was established. The subject of the cooperation project was to support the decision finding process of a hospital regarding the development and/or selection respectively of an integrated Hospital Information System (HIS).

The method used in the context of the cooperation project is founded on the tradition of evolutionary system development, in particular STEPS (Software Technology for Evolutionary Participative Systems development) (see [7], [8]) and the Tools&Materials approach (see [2], [15]). The emphasis and aims of these approaches lie in evolutionary software development, based on a cyclical process model, in the support of participative communication and learning process for the developers and users alike. This is achieved in explicitly using documents as working material during analysis and design. Documentation purposes are secondary. It implies that documents are shared among teams and are constantly undergoing well-defined feedback cycles. Due to an emphasis on participation it requires document-types which are easily understandable for users and it assumes access of users to actual documents.

Nevertheless, besides the above mentioned obvious benefits of using the WWW technology for maintaining document spaces drawbacks are also well-known. They concern the lack of improved tools for setting up as well as opening up the document space. In the context of a specific design method a need for specific tools and new concepts arises.

Working on these tools and concepts was the task of the WWW group. Its results and tools are described in this paper. They provide basic and method-specific support for setting up and opening up the document space.

Two different WWW extensions are distinguished. The first one dealing with improved WWW-Server maintenance and cooperation support is described after the next section. Following the second extension concerning navigational aids and project specific entry points to the document space is presented. Finally, the gained experiences from that concrete project are reflected.

As the examples in these sections concerning the requirements analysis are taken from the cooperation project with the hospital, first we want to give a short scenario of this project.

## The Project Scenario

The subject of the cooperation project is to support the decision finding process of a hospital regarding the development and/or selection respectively of an integrated Hospital Information System (HIS) in the clinical sections and planning the configuration and use of this HIS in the light of changing demands. The cooperation partner is a small acute care hospital with 230 beds and 560 employees. The assignment of the project is embedded in the organizational development in the hospital which is taking place with the participation of all groups of employees from the different departments: internal medicine, surgery, anesthesiology, nursing staff, administration, maintenance/technical support. These will be the future users of the system. The involvement of the users in the development and/or selection of the system is presumed and supported methodically.

The course of the project was planned in four partly activities, each of them concluded by a workshop:

- the *task oriented analysis* of the work practice by means of interviews and group discussions on the basis of scenarios and glossaries;
- the *requirements specification* based on system visions with consideration to the required organizational development and the existing hard- and software systems;
- the *market analysis* of the available software systems with regards to adaptability, extendibility, usability and data security. In the context of this activity pilot systems are to be used and evaluated;
- the *decision process* whether a cooperation with potential software producers is wanted and if so in what frame. The cooperation may either consist of the adaptation and integration of package software or of a customized solution for the hospital.

A period of nine months was estimated for the project.

# Extensions for cooperatively setting up the document space

In this section our extensions to the functionality of the WWW are shown. As discussed above the WWW is used for both storing and representing design documents. Therefore, we have to add improved functionality for making documents available to a WWW-Server and for supporting cooperative work on these documents. The techniques and concepts developed will be described in the next two subsections.

## Basic Functionality

A basic problem in distributing common software design documents using the WWW is making them available to a WWW-Server. The concepts of the WWW only allow representing given material via browser. There is no standard software to extend the amount of documents on a server by means of the browser.

To solve this lack of software we created a software system called *web(man)ager* which allows the distribution of several different document formats such as HTML, GIF, MPEG, etc. on a WWW-Server directly via browser (see [5]). This means that the software is running on the server platform while user interface and interaction are settled on client side accessible from every browser-supported platform. Based on this program it is possible to add, update, rename and delete documents. Even making small changes to documents written in the Hypertext Markup Language (HTML) is supported using a simple editor displayed by the browser.

Additionally, all changes on documents are recorded by an underlying version control system so that information on both the author and all changes made are available. This information can be combined with the content of the document to visualize its state.

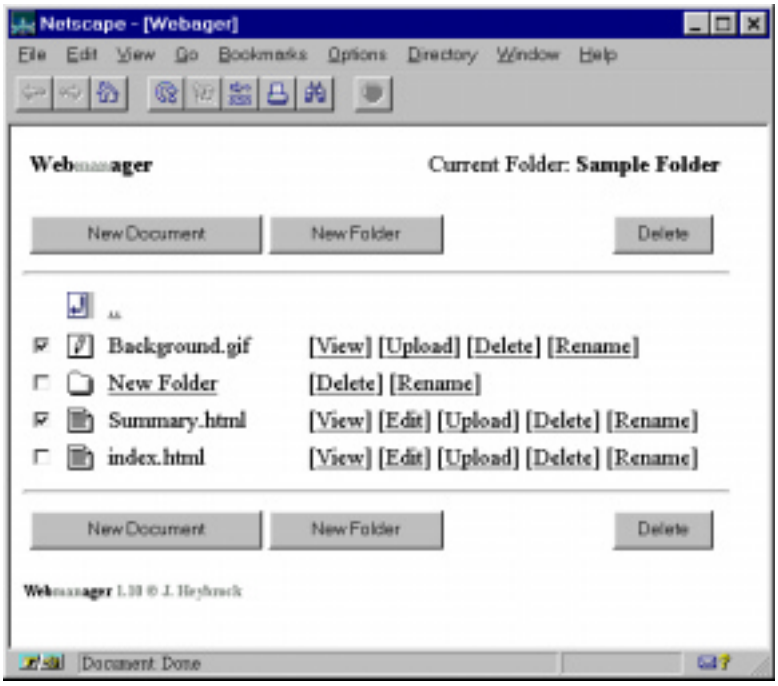


**Figure 1: Web(man)ager**

The user interface of the *web(man)ager* is presented in Figure 1. The program itself is constructed as Common Gateway Interface (CGI) script (see [13]) which is protected by authentication control to avoid abuse.

Providing the *web(man)ager* facilitates a comfortable way of dealing with documents concerning the WWW. This serves as a basis for the concepts concerning cooperative work on these documents presented in the next subsection.

## Coordination Support

To get an idea of the underlying cooperative processes the WWW subgroup evaluated the proceeding of the hospital project team during the requirements analysis. This was done by using the same approach as presented in the introduction i.e. holding interviews with project members of the hospital project, writing scenarios and constructing systemvisions out of these analysis documents. The results of this evaluation lead to a prototype based on the infrastructure provided by the *web(man)ager*.

In the hospital project the members were holding a meeting after each interview carried through with employees of the hospital. In those meetings they extracted a list of scenarios which had to be written. Further an author and a title were assigned to each scenario. To gain an overview this information was fixed on a form called “coordination form“ containing different possible states of the scenarios such as written, checked and revised. By changing a state the corresponding field in the form was marked. Therefore all members could get an idea of the project’s progress. The coordination form is a „shared material" which is used for coordination in the work process (see [16]).

In the process of computerizing this coordination form we paid attention not to change or to lose crucial properties of the material. To achieve this computerization the coordination form is placed in a „shared information space" (see [1]) where project members can find all kind of information and documents dealing with the project. This

shared information space is represented using the WWW and maintained by means of the *web(man)ager*. To implement the coordinative aspects of the coordination form we use two concepts, event mechanism and meta-information.

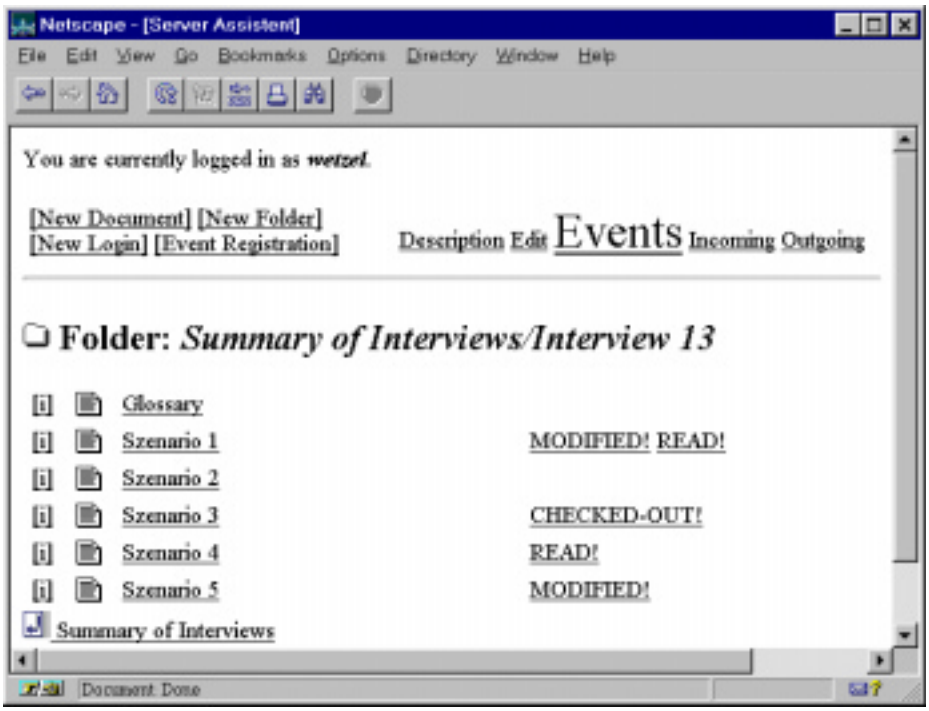


**Figure 2: The event mechanism**

The shared information space is always changing and growing. Awareness is a key mechanism to coordinate and fine-tune cooperative work (see [6]) so there is a need for making changes and activities visible to the users of the system. To accomplish that we apply an event mechanism similar to Fuchs et al. (see [9]). They distinguish two basic types of events: modifications and activities. Modification events result from changes of documents. There are different kinds of changes i.e. a change of content, a change of state or a change of task. Activities describe synchronous events, related to the users in the system. One example is that someone is actually working on a document. The visualization of events offers an orientation about modifications and activities occurring in the information space.

On the other hand meta-information regarding single documents is important for collaborative work on shared documents. All modifications on meta-information result in a corresponding modification event. Meta-information provides more detailed information on a document and defines its state. The following is part of meta-information:

- date of last changes,
- author of last changes,
- remark about last changes,
- version,
- state,
- task, which should be executed on that document,
- author assigned to the task and
- history (all previous events).

By using meta-information project members on the one hand get an impression about the state of the project and on the other hand they can estimate when to expect further actions.

As mentioned before the computerized coordination form is placed in the shared information space and resembled as a special view of the extended folder-oriented user interface provided by the *web(man)ager*. Consequently for every interview a new folder has to be created. Within this folder all scenarios belonging to one interview are included. Besides the introduced basic editing functionality of the *web(man)ager* different views are offered such as an event view. In this view all events which occurred since the last visit of a user are displayed. For example in Figure 2 one can see the different events happened on the scenarios in folder `Interview 13`. The document `Scenario 1` has been modified and read since the last visit.

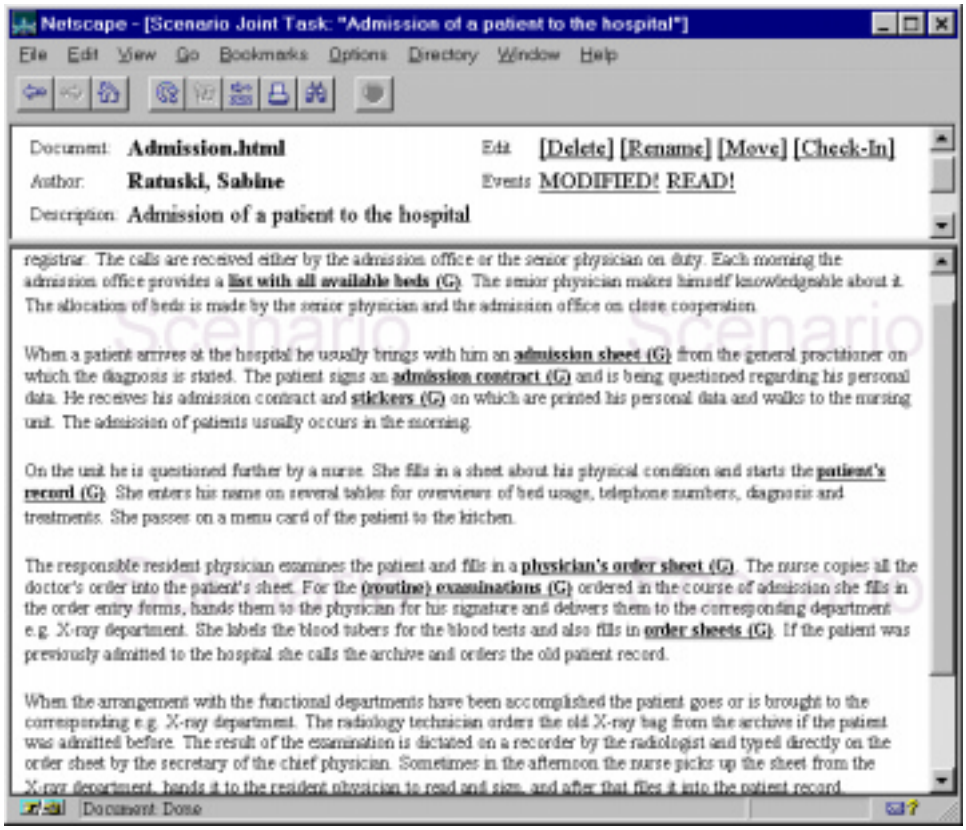


**Figure 3: Scenario with meta-information**

Apart from this Figure 3 shows a combination of both meta-information and content for a single scenario. In the heading a choice of available meta-information, events and basic editing functionality is provided while underneath the pure content of the design document is displayed. Furthermore there is of course the idea of displaying the state of the document either in a textual or graphical representation.

With these concepts and tools the computerization of the coordination form as well as meta-information for coordinating the setting up of a shared information space using the WWW is supported in a suitable manner.

# Extensions for opening up the document space

After introducing methods for setting up a document space we describe in this section the different document-types we worked with, their relations and what kind of extensions we have implemented in order to support an easy opening up of the document space.

## Method-specific documents

For introducing the method-specific documents used during the analysis and design process and the various interrelations between them we briefly summarize the analysis process in the context of the hospital project.

To acquire a profound understanding of the application context 20 qualitative interviews with employees of the hospital were held at the corresponding workplaces. From these interviews scenarios were extracted describing the present way of accomplishing single work tasks including the means and objects of work in the professional language of the users. In addition a glossary containing the technical terminology and the explanations was elaborated. The scenarios were then discussed, again reviewed from the corresponding employee and revised.

Apart from these documents describing the application context design documents such as visions of the later system and prototypes together with other documents from the market analysis were worked out and discussed. These documents base onto each other and are strongly interrelated. For that reason they cannot be regarded as isolated parts but as a whole. In our context a scenario could e.g. reference to an entry in the glossary, to a design document or even to another scenario (see [2])

## Navigation-support for method-specific documents in the WWW

Besides the mentioned benefits using the WWW as medium to store and represent these documents for facilitating access to the documents for all parties we exploit its hypertext character to support the interrelations between the method-specific documents.

Unfortunately, new problems arise from the complexity of the resulting document space especially in gaining orientation within the documents while reading them.

A possible loss of orientation in hypertext has its main reason in limited space on the computer-screen seeing only one document (or even only a part of a document) out of the whole document space at a time while rapidly exchanging the regarded documents.

Since we work with a fixed (still extensible) set of document types one solution to this problem is to exploit the type information of the documents to support orientation. We provide typed documents together with typed links in the following way. We created a unique layout for each document not only stating the type of document in the title but also providing a discreet background with the written-form of the document-type and additional meta-information (see Figure 4).

To prevent the user from losing directions in the hypertext information about what type of document he reaches if he follows a link links are always typed. For that reason we have introduced letters (s: scenario, g: glossary) characterizing the type of a link (see [4]) (see Figure 4). The title of the referenced document can be read if the cursor touches the

link This is realized by internally parsing the referenced documents and retrieving the necessary information.

Instead of using letters for indicating the link-type it is of course possible to use icons. However, the use of icons has its drawbacks. First, icons representing unambiguously the type information need to be found and secondly they can disrupt the reading process. For that reason an option for switching on and off icon-support in navigating hypertexts was offered.

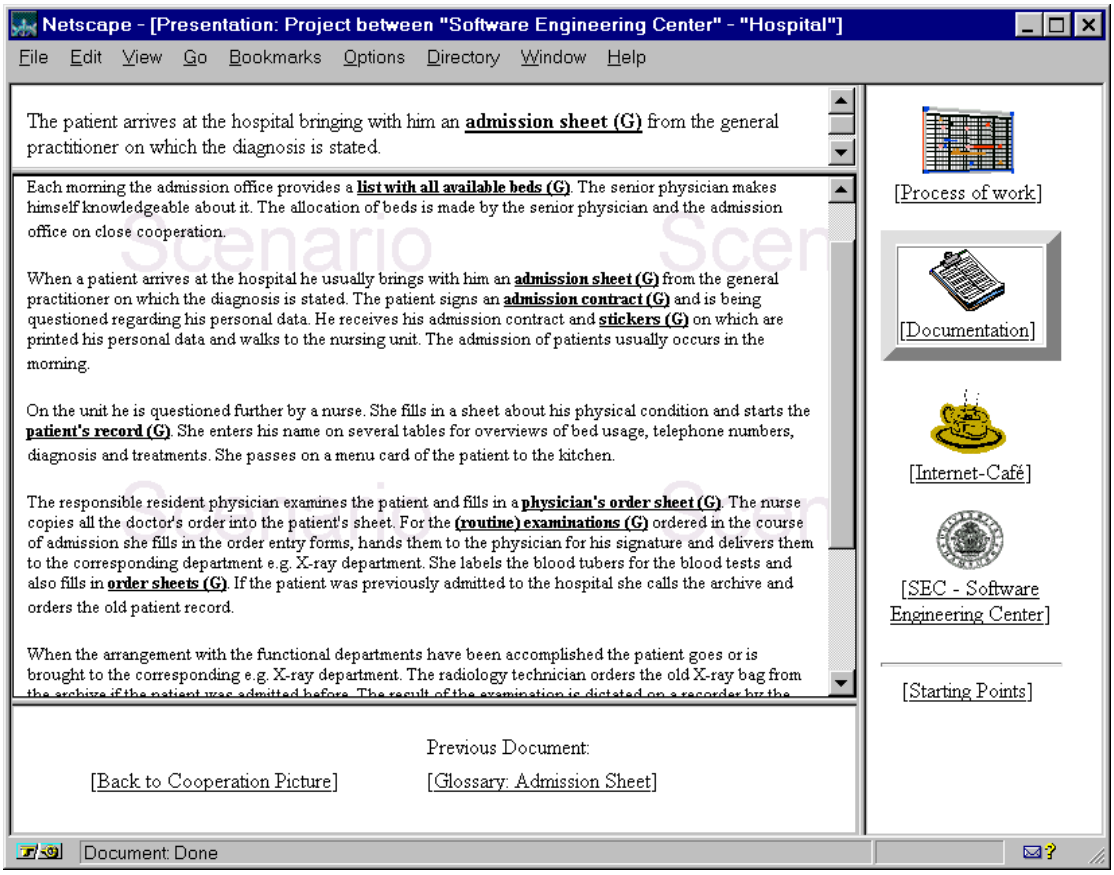


**Figure 4: Typed Scenario with navigation aid**

As a second orientation support we exploit the idea of different logical areas realized as frames around the regarded document for indicating meta-information. This meta-information provides information about the individually taken navigation through the document space and offers constantly general entry points (see Figure 4) to allow quick access to all other documents.

## Graphical Entry Points for the Document Space

Despite the provided support we still considered problems regarding to large document spaces. Entry points need to be more specific than the above given ones. According to the exploitation of document types we offered landscape-like graphical entry points providing type-specific overviews and access to corresponding documents.

However, due to our project experience the landscape approach is more successful if landscapes are not devoted to structural information alone but capture content-specific knowledge.

For introducing our content-specific approach to landscape support we first have to outline some evolution during the hospital project. With regards to the specific topic of the cooperation project, i.e. developing integrated systems, additional requirements concerning document-types and their linkage arose. It became apparent that the complexity of document linkage increases. In the following, new invented graphical documents visualizing e.g. joint tasks will be presented by example and motivated for serving as entry points and ordering factors for the manyfolded documents. Additionally, the mutual stimulating effect between project activities like workshops for user participation and knowledge transfer and the provided document space are emphasized.

During work practice analysis in the hospital it became more and more apparent that the mere technical integration of specific stand-alone solutions being offered on the market would be far too less. Instead the need to support complex cooperations found in the application was recognized in identifying joint tasks.

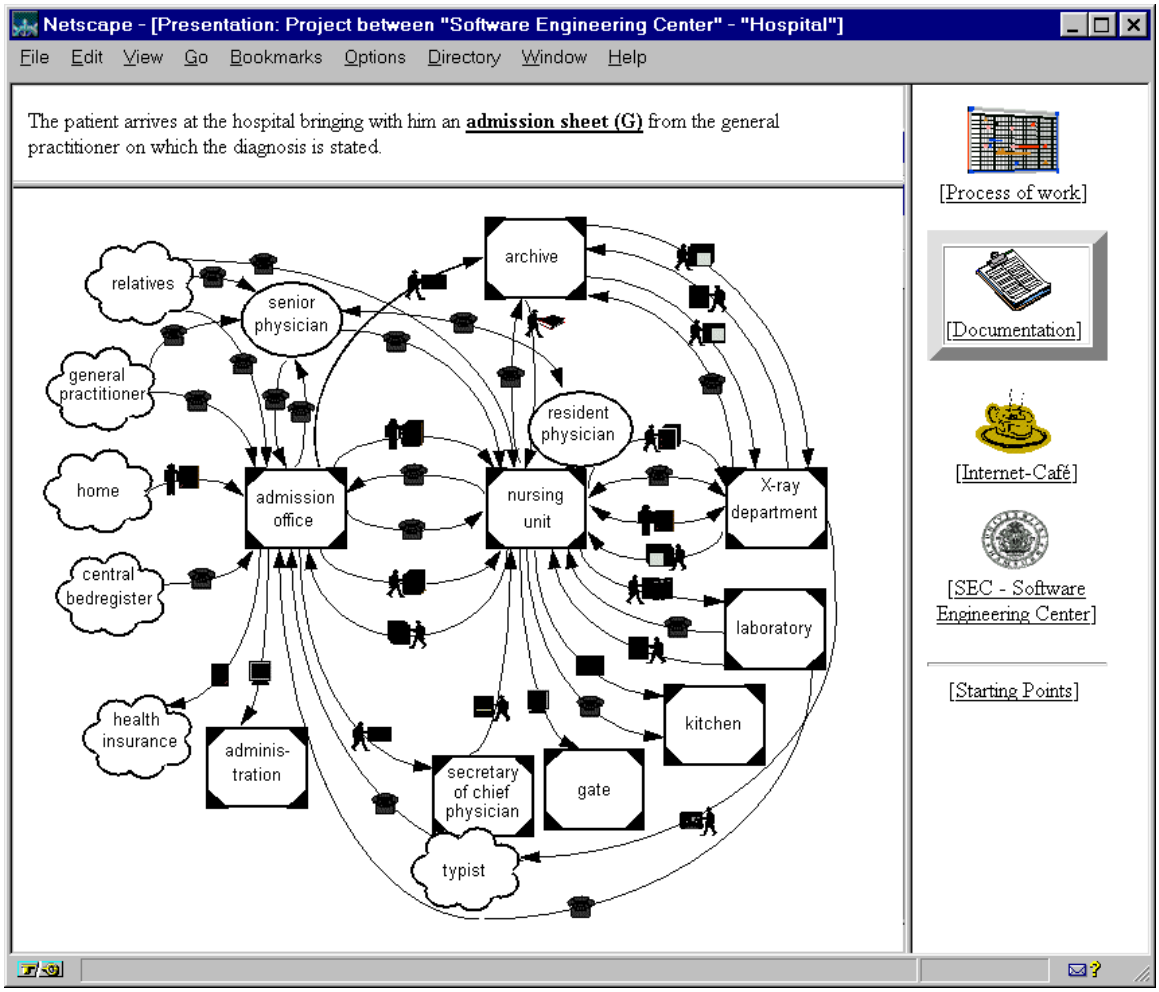


**Figure 5: Cooperation Picture as WWW solution**

Before discussing the relationship of special documents describing joint tasks and scenarios describing work tasks in single workplaces we give a brief characterization of joint tasks and present graphical means to visualize them. The characterization is based on requirements identified in the area of clinical care, nevertheless, it matches situations which are found in other application domains like servicing airline passengers or hotel guests. For a more detailed introduction see [10], [11].

Joint tasks require the cooperation of a multitude of people from different occupational groups often with highly varied fields of activity, e.g. administrative employees, nursing staff, radiology technician, surgeon, internist, anesthetist, and so on. Additionally, they require a high degree of flexibility since their accomplishment is dependent on external factors like the patient's condition. Within joint tasks a multitude of single activities are performed solely for coordination purposes, e.g. passing objects, especially documents, processing knowledge for information sharing, coordinating appointments, allocating resources or signalizing urgent changes. Joint tasks have to be performed within narrow time limits or up to a certain qualifying date, e.g. examinations which need to be performed at the admission day or before an operation. They consist often of simple subtasks which need to be repeated for several patients.

For acquisition of a detailed understanding and for the feedback of joint tasks the cooperation project developed so called Cooperation Pictures for the purpose of graphical visualization which were influenced by Rich Pictures (see [3], [14]).

Because of the characteristics of joint tasks the emphasis of Cooperation Pictures is - in contrast to Rich Pictures which serve for the description of differing views of different user groups on an integrated system - on the description of kinds of cooperation, see Figure 5. For that purpose the passing-on of information and objects of work has to be visualized. This implies the representation of „places" between which information and objects are exchanged. The kind of exchange is represented by annotated arrows between places (institutions) which illustrate who passes on what entity or by what medium information is passed on. The employment of icons as they are frequently used as signboards in public places leads to an immediate understanding of the meaning by the users and enables them to handle them promptly.

Within the cooperation project Cooperation Pictures were utilized during workshops where the participants draw them as wall paintings. As pointed out in [10] Cooperation Pictures are suitable for users as well as software developers in describing the existing status of joint tasks. For users they support knowledge acquisition about their own work context, active participation in elaborating the cooperation involved and provide an illustration of the complexity of their work which forms a basis for discussing future system support. For developers they serve as feedback techniques and indication of weak points in the organization and of the density of information flow.

Coming back to the question of landscape support our solution was to exploit Cooperation Pictures as entry points connecting them directly with the appropriate parts within the existing scenarios and glossary. The symbols representing places are connected with passages about the subtask to be performed at this working place whereas icons annotating arrows between places are linked to entries in the glossary describing the document being transferred. If available these textual descriptions were linked to the original scanned documents.

This has several very interesting effects for orientation within large document spaces:

- Cooperation Picture documents serve as easy understandable entry points into the large document space.
- They form a further document layer providing different entry points onto the same document space. Depending on the interest of the reader - e.g. which joint task he or she is interested in - they support a quick entry into the whole document space.

- They support quick reading and understanding of complex relationships as being captured in joint tasks by supporting links to the involved subparts of interviews and down to glossary terms and scanned forms from the application area. Among other things this supports knowledge transfer between analysts and prototype teams.
- Cooperation Picture documents highly support user participation since users recognize and identify „their" pictures having jointly been elaborated during workshops.

Additionally, during other design activities the cooperation project invented further graphical documents for requirements specification. These documents visualize e.g. a kernel system with its relationships to subsystems or planned levels of system versions with its logical dependencies among future task support.

Each of these graphical documents again was introduced in workshops and is integrated as entry point for various documents describing the requirements specification providing even references „down to" runable prototypes realizable as Java-Applets.

Based on our experience we come to the conclusion that introducing few easily understandable and sensitive graphical document-types capturing dense information for each of the development activities helps building and sharing common understanding and supports enormously each single developer or user in navigating through the offered document space.

# Conclusion

Providing project support using the WWW is of course an improvement in quality regarding permanent availability of documents and the representation in non-linear form compared with traditional methods of collecting and representing the project’s documents in folders or on the computer in files.

But as stated above adding improved functionality is crucial for a sufficient use of the WWW. For that reason we extended the functionality for setting up the document space by supporting easy ways of making documents available on a server and adding a version control system. This allows simple administration of the documents in all stages of the writing process. Furthermore taking into account the numerous people involved we developed prototypes to support the cooperative work on and with documents. Additionally, simple tools to create and connect hypertext documents are important for the acceptance of the medium WWW, but they are not subject of this article.

To open up the document space and to avoid disorientation the basic navigation of the browser was refined by providing document-type-specific navigation support. Furthermore, problems arise displaying hypertext documents within a limited space on the computer-screen. Therefore, the display should be divided into certain logical areas strictly distinguishing between the document’s content, its meta-information or navigational aids.

Additionally, using content-specific graphical documents worked out in workshops serve as valuable entry points for both, developers and users. Their landscape-character

provides extra orientation besides overviews based on structural information like document types.

Using the WWW and the developed extensions for project documentation not only improves its quality but also new perspectives become apparent. New benefits regarding especially accessing the document space will result. Specific entry points might be generated exploiting information retrieval mechanisms. They can capture esp. the dynamics of the documents in the development process which can be of thoroughly importance to accomplish an overall view of the project's progress.

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