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Computing Science Institute/

**CSI-R9707 May 1997**

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# A User-centred View on Hypermedia Design

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**Abstract.** Ever-increasing quantities of information, together with new developments on storage and retrieval methods, are confronting today's users with a huge information supply that they can barely oversee. Hypermedia information retrieval systems try to assist users in finding their way through the supply, but in reality this is where many systems fall short. The reason is that most of them do not *really* communicate with users to find out what they *really* want. Instead, a bottom-up approach that reasons mainly from an information-oriented view point, has been a major design focus. We argue that the design of hypermedia systems should be based on an integration between *both* a top-down (user-oriented) *and* a bottom-up (information-oriented) approach, to develop hypermedia systems that *know* and *understand* their users. In this article, we present initial results of a new user-oriented approach.

**Keywords:** Hypermedia design, information retrieval, user modelling.

**Classification:** 68P20 (*AMS-1991*), H.1.2, H.3.0, H.5.1 (*CR-191*).

## 1 Context and motivations

Growing amounts of information and technological improvements that allow for new ways of storing and searching information, have led to an ever-increasing information supply. At the same time, many information sources have evolved into *multimedia* information sources, as they contain besides texts, a wide range of images, pictures, animations, video, audio and so on.

Nowadays, it has become more and more difficult to maintain an overview of this vast quantity of multimedia information. New developments in areas such as digital libraries, virtual organisations, electronic commerce and the Internet are only fortifying these tendencies. This is probably expressed best by the advent of the World Wide Web (WWW), that provides access to innumerable virtual information sources all over the world. Sources such as multimedia databases, hypermedia collections, and digital libraries in its various conceptions [1].

Today's users are facing a huge load of multimedia information and the ever swelling information flood has started to slowly turn their established environments into a huge, disordered swamp of information. To keep their heads above

water, it is increasingly important that users are provided with good multimedia information retrieval systems, that allow them to sail the seas of information, rather than to drown in information swamps.

One way to achieve this, is by means of a *hypermedia* system (see for example [2] and [3]). A hypermedia system structures an information source as a network of nodes and links. The nodes represent pieces of information (*information objects* [4]) contained in the source, and the links represent relationships between them. Users can now navigate (*browse*) through the hypermedia information source, without being forced to put down in words what they are looking for. A good hypermedia system (from now on referred to as the “hypermedia”) eliminates, or at least reduces, the well-known problems of query formulation (e.g. [5]), and is organised in such a way that users are able to find what they *really* need.

Exactly this, however, is one of the important shortcomings that many of today’s hypermedias suffer. It is often claimed that the design adopts a user-oriented point of view, but in reality this does not go beyond involving users in a mere information-oriented approach. Users are allowed to interact with the hypermedia, rather than that they can really *communicate* with it. The difference is that interaction is often a matter of one or a few (independent) actions whereas communication also involves *understanding* between the parties.

In the field of human-computer interaction (see for example [6]), we also see this happening. Users are indeed involved in an early phase of the design, but this mostly concerns their desires regarding the future hypermedia’s functional specifications, and not so much *how* users want to find information and for what reasons. As a result, users have to interact with the hypermedia, on the hypermedia’s terms that were imposed by the designer. Research on visualisation (e.g. [7]) looks into “how do users want to interact” issues, but is limited to the presentation. The fairly new area of cognitive systems engineering (e.g. [8]) is one of the first to argue the importance of cross-disciplinary cooperation between researchers from several fields (e.g. engineering, psychology and cognitive sciences).

Designing hypermedias from an information-oriented point of view implies that the hyperlayer the user has to browse through, is often rather fixed and based on the implicit structure of the information. The enabling technology may also limit the user’s possibilities to a certain degree. Different users with different needs and therefore different searching strategies and motives all have to approach the information source in the same fixed manner. Sometimes, hypermedias provide an additional query based search mechanism to assist individual users, but this sometimes is a rather artificial solution, for users now have to concentrate again on putting down in words their need which is often a torment.

Users are the ones who eventually have to work with the hypermedia, notwithstanding whether the user is a person or an organisation, and their satisfaction eventually decides on the usefulness of any hypermedia. True user-oriented design must take into account the *whole* spectrum of issues regarding who the users are, what they want and how they want it. Furthermore, these issues should be

related to information objects modelling aspects.

It is our aim to develop a framework for true user-centred hypermedia design; i.e. a design that involves and integrates user characterisation and information objects modelling. The approach we take to achieve this, consists of three main steps (see Figure 1):

**1. User characterisation.**

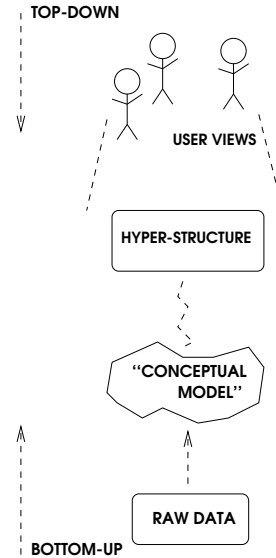
A *Top-Down* approach where we place ourselves in the position of the user with the aim of mapping out who users are, what they want from a system and how they want that.

**2. Information objects modelling.**

A *Bottom-Up* approach where we take an information-oriented point of view, to investigate the “technical” issues such as information object modelling and characterisation.

**3. Integration.**

Here we focus on the question how user issues (1) reflect on information objects modelling (2), how this can be integrated into a framework for user-centred hypermedia design, and how the framework should be evaluated. In Figure 1 the term “hyper-structure” refers to the network of nodes and links, whereas the term “conceptual model” is used to refer to the integral model that is going to be used to represent the characteristics of the information objects.



**Fig. 1.** An integral approach to hypermedia design

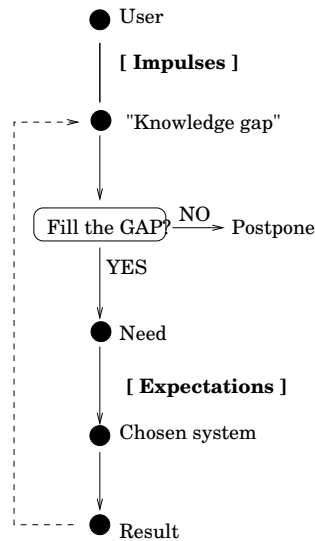
Belkin and Marchetti also use an integral top-down and bottom-up approach in [9], though their focus lies in a different direction. Their goal is to specify the *functionality* of an interface to an information retrieval system, whereas we focus on the design as a whole, including information objects modelling.

The importance of user issues is also reflected in the work-oriented perspective Levy and Marshall take in [10]. They focus not solely on people’s work though, but rather on people’s work *in relation to* library collections and technology, which endorses our user-centred point of view.

In this paper we present the initial results of step 1: a Top-Down approach from the user’s point of view. We present a user-centred view within which we introduce the notions of “user purpose”, “user identity” and “cost” and the relationships between them. Furthermore, we introduce the concept of “expectations” and we make some concluding remarks.

## 2 A user-centred view

The user is the pivot the discussion hinges on. It is his individual need in the first place, that encourages him to approach a hypermedia and the degree of his satisfaction will be the judge of the hypermedia's effectiveness and usability.



**Fig. 2.** Life cycle of user needs

To satisfy it, the user initialises a *search path* towards an answer. On his path he may encounter various hypermedias, and for every one of them, he has to judge for himself whether that hypermedia could provide an answer to his need. Hypermedias on their turn, have been designed for some reason as well, resulting in the hypermedia having to meet certain requirements in some domain. From the point of view of a potential user, the hypermedia makes certain promises with respect to its usefulness in fulfilling related needs. These promises arouse expectations with the user that strengthen him in his decision whether that hypermedia can be of any use to him.

The decision has now become a *match* between the user need and the hypermedia's inherent promises.

If the user eventually chooses one hypermedia, he *expects* this hypermedia to provide the best possible answer to his need. He communicates his need to this hypermedia and the fact whether it indeed comes up to the expectations, has its repercussions on the user's satisfaction with that hypermedia. The better it comes up to those expectations, the happier the user will be.

So far, we have only been talking about finding *what* information objects respond to a user's need (*content*) but we have not at all considered yet *how* they respond best. Users do not always explicitly need information objects; sometimes

From a top-down point of view (Figure 2), the user is our starting point. A user can be an individual person, or a group of persons possibly united in an organisation. For the moment, we limit ourselves to single users. Due to external (environmental) or internal (personal) impulses that occur at some point in time, the user's state of mind may change. In dealing with these changes, the user may stumble across a gap in his knowledge [11]. The uncovering of such a gap gives rise to the question whether he should seek to fill the gap. An affirmative answer to this question calls a *need* into existence; a need for appropriate information objects that can fill the gap. If he decides not to fill the gap, it apparently is not very important or urgent. He may come back to it at a later stage, e.g. by trying to find a more effective tool, or not at all. (In Figure 2 this is referred to as "postpone").

In principal this need is *independent* of specific hypermedias and information sources. To

they look for something diverting that will keep them busy for a lapse of time. They need the information objects not in the first place for the information they carry, but for the engagement they can provide, possibly via that information.

To this engagement we refer as *experience*. This quality of user need is a very important second dimension that we define as *user purpose*:

The user purpose is the *conceptual need*, expressing the user's preferences regarding the quality of the need from a generic point of view.

Besides the information objects and their quality, there are two more aspects that must be considered. Firstly, it is important to note that different users will respond differently to a hypermedia, for they have different personalities and behavioural patterns. Issues like these can be captured under the term *user identity*. Secondly, different qualities of user needs are very likely to have different effects on a user's willingness to put time and effort in searching. This can be conceived as the *cost* a user is willing to pay to provide for his need and it can be expressed in terms of a number of parameters.

In the remainder of this section, we deepen these various issues and concepts on the basis of Figure 2. First we will pay attention to user identities and impulses, then we go more deeply into the concepts of user purpose and cost, and finally we discuss user expectations.

## 2.1 User identities and Impulses

*User* literally means "one that uses" ([12]) and in this context we clearly mean "one that uses an hypermedia". Generally users are people; single persons or groups of persons. This can be groups of people with similar needs but different objectives, or groups of people with similar needs and similar objectives. An example of the latter case is an organisation. An organisation is in fact a group of people with one main objective; the *mission* of the organisation. Other systems could also be a user, but in this discussion we concentrate on single human users.

By *user identity* we understand the whole of personal characteristics such as age, gender, education, cultural background and so on, as well as cognitive and technical skills, such as search behaviours, the ability to reason, experience with computers and automated systems etc. Also, someone's *role* (student or teacher, manager or secretary and so on) during a search is considered a part of his identity. In case of an organisation, role can be conceived as the organisation's mission.

No two people are the same and at best, we can say that people respond "similarly" to a given situation. As hypermedias are hardly ever designed for one person only, it is unavoidable to abstract away to some extent from this kind of personal details. Hypermedias should respond well to the average; specific personal requirements can be the 'finishing touch' providing a certain *context* for any need.

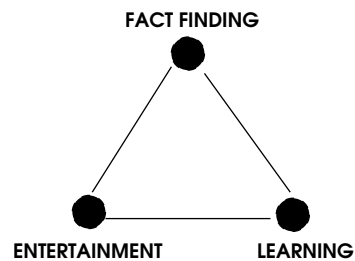
An *impulse* is a motivating force, stimulus or influence that may trigger a person's current state of mind to change. Impulses can be individual or environmental, i.e. originating from the person himself or from his environment. They

can be totally unexpected but also to a certain extent predictable. For example, suppose your car suddenly breaks down. This environmental impulse causes an immediate need for a mechanic. If you are driving a very old car that has had problems before, its breaking down does not come totally unexpected but if your car is only a few months old, its breaking down probably comes as a total surprise.

In our discussion, we apprehend the notion of impulse as any stimulus that causes a person's state of mind to change, as a consequence of which he discovers a knowledge gap.

## 2.2 User purposes

Besides the question what information objects a user needs, it is equally important to know *how* he prefers to receive them. Perhaps he wants them summed up one after another, without any unnecessary finery. Or maybe he likes them in a more specific, comprehensible and well-balanced order. Or perhaps he is not interested in the information objects themselves, but only in the experience they cause. This property of the user need is concerned with the quality of the need and we refer to it as *user purpose*. Basically, there are three main categories:



1. Fact finding;
2. Entertainment;
3. Learning.

These types are essentially different, though combinations are possible. For example, entertainment can be informative at the same time, and education can be given in such a way that it is entertaining. Popular terms often used for these phenomena are “infotainment” and “edutainment”. To express this “sliding scale effect”, the user purposes can

**Fig. 3.** User purpose triangle

be depicted as a triangle, presented in Figure 3.

### **Fact finding**

A very straightforward need a user can have, is the need for one or a few concrete pieces of information. This kind of need usually comes into being as occasion arises, the relevant information objects are used right away and then discarded. This typically is a factual information need.

### **Entertainment**

In this case, the specific contents of information objects are not the user's first concern. Instead, he is interested in the engagement these information objects can provide. *Experiencing* the objects is what entertains the user. Basically, there are two ways in which information objects can create an experience:



1. by the actual communicating and interacting with the hypermedia, where the information objects are a means of communication, or
2. by the effect the information objects have on users' emotions.

Playing a game is an example of the first. Here an important part of the diversion lies in the actual communication between user and game. Information objects (the contents of the game) are only a means of communication. An example of the second is listening to music. The interaction with the CD player is necessary to get the music out of the CD, but physically hearing the music provides the real experience.

Experience is a rather subjective matter. Different hypermedias provide a different level of experience, and different users will often experience the same hypermedia in different ways. Even when two users have similar identities, it can still be simply a matter of taste. Also, their background plays a role: if they have heard many times that some game is a lot of fun to play, their expectations will be fairly high up. This also means that if the game turns out to be rather boring, they will be quite disappointed.

### **Learning**

There are several definitions of this notion; the following two [12], are pertinent to this discussion:

**A:** *“to gain knowledge or understanding of, or skill in by study, instruction or experience”* and,

**B:** *“to memorise, i.e. to commit to memory”*.

We are aware of ongoing discussions within the field of (cognitive) psychology about the difference between “learning” and “memorising” but in our discussion we can confine ourselves to a more superficial discussion of the subject.

From our point of view, we mean “learning” as in definition 1A when we are speaking about the purpose of learning. Pure fact finding can be viewed as “memorising” facts to solve a particular need. As soon as the need has been taken care of, the facts are no longer relevant and are discarded. Fact finding often concerns referencing, that is, to inform oneself about some facts that often serve a one time use only.

Learning on the other hand, is more than temporarily knowing information. It also involves *understanding* it. Learning increases a person's expertise and a person tends not to discard expertise. Contrary to fact finding, learning thus brings along a certain willingness to put effort in maintaining the skills.

### **2.3 Cost**

Providing in a need demands effort and time and it is not self-evident that every need is seen to with the same intensity. Some needs may be more important than others, or may be more difficult to fill than others. In general, users are willing to pay a certain ‘price’ for a need: a maximum effort to provide in their need.

This is the *cost* of satisfying the need. If it demands more than that, users will find the need too expensive.

The notion of cost can be expressed in terms of a number of parameters. Together they represent the user's *investment* in fulfilling his need. We distinguish at least the following, which we elucidate in the remainder of this section: *Money, Time, Challenge, Tolerance and Accuracy*.

**Money** The physical price a user is willing to pay to take care of his need.

**Time** This parameter represents the *estimated* amount of time an individual is willing to spend on providing in his need ( $T_e$ ).

Another conception is the amount of time the individual is actually *interacting* with a hypermedia, which may differ from the estimated amount ( $T_i$ ). A third conception of time is the so called 'duration of *life*' of the need, referring to the existence of the need ( $T_l$ ). This again may differ from the other two interpretations. For example, suppose a need turns out to be very difficult to satisfy and the user cannot afford to spend more time on it than some estimated amount  $T_e$ . He decides to stop searching, thus completing  $T_i$ , but the need continues living ( $T_l$ ).

**Challenge** Challenge refers to an individual's willingness to spend more effort on interaction with the hypermedia than would have been strictly necessary. Implicitly, the value of challenge influences  $T_e$ .

A game challenges people's capabilities, for example by inviting them to solve a riddle, and it will try to make this as hard as possible, without frustrating them. To a certain extent, users accept this challenge since that was one of the reasons why they decided to play the game in the first place. But if this person needs some information, he wants the answer without unnecessary delays and he will not be satisfied with a hypermedia that is being mysterious about his request. A hypermedia that educates, challenges its users in a different way. The aim is to teach people but part of the learning process is that people think for themselves. So the hypermedia should challenge people to think about the issues in a supportive way.

**Tolerance** This is the user's willingness to put up with the behaviour of the hypermedia that deviates from the user's desired optimum.

The desired optimum may vary within a certain range, not only depending on the user's personality (e.g. very patient or very impatient) but also on the nature of his need, which partially finds expression in  $T_e$ . For example, if someone needs the phone-number of the fire department because his house is on fire,  $T_e$  will be extremely small and he will typically have very little tolerance for hypermedias that do not instantly provide an answer. However, when someone is playing some game because he has some time to kill anyway, interacting with the hypermedia has become a mere pass-time and this person will tend to be very tolerant to the hypermedia's behaviour.

Furthermore, the complexity of the need counts: to a very straightforward look-up, a user will be less tolerant than to a sequence of complex computations. For the latter, the user's  $T_e$  will be higher.

**Accuracy** The accuracy reflects the user's demands upon the precision with which a hypermedia accommodates his need.

Fact finding implicitly involves more detail than entertainment. If a person needs facts, he means concrete pieces of information rather than vague hints and ideas. Finding a phone number for example, is a very accurate need that requires a precise answer. An answer like "it starts with a 3" is of no use to a person who needs to make a phone call. In an adventure game on the other hand, vague hints and unclear answers are part of the experience and therefore interesting as the user has to find out what they mean.

## 2.4 Expectations

We have now identified four components (Content, Purpose, Cost and Identity) that play a role in the way a user's need is satisfied. Together, these four components span the user's expectations. This idea is depicted in Figure 4.

Expectations is what a user has *before* he actually uses any hypermedia. It partially is what makes him use a particular hypermedia in the first place. Expectations form the basis of user satisfaction: whether a hypermedia surpasses a user's expectations or whether it falls short of them, does make a significant difference for the user need satisfaction.

Another view on user expectations is the notion of *user history*: the behaviour of the hypermedia that the user expects, on the basis of earlier experiences with (similar) hypermedias.

Different purposes bring along different expectations of the users. Games are supposed to be a pass-time and the user expects to be kept busy for a while. If the game is too easy it disappoints the user but if it is too difficult, it might frustrate the user. In both cases the user will loose interest and stop playing the game. A person with a fact finding information need turns to a hypermedia to get an answer but he will want that as soon as possible. Contrary to the game-situation, he will not tolerate to be "kept busy for a while".

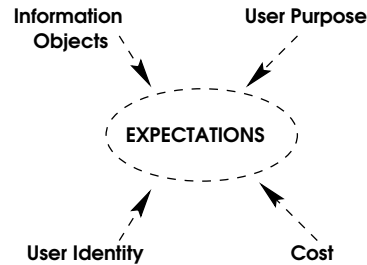


Fig. 4. Expectations

## 3 Conclusions and further research

In the design of hypermedia systems, information-oriented and technique-oriented approaches are still prevailing, which often leads to a rather one-sided view on

the interests of the future users. Nowadays, users do get involved already in an early stage of the design, but this is often interpreted as having the users talk to the technicians about what they want. They do not get beyond the point of expressing their wishes concerning the hypermedia's functionality and the way of presentation. The designers remain the ones to interpret the users' desires and to decide how they should be shaped.

It is our opinion that design should better incorporate *both* the side of the users, *and* the side of the information and enabling technology. We have argued that a top-down approach to involve user aspects, and a bottom-up approach to involve information objects modelling, are equally important, and that they should be integrated into one design framework. In this way, the user's interests do not remain behind on the level of presentation and functionality but they can reach down into the level of information objects modelling.

In this article we have deepened the top-down aspect of our approach and we presented the initial results of the development of a new user-centred view. A next step will be to develop a quantification of the concepts introduced, and to evaluate them in an experimental environment.

Currently, a case study is in progress at the University of Nijmegen. Shortly, other case studies will be started also within the commercial environment of Origin B.V.

Future research will focus on issues regarding information object modelling, with the final aim of combining this information-centred view with our user-centred view into an integral framework for hypermedia design.

### **Acknowledgement**

The authors are grateful to Erik Proper for his help in thinking through the ideas in this paper and for his time and effort in reading and commenting on its various versions.

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