SMART MEDICAL SOFTWARE SYSTEMS FOR DUMMIES?
The Case for a User-centered Systems Design

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Abstract: In this position paper we ask the question of whether current medical software systems adequately support the "dumb users" in their routine work, or whether the software systems are rather function-oriented and their development far removed from reality. In a multi-year study, the medical faculty of the University of Heidelberg and the German Research Center for Artificial Intelligence (DFKI) cooperated on a review of the current situation in medical software systems. The first project involved the joint development of a prototype of a user-centered software system for the allogeneic stem cell transplantation procedure. Additionally, a comprehensive survey was conducted among the medical staff of the Hematology and Oncology Department at the Heidelberg University Clinic. The results of both the project and the survey are presented here.

1 INTRODUCTION

When we look at the situation today in the area of clinical IT systems, we can find major advances in the performance capacities of modern software systems, but must also note their rapid penetration into almost every facet of the daily clinical routine. A myriad of very good software products now exists for patient administration, resource management, personal data administration, drug prescriptions, and many other activities, all of which have proven their worth in numerous clinics.

Surveys among clinical staffs have shown, however, that the operation of the software systems has very little to do with the actual tasks performed by the operator. Developers have a different way of looking at the systems than do the future users who, in their work, must frequently use several different systems, each supplied by a different manufacturer, in parallel in order to complete their tasks (cf. Nielsen, 2005). In the event of a problem or when the user rejects the software support system, it is often all too easy to put the blame on the "dumb" user. The situation is briefly introduced in the following example.

2 SMART TRANSPLANTATION

The aim of the Smart Transplantation Project was to determine how software systems could provide more efficient support to medical personnel (physicians, caregivers, transplant-coordinators) during complex medical procedures (Meixner, Thiels and Klein, 2007). To this end, in 2007 the authors conducted a situational analysis into the subject of software support for allogeneic stem cell transplantation (one of the most complex medical procedures) at the Heidelberg University Clinic. In a comprehensive study, user requirements, relevant data requirements, work processes, etc. were examined by means of observation and expert interviews. In the process, a series of significant findings were observed.

Notably, we found that members of the medical staff must make safe and proper decisions, effectively and efficiently even when

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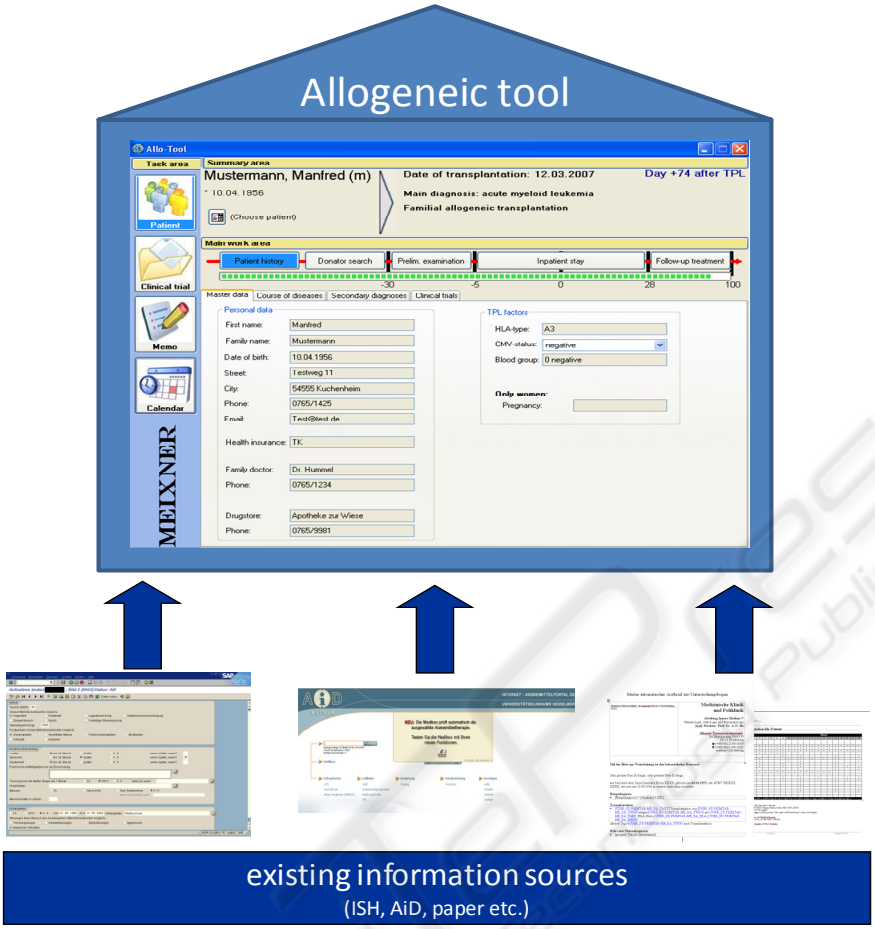

Figure 1: Integration of various information sources into the task-centered allogeneic tool.

performing under time pressure (stress). Other aspects like the simple and intuitive use of the operational interface (usability) or joy-of-use (hedonics) are of equal importance.

An initial prototype was then developed with the aims of providing optimal support to the medical staff throughout the complete workflow of allogeneic stem cell transplantation and integrating the various existing IT-systems, for example, paper based files, hospital and drug information systems into one application (see figure 1). A previous analysis of tasks revealed a software system that included the following functionalities: extraction of medical data from several different sources, structured presentation of processed information, and automated generation of medical documents such as physician's letters or pharmaceutical plans.

Furthermore, the procedure for allogeneic stem cell transplantation was broken down into a 5-phased treatment plan and placed onto a timeline. The different information needs in each of the individual phases (patient history, donator search, preliminary examination, inpatient stay and follow-up treatment), had to be presented according to the respective needs of the various users. This task-centered approach resulted in efficient search and documentation of information and, in this way, provided some relief to the medical staff. In addition, the operational interface was adapted to the needs of the respective users with various screens developed on the basis of user groups.

Prototypes designed on the basis of the findings in the Smart Transplantation project revealed problems, for example, the time consuming searches, the redundant data entries, or the use of different software to perform the various tasks, which could be significantly reduced by the introduction of an integrated software system.

This project was limited in scope to one complex medical procedure. The overall situation pertinent to software support of medical professionals within one department of a major healthcare clinic was investigated by the follow-on survey.

3 CLINICAL SURVEY

More than 30 staff members of the Department of Hematology and Oncology at the Heidelberg University Clinic participated in an online survey which asked about various areas of application of Information and Communications technologies (ICT) within the hospital. 94% of those asked responded that IT applications are critical to the daily routine at the clinic and 90% said more than 50% of their work involves the use of computers; 58% even reported more than 75%. Important criteria for the respondents was not only a timely system response but also that the system be efficient and user friendly. The responses were ambivalent concerning the current state of integration of the IT applications in the daily work routines. No clear conclusions can be drawn - positive or negative – from these answers. However, when we evaluate the responses in terms of the question about IT systems optimization, the dominant answers mention, besides the timeliness, the integration of the different individual applications into one system and the elimination of redundant data entries. The analysis of the individual systems used in this job area showed major deficits in usability and effectiveness, especially in the accounting and technically oriented administrative applications. The assignment of responsibility for specific functions was analyzed in terms of the professional medical staff and the IT applications. The functions assigned to the computer systems were: the logistics, the processing of previously selected data as well as the recommendation of appropriate diagnosis and therapy. The actual selection of patient data and the decision making for diagnosis and therapy were assigned without exception within the sphere of responsibility of medical professionals. Another subject area in the survey solicited attitudes about decision support systems. 82% of those asked reported no knowledge or, only a vague idea of what the term means. After a brief clarification, respondents were asked to comment about the uses and benefits, the reliability, the prospect of success, and the acceptance of decision support systems. While the benefits were generally given a high rating, the reliability and acceptance were rated rather low. Nevertheless, 60% said they would follow the recommendations of the decision support system.

Overall, the findings of the survey show IT technology in hospitals has attained an important status and with the optimization of the software structures, tasks and processes can become more efficient, quality can be improved, and performance stress can be reduced (time pressures). The concern that computers will replace the professional staff seems to have retreated in the face of the view that IT solutions can effectively support and simplify their work.

4 CONCLUSIONS

The contemporary leading IT applications for hospital information services and, by extension, the major patient data administration applications are, with some exceptions, oriented for historical reasons on business and accounting theory. This not only makes them quite user-unfriendly, fairly inefficient for a clinical environment, but also dangerous (Nielsen, 2005; Koppel et al., 2005). At the same time, the users recognize their dependence on computer systems in their daily clinical routines and criticize the inadequate level of integration among the individual systems and the resulting need for redundancy, poor functionality, and deficits in data presentation. These smart systems may be brilliantly programmed, but they go right around the actual requirements of the various user groups found in hospital operations. For example, some feature that a business accountant appreciates may be totally useless for the doctor. The issue is not the ignorance of the user but rather, the historical development of hospital software and the apparent lack of interest in developing software that would satisfy the everyday job needs of a nurse or an internist. Among this group, the longstanding opinion that computers would disrupt the clinical activities has been replaced by the desire for IT systems that support their work through integration, efficiency, and appealing presentation of important data. The user community today brings a readiness to use the wide range of opportunities made possible by computers. They are by no means dumb or unwilling, but they simply must rely on IT concepts that, to be of any use in practice, must be tailored to their needs. We saw this, for example, in the willingness to use decision support systems and not categorically reject them; and, again in the re-assignment of some responsibilities from the medical staff to the intelligent software solutions. The potential is great in daily healthcare routines for IT solutions that isolated applications will never be able to satisfy. Much more, it will require integrative, comprehensive, and user friendly software products.

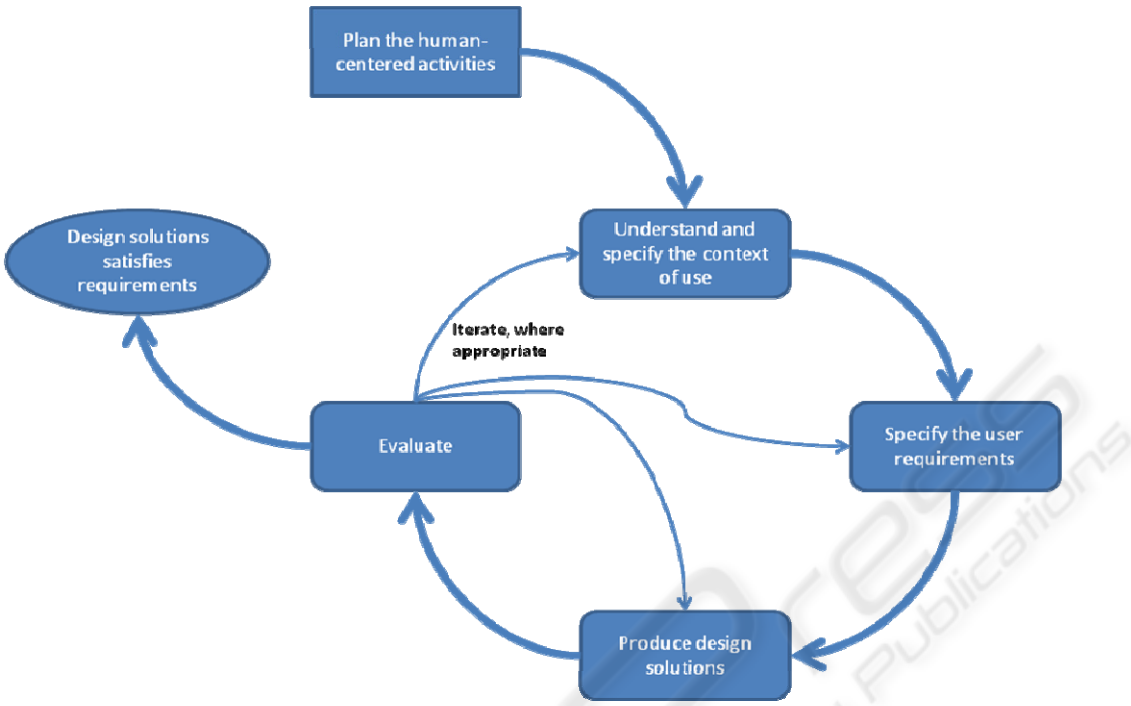

Figure 2: The interdependence of human-centered design activities (ISO, 2009).

One possible solution lies in user-centered interface design which has long been a decisive factor in the acceptance of new software. However, in the fields of healthcare and medicine this development still presents an enormous challenge. Truly user friendly operational interface designs can only be assured under a systematic development process (Zuehlke and Thiels, 2008).

A user-centered development process is broken down into several iterative phases (see figure 2). Beginning with the user and context analyses, requirements are defined for the operational interface, implemented in (visual) prototypes, and then tested and evaluated by current and future users (ISO, 2009). Especially the evaluation of visual prototypes is important, because prototyping and testing can focus on specific improvements in metaphors, mental models, navigation, interaction, and appearance (Marcus et al., 2000).

None of these phases may be pursued in isolation, but rather, they should be seen as overlapping. The focus during the analysis phase is on the users (e.g., doctors and caregivers), their tasks, and their work environment. Several different methods such as surveys, observations, or questionnaires are used to identify and develop a comprehensive list of requirements (cf. (Holzinger, 2005)). A parallel evaluation, for example, employing structural, paper, or functional prototypes, allows users to be integrated directly into the test and evaluation process of the development concept.

It is especially important to convince manufacturers, developers, and buyers of the user-centered development approach. The benefits are already clear and include time and cost savings, improved software quality and greater user satisfaction. The successful application of user-centered development processes for operational interfaces in medical field has already been demonstrated, for example, in (Meixner et al., 2008).

A key problem is still whether the users of medical software systems are simply not smart enough (PEBKAC: Problem Exists Between Keyboard and Chair) to operate the systems correctly and efficiently or, perhaps, whether the software systems are simply inadequate, not user-centered and, to this extent, the product of intelligent development. In the future, the development of medical software systems will no longer be oriented on technology and business accounting, but will focus more on the actual users and user support in the daily clinical routines.

In this respect, there must also be a serious review of the myriad of different isolated applications and special system solutions in the medical field. An appropriate standard for the development of graphic displays based on a generic

operational interface would be a major step towards a standard solution. This would facilitate integration of existing expert systems under a common operational interface. The main benefit of such a (platform independent) standard user interface description language for medical software systems (e.g. developed as a XML-language) would be the easy adaption to specific constraints and conditions. There would be no need for using different graphical widget libraries – just one standard which could also be automatically transformed into specific final user interfaces (e.g. source code). Successful Examples of such languages in computer science are the User Interface Markup Language (UIML) (Ali, Pérez-Quiñones and Abrams 2004) and the eXtensible Interface Markup Language (XIML) (Puerta and Eisenstein 2002).

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