Designing medical hypermedia: the FORUM project

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Abstract. Medical activity in learning stages or in usual tasks is a wide field for information technologies. But it would be a mistake to focus on technologies and minimize the organisational, social and cultural aspects of integrating such technologies. Medical hypermedia design based only on a technological approach is a case in point. This paper describes our experience in hypermedia development. It reports on the technical, methodological and organizational aspects destined to help the medical community get involved in the development of such applications.

1. Introduction

The medical community has always felt that informatics could help in initial training, continuing education and in accessing large knowledge bases. Now, the highly publicized technological innovations are launching a new debate and creating a new enthusiasm. The medical profession is particularly aware of multimedia and network developments. But emphasizing only the technological approach is dangerous. For instance, many people want to "make a CD-ROM" and do not wonder about the interest of a broad image bank if the users do not have effective tools to know if an image does exist, where it is located and how they can gain access to it.

Hypermedia applications abound in medicine [1,2]. But in most cases, the "media" component is more important than the "hyper" one. The models proposed are often data structures when they should be knowledge models. The growing popularity of Internet [4] would have us believe that the creation of a hypermedia is just a technological approach without cognitive problems.

The FORUM project aims to create conditions for the hospital and university community to: (i) access the new technologies, (ii) go beyond a purely technological approach in order to focus on cognitive needs, (iii) integrate applications in daily practice, (iv) evaluate the application's ability to achieve the desired results. This project is both a research project in information technology and a development methodology to assist the authors.

This communication includes a recall of the conceptual model of the FORUM hypermedia authoring system, gives precisions on development modalities and provides some reflections on concrete applications.

2. FORUM Hypermedia Authoring System

2.1. Conceptual model

There is a lack of conceptual model for hypermedia applications. Many people confuse multimedia and hypermedia, which are very distinct notions. Multimedia is a technique for presenting information in a pleasant manner for the end user. Hypermedia is a technique for adding value to information. Hypermedia applications use semantic relationships among the information to help the end user access the desired information. Managing these semantic relationships is a challenge for improving hypermedia engineering.

In practice, hypermedia is often defined as a set of nodes interconnected by "hard" links. This very poor definition induces: (i) a difficulty in creating and maintaining large applications, (ii) a navigational disorientation and cognitive overload [3]. To maximize the strengths and to minimize the weaknesses of a hypermedia, an approach is to consider that a hypermedia handles information and knowledge [6]. The information is what the user wants to reach whereas the knowledge corresponds to informatic procedures to reach such information. This separation improves the link management system.

This approach is implemented in the FORUM hypermedia authoring system [5].



Figure 1. Conceptual model

The FORUM conceptual model (figure 1) allows a link management with three properties: (i) Navigation between information nodes, which are instances of node types, is done by

hyperlinks whose activation sets knowledge in action. To each link is associated the semantic relationship that it expresses. The semantic relationship between nodes, called intention, is made explicit at the time of link creation. Afterwards, the intention of a link is proposed to the reader before link activation. By consulting intention, users know what information will be proposed so that they can choose whether to activate a link or not. This mechanism helps the readers by reducing the risk of cognitive overload. In the case of a multidimensional hyperlink, a list of intentions is proposed (figure 2).



Figure 2. The superior collateral circulation hyperlink

(ii) Relationships such as synonymy can be established between hyperlinks. A hyperlink defined as synonymous of another hyperlink inherits its properties.

(iii) Knowledge associated to hyperlinks can be defined at the hypermedia general level or at the node level. A general hyperlink is defined once and can be reused in different nodes. A local hyperlink allows contextual knowledge to be represented in a node.

Exercise node types allow the user to be evaluated. They are made of multiple choice questions or image area designations. After response analysis, weighted production rules can be activated to evaluate pedagogical goals [7].

2.2. Upgrading

Breaking the traditional boundary between author and reader is a main challenge in hypermedia. In a learning context, being an author is building knowledge. This is richer than merely acquiring knowledge in reader's mode, but it is more difficult. Many projects try to create conceptual conditions to facilitate dynamic evolution and cooperative working [8,9,10]. In the FORUM hypermedia applications, readers can take the following initiatives:

(i) Add "post-its" to each node to take notes and to propose improvements.

(ii) Add nodes and links to adapt the document to their own needs. A workspace is reserved for this use, where the added objects are: (i) protected by the password of their owners, (ii) dated, (iii) in one of three states: in creation, validated by the hypermedia manager, in modification. These tools allow for asynchronous cooperative working.

3. Methodology of development

One of the standard mistakes is to give authors a hypermedia authoring system without making them aware of the possibilities and conceptual difficulties in starting it. We know the rift between concept simplicity and concrete implementation of a hypermedia application. In a learning context, the other risk is that the teachers reproduce pedagogical model they usually use, without taking advantage of interactions which give hypermedia its originality. Our experience has confirmed that authors, in their first creation, are inevitably inclined to reproduce article or book structures, which are multimedia but only "turn page" type.

To lead to significant and useful hypermedia, we design it through the following method:

(i) Do not push authors to develop applications but rather be attentive to their requests. This guarantees a minimum level of motivation.

(ii) Analyze goals and motivations. Author motivations affect the finished product. Many people see in this technology a modern and worthy means to communicate new medical knowledge. Hypermedia replaces paper communication. The scientific contents justify the creation, but the cognitive reflection is very weak. Other authors approach the problem with an experimentation goal. Not wishing a durable investment, their goals are to develop an application rapidly just to test it. The field is often restricted and there is not a concrete perspective of use. Finally, for the authors who want to create a hypermedia for real utilization, two factors could slow down the development: the time they can invest and the lack of recognition for such an investment. The authors are teachers and researchers whose promotions are based on their research activities more than on their teaching activities.

(iii) Limit the field and specify the target. The medical training field stretches from the first year student to the continuing education of the active physician. These populations have different behaviors and learning motivations: for the students the goal is to pass an exam, for the active physician the goal is to solve daily problems.

(iv) Draw on the human possibilities. To bypass the brake represented by development time, the common way is to entrust the greater part of the development to young specialists such as residents. Since they occasionally choose the development of such applications as a medical thesis subject, their motivation will be increased.

(v) Organize the project by putting it in an innovation context.

(vi) Train the author in technical manipulation and in hypermedia concepts. An initial seminar of a few days permits the author to be autonomous. The interest of this approach is that the authors appropriate the tools and feel that they have full control of the document creation, thus improving their motivation. Like all creation, the project leads to success after many iterations: training, conceptualization, development.

4.1. Medical application typology

Numerous FORUM medical applications exist in different areas such as uterine magnetic resonance imaging, angiomyolipomas of the kidney, transjugular intrahepatic portosystemic shunt, onychomycosis, treatments in pediatric oncology and neurological rehabilitation.

For the first four applications (100-200 nodes), those concerned are the residents who are trained to deal with the applications. This represents 20 residents per semester. At the end of the semester, a staff meeting is held to discuss post-its and suggested evolutions.

The last two applications (> 500 nodes) are destined for all the members of a unit. For example, the pediatric oncology application is intended for both the medical and paramedical staffs (about 40 individuals including the night shift). The aim of this application is to improve the care quality and safety by: (i) improving the staff's knowledge, (ii) providing faster and direct access to accurate information, (iii) allowing the pooling of knowledge with constant refinement of the team's knowledge. The kernel of the hypermedia was created by a chief physician, and nurses are now adding sub-themes. An evaluation of this approach and its social, medical and organizational impacts in a medical unit is in progress.

4.2. The Users' Behavior

After 3 years of experimentation, we have observed three types of behaviors:

(i) The "readers" who passively consult the hypermedia without using any tools that authorize them to take initiatives. Often, it is a simply curiosity that motivates access to software. Passivity can also be the consequence of a lack of information about interaction possibilities that are unusual for the reader.

(ii) The "players", not interested by the knowledge field and whose interest is to test all the functions of the system, and who sometimes tries to jam it. There is no learning motivation for these users. It is by obligation or coercion that they are made to use this software, to evaluate it for instance. This relativizes the interpretation of the results.

(iii) The "learners" who really need to acquire knowledge to solve a concrete problem. For them, one must create organizational dispositions relating them to the software to deal with the problem. Many users cannot gain access to this kind of application because they do not know if exists or its access is very difficult.

Training is essential to exploit the whole range of interaction tools. An experiment was carried out on this subject. During 6 months, the uterine MRI application was used by 35 residents in 4 hospital centers (Lille, Nice, Rennes and Marseille). The results show:

(i) The more powerful the kind of interaction, the less it is used. Link creation is exceptional, although the technical aspect of a creation is not complicated for the users.

(ii) Post-its are widely used. In analyzing the origins of the users, we note that they were exclusively from the Marseille hospitals. In fact, during the system presentation these residents had been made aware of how to use the Post-its to improve the application. In the other centers, this awareness did not exist, thus explaining this disparity in behavior.

(iii) Interesting technological interactions that do not create a learning process are underemployed. For instance the image zooming process is not appreciated because it is not accompanied, for each image, by information explaining zooming benefits.

These results confirm the preponderant role of training for users, as well as their psychological preparation for information that is not stiff and that they can upgrade.

5. Conclusion

We have described an experience in designing hypermedia within the FORUM project, focusing on both technical and human aspects. We show that handling information and knowledge improves the link management system and facilitates both the creation and the consultation of a hypermedia. But to successfully involve the medical community, we found that it is important to consider aspects besides the technical. Establishing a development methodology is essential. It allows one to appropriate tools and to progressively acquire the culture needed for this kind of development.

The current investment of a part of the medical community and the projects planned push us to continue in taht direction by: (i) improving the concept's representation in the authoring tool, (ii) strengthening the potentialities that facilitate cooperative working, (iii) integrating more the applications in the curriculum.

FORUM applications run in an APPLE environment and we plan to move into the world of cross-platform multimedia, including Web browsers.

More generally, hypermedia seems promising for medical community: (i) conceptually it proposes rich interaction modes to access information and also to transform and adapt it, producing new knowledge, (ii) technological progress will increase interaction modes, (iii) the multimedia appeal will attract new authors to invest in this field.

But we cannot but wonder about the real impact in the training process and daily practice. For instance, will the hypermedia have the same "success" as the intelligent tutoring system?. Will the culture be developed and the structure be adapted?

Hypermedia applications that favor form over substance will likely be transient; the others, much heavier to get started, will be not frequent, especially if designing hypermedia is not given full appreciation by those in supervisory positions.

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