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INTERDISCIPLINARY DEVELOPMENT OF A COLLABORATIVE PORTAL FOR A HETEROGENEOUS SCIENTIFIC COMMUNITY

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ABSTRACT

A distributed interdisciplinary team consisting of computer scientists, designers, ergonomic scientists, psychologists, and engineers from four universities are developing a web portal with and for the German human-machine interaction community. The portal integrates existing and new information services with a collaboration platform. In particular it is designed to enhance collaboration and communication within the community. This paper highlights some aspects of the iterative design process and outlines the interaction principles, which are expected to support the desired virtual community building process.

KEYWORDS

User adaptive portal, shared workspace, virtual community, iterative design process, computer supported cooperative work, requirements engineering

1. INTRODUCTION

A distributed interdisciplinary team consisting of computer scientists, designers, ergonomic scientists, psychologists, and engineers from four universities are developing a web portal with and for the German

Human-Machine Interaction (HMI) community. The portal integrates already established and new information services with a collaboration platform. In particular it is designed to enhance collaboration and communication within the community. This paper highlights some aspects of the iterative design process and outlines the interaction principles which are expected to support the desired virtual community building process.

2. GENERAL DESIGN GOALS

The most important design goal that has guided the whole development process of the web portal is the acceptance by the specified user group. This includes all interested parties in the thematic field of Human-Machine Interaction including scientists and practitioners. For this large-scale usability tests are performed including the graphical user interface design as well as the functionality of the services and the whole site. Even more challenging for the system design, after roll out and start up the portal shall be run by the users themselves, i.e. the users shall be the editors of the site.

One central approach to support the online community establishing process is an elaborated but simple role-concept. For the first contact with the community, anonymous users already have somehow limited access to the functions of the portal. Once registered (pseudonymous or named) users can dig deeper into the information space and can accept particular roles like being noted as an expert in the expert database, being responsible for the moderation of a particular area of interest or to enter upon office as an editor.

The target group of HMI-prospects is interdisciplinary and heterogeneous. In combination with the already mentioned users as editors (UAE) concept we have to face the fact that the portal has to serve very different needs. Therefore user adaptive algorithms are used for information selection and presentation. These algorithms use content ratings (given by other users) and the interest profiles of the particular user to calculate personal relevance measures.

The interest profiles mentioned above as well as the UAE concept require handling and storage of personal data. To ensure that the rights of the users are not violated in respect to their privacy a personal data safety and security concept has been developed and implemented.

3. SOFTWARE ENGINEERING PROCESS

The portal is currently being implemented. The software engineering process is structured by the concept of a parallel iterative engineering process (PIE), which divides the process into clearly separable stages (figure 1). It includes iterations during each stage and allows to integrate the needs of human machine operators or software users with the engineering of the technical functions of the intended human machine system. In each stage, the iterations can be structured according to ISO 13407 (1999) which describes a cycle of four basic design activities: understand and specify the context of use, specify the user and organizational requirements, produce design solutions and evaluate designs against requirements (figure 2).

PIE is a high level frame work which needs to be concretized with and adopted to available engineering knowledge and best practices to set up a working structured and controllable software engineering process. Within the project presented in this paper the system objectives were analyzed and documented with use case techniques. During the planning stage task analysis of functions utilized once more the use case method while task analysis was supported by the results of a survey conducted with members of the target user group (see section 5 for details). The results of both analysis tasks were integrated in an initial system design. For the engineering and implementation stages we have chosen to adopt the **Feature Driven Development** (FDD) concept of Coad et al. (1999) to our needs. Features, i.e. "*functions, valuable in the eye of the client and implemented in less then two weeks*" and feature sets were derived from the use cases and prioritized according to the results of the evaluation of users needs. The implementation of the core functions (basic servlets and classes) was paralleled by testing different designs and interaction principles on paper mockups and click models. Intermediate results of both streams were assessed and fed back into each of the parallel engineering tasks. Before going into operation in mid 2003 the results of a currently conducted evaluation and a set of usability tests will be implemented.

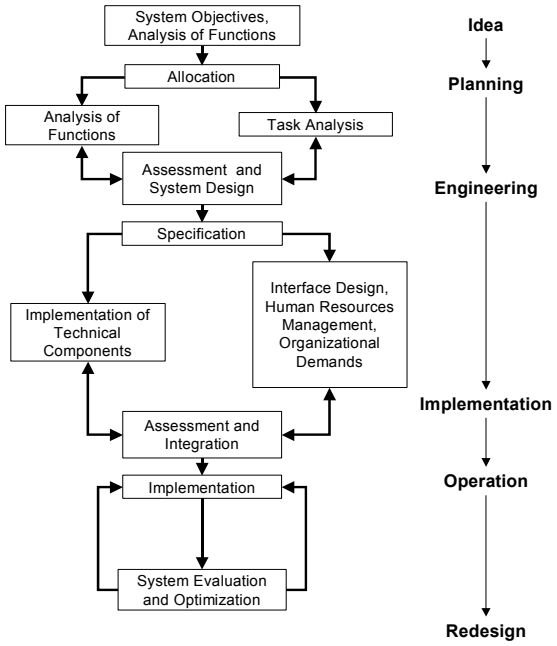

Figure 1 The concept of parallel iterative engineering (PIE) for human machine systems

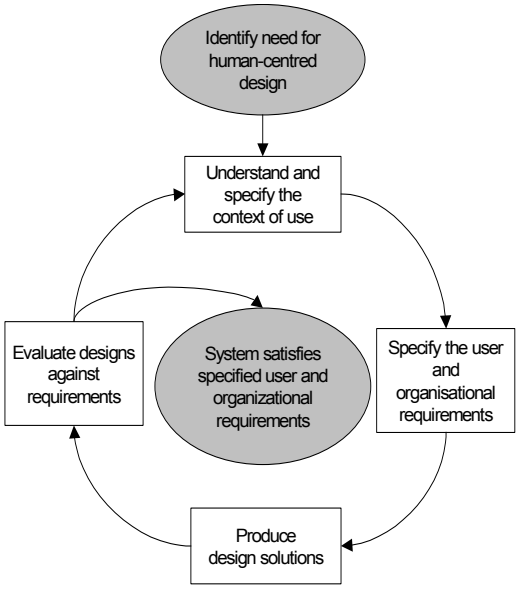

Figure 2 Interdependence of human-centered design activities according to ISO 13407 (1999)

4. COMPONENTS OF THE PORTAL

Figure 3 shows an overview of the collection of already established and new components that are integrated within the portal to provide a wealth of relevant information items.

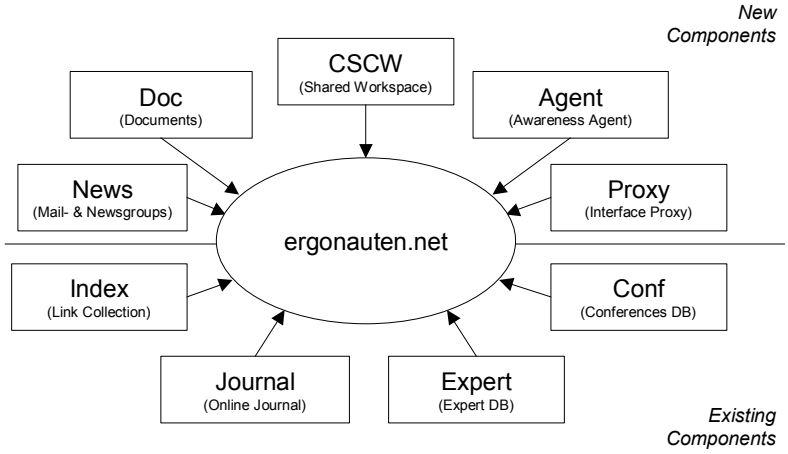

Figure 3 Components of the ergonauten.net portal

The existing components **Index** (collection of links), **Journal** (reviewed online journal), **Expert** (collection of HMI experts) and **Conference** (collection of HMI relevant conferences and workshops) merely provide access to collections of information, which are relevant for work in the HMI field. The newly developed components add functionality that aims on collaboration, communication and personal support:

The web-based computer supported collaborative work (**CSCW**) component is implemented as a file oriented shared workspace to ease data exchange and communication within distributed teams and special interest groups. The tight integration with other services of the portal results in additional benefit compared to other CSCW projects (see section 7 for further details).

As mentioned before, the heterogeneity of the user group may lead to usability problems which are addressed by user adaptive selection and presentation of information based on interest profiles. Because most of the users will not adapt their profiles to their changing needs, user-modeling algorithms are used to keep the profiles up to date. These algorithms analyze information that is derived from user actions like retrieving, editing, changing and rating of content. The **Agent** component uses these profiles to notify users, if relevant content changes have occurred. Synchronous, i.e. by selecting a particular page of the portal, as well as asynchronous, i.e. daily, weekly notification is implemented.

The **Proxy** component connects the well-sorted, high quality community rated and commented world of the portal with the largely unstructured World Wide Web. If users of the portal activate this component, their connection to the WWW is tunneled through this service. The proxy will add an additional small and simple interface (like a tool bar) at the head of every requested page to link it to the content of the databases of the portal. The proxy interface indicates if the page is already referenced and rated and offers an one-click opportunity to do so.

The integration of the various information services requires that the portal provides some **core functions** itself. To support structured storage and retrieval, items are associated with *categories* that are organized in a multi-hierarchical catalogue. Second, all items are indexed by a search engine to provide access by search patterns. Threads that are maintained by moderators of catalogue sections give further aid. These threads shall help guests and members to get familiar with new thematic areas by exponating commented important items.

Other core functions of the portal are user administration and maintenance. Here the consideration that guided the software engineering process was to ensure the privacy of users. Access to user data can only be gained by particular *information policy* objects that act as barriers between the user database and the application logic. This approach is rather expensive in performance and development time. Nevertheless this approach efficiently inhibits slips or errors in coding. Furthermore this approach enables us to manage possible changes in user data access policy efficiently and provides an easy entry point for proving behavior assertions for a future privacy audit.

5. ANALYSIS OF USER NEEDS

To learn the various requirements, needs, and wishes of the potential members of the virtual community an user analysis was conducted during the planning stage (Leuchter et al., 2002). The UAE concept in mind, we carried out a two part survey using on-line questionnaires with 72 participants (45% engineering, 40% human factors & ergonomics). The first part of the survey measured quantitative indices for work and cooperation habits by weighting different alternatives for answers. The survey included aspects of information processing, type and extent of cooperation and experience with Internet technologies. Participants had to express their subjective ratings on percental scales allowing for ranking different answers and weighting them against each other. The second part was undertaken to qualitatively single out ambiguities and discrepancies that came up with the results of the first part.

The results of the survey are not really surprising. Most net-users know the problem of ‘lost in information’. There is an endless depot of information with high actuality and unproblematic search time, but the time needed to filter out the relevant information for the individual and current focus of the user is the real problem. A corresponding problem is the low user knowledge about the handling of web tools, e.g. search tools. The results have shown, that more than 50% of the participants have never worked with a shared workspace and 38,3% do not know for what they can use it. Software archives, mailing lists and newsgroups were offerings with a low usage rate. All participants have the most experiences with search engines, but feel not well informed about the handling of this opportunity. The participants expect from the further tool a support for: concentrated information search, support with information filtering for a specific task and support of professional cooperation with colleagues. Other aspects are: easy working in into a new topic (e.g. research field) and self-presentation in professional context.

After all, the following requirements for the MMI-portal were derived:

- There is a misbalance between the in- and output of information. To balance this relationship, the UAE concept should be analyzed and usable information extracted for the integration into the portal.
- The user analysis has shown that there is a great need for better quality observation to reduce the information flood. To realize this: the information of the portal should be ratable and the rating results must be presented recognizable.
- To support the information filtering: The ratings are to be used to filter information for the user. The presentation of search results must be configurable, e.g. presentation via time or author criterion.
- The benefits of the portal must be well presented to support user participation, especially with the assessing of information. Offering of training documents, online-help, etc. could be useful for the novice user of the portal.
- One current problem for net-users is the limited availability of research papers. A preprint server could be an interesting offer to support very actual work in a non-conform academic format and the early prepublication of book chapters (e.g. white papers).
- Net-cooperation in working context is still rare. Nevertheless, the participants of our analysis expect better support for the handling of such cooperations. The interest for online-cooperation is high, but the current offers have technical and bad handling barriers. Therefore the combination of an easy-to-handle and well documented shared workspace and the portal is necessary.

6. DESIGN OF INTERACTION PRINICIPLES

The design purpose which has to be followed during the development of the portal, is like at any other complex system, to compress a high amount of information into a user friendly structure: It is very important to decide how deep and how wide spread information can be layed up. That means how much information can be placed on one single page or must be spread on additional pages. Furthermore it is very important to organize the amount of information that the user gets only a focus on the information he or she needs during a process.

The fundamental part during the development is the difference between the non-registered and the registered user. Only the registered user has access to all of the functions the portal offers. That means for instance that only the registered user can go deeper into the structure of the portal and has the ability to publish and rate content. These extensions, which the user gets after registration are graphically supported with a navigation which offers more abilities than the non–registered user has.

One of the challenges of the UAE concept is to show the user his or her possibilities with the portal with the help of the graphic interface. The user must know at any place and time what he can do with the content as a publisher. Furthermore he must know all the consequences that his editing can have to the Portal. The possibilities the user has to edit some content are shown in a „dropdown box“. After the users decision to perform an action to some content, a formal dialog will appear to show the user, that he has from now on the ability to create active the portal. To focus the work on the dialog, the navigation will be limited down to the portal logo, so the user can only perform steps that are important for his process. During this process the user gets the information what kind of action he selected and how many steps he has to perform before his action can be finished successfully.

All content changing actions of all users will be transparent to the whole community, i.e. the community will know who performed the content editing. With this feature the sense of the individual responsibility for the portal shall be raised. This is very important for the UAE concept. The basic condition for this concept is a responsible and engaged attitude of all users!

To raise the attitude of users, the navigation will show a status of the current portal activity through a graphical brain. This symbol represents the cumulated knowledge of the portal and is used to visualize the current quantitative overall participation index. This measure is defined as the balance between active and passive activities that is publishing and editing vs. downloading and reading of content. Furthermore the user has access to a history of his or her individual participation index as an immediate activity reward or a reminder to become more active.

7. SHARED WORKSPACE

Cooperative work is an important part of the work of the targeted HMI community, but it is done mostly 'offline' so far. Web-based cooperative tools are used by only 5 percent of all interviewed persons but nearly 40 percent do not even know what a *Shared Workspace* is (Leuchter et al., 2002). However, there is a need for a better technical support of cooperative work. For this, a web based Shared Workspace was highly integrated into the portal to offer an additional benefit, as compared to other separated solutions. Users share workspaces (e.g. for different projects) with each other or have their private ones (e.g. for personal documents). A shared workspace can contain different kinds of information such as documents, pictures, URL links to other Web pages, threaded discussions, information about other users and more. The contents of the workspaces are often arranged in a folder hierarchy, based on structuring principles agreed upon by the members of a workspace (see Appelt, 1999). Automatic notification via email to inform about new or changed objects is also possible.

To implement a shared workspace component for the portal, a java-based framework called SWOF (Shared Workspace Open Framework, see Künzer, 2002b) has been developed. This framework focuses on an easy adaptation and extension (fig. 3). Hence, other developers can integrate it smoothly into web-based portals like the one presented here.

In order to increase the usability of the shared workspace component, the common metaphor of a folder hierarchy with included objects was changed in the portal context. Though, it is still possible for a user to structure a workspace with folders, the natural connections between objects allow a much easier organization according to the users' expectations. For example, when creating a document cooperatively, all the relevant information like notes, web links, documents, etc. can be added directly to this document, even hierarchically. So additional folders are not necessary. Furthermore, documents can be locked to avoid modifications by other users, have detailed versioning information, and support an easy publishing of the ready document into the portal.

Regarding the suitability for the tasks, the upper level of the workspaces consists of project spaces, workgroups and private workspaces instead of folders. Caused by these pre-structured object types, the communication effort of a distributed working group to organize their workspace can be reduced. For example, the decreased possibilities for naming conventions lead to a more consistent structure as well as to a unified naming of a workspace and the included objects (fig. 4). This increases the conformity with the users' expectations according to their orientation in the shared workspace.

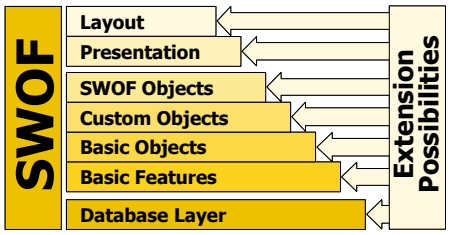

Figure 3 Different possibilities to extend the Shared Workspace Open Framework (SWOF)

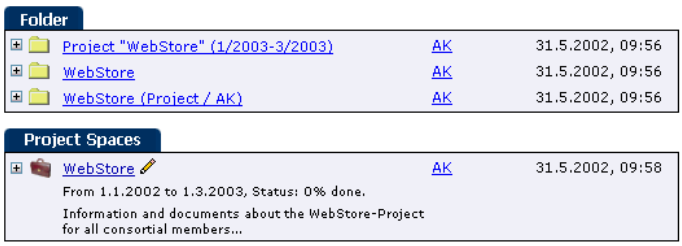

Figure 4 Example of structuring without naming conventions vs. a pre-structured object type for a project space

In order to make the handling easier, the functionality is based on the context of the object type. Additionally, the object types can be recognized by the visual appearance and the different functionality according to the natural habits of the user. In this way the self-descriptiveness of the object types is supported (Künzer, 2002a):

- Private space: Allows the user to store information objects of interest in a hierarchical file system, like links to the portal or documents he or she found. Privacy is especially important here and the access for other users is not possible.
- Workgroup: Emphasizes the common interests of the members by showing their activities (last access, number of online-times) and so increasing their self-confidence. This is one possible way for user motivation (Kindsmüller et al., 2002).

- Project Space: Focused on solving a special project together with other users and contains additional project data (start/ finish date, project status).

Further object types can be implemented easily to meet the evolving cooperation needs of the users of the portal. For example a new workspace type is developed to support the MMI-Online-Journal with its distributed review and publishing processes.

8. EVALUATION

The evaluation is a necessary step to fulfill a successful realization of an user-oriented portal. For the presented project the method of several parallel-iterative evaluation steps was choose. Evaluation steps are: expert interviews (mind protocols and structured interview by first contact and after 6 month), log files (usage protocols), structured interviews in combination with questionnaire (qualitative evaluation of specific 'logged' use-cases) and online-questionnaires (Email and quick-questionnaire during leaving procedure of portal usage). In the moment the log file protocols are realized and the first expert interviews are started. Results of these evaluations are not presentable at the deadline of this paper, but they will be presentable at the conference.

9. CONCLUSION

Interdisciplinary software engineering process approaches as described in ISO 13407 and presented within this paper are enablers for innovative software development, in particular for heterogeneous user groups. Parallelising the development activities helps reducing development time, nevertheless the high coordination effort in interdisciplinary teams might be somewhat limiting and calls for disciplined practices on all involved parties. The intended user as editor concept seams to be very appealing. Nevertheless it is not yet clear if this concept is successful in the HMI community. The evaluation will prove if current design decisions made to support the community building process are sufficient.

We plan to port our information and cooperation platform to other scientific communities. Possibly adaptation support that is especially important for heterogeneous interdisciplinary groups can be omitted. But group motivation that had to be fostered by community appropriate design has always to be the most important issue on porting such technology.

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