

## **A hypertext with multiple, interchangeable paradigms of interaction and dynamic links**

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# **A hypertext with multiple, interchangeable paradigms of interaction and dynamic links**

*Oreste Signore - Stefania Malasoma - Rossella Tarchi - Lina Tunno - Giuseppe Fresta*

## **1. Hypertext: Concepts and Fundamental Issues**

Hypertext and hypermedia have been object of great interest in the last few years. According to (Nielsen 1990), ‘hypertext is non-sequential writing: a directed graph, where each node contains some amount of text or other information. The nodes are connected by directed links. In most hypertext systems, a node may have several outgoing links, each of them is then associated with some smaller part of the node, called an anchor. When users activate an anchor, they follow the associated link to its destination node, thus navigating the hypertext network’.

When the content of a node is made not only of textual information, but also of other kind of media, like graphics, sound, and so on, we may use the term hypermedia.

Two major areas of application are education and documentation.

In the following, we will briefly illustrate the importance of the links, that are a fundamental component of the hypertext, and will discuss some design issues that can lead to the implementation of effective hypertext applications.

### **1.1 The Links**

A hypertext is constituted by nodes and links, which are of greatest importance. In effect, we can say that they are, in a certain sense, the ‘essence’ of the hypertext.

Really, the links are the basic component that contributes to the *enrichment of the knowledge*, as they have a fundamental role in *stimulating the user’s interest*, implementing *various types of connections* among the nodes.

Regarding this last aspect, we will make reference, in the following, to a taxonomy of the links proposed by (DeRose 1989). According to this classification, the links can be divided into two main classes: extensional and intensional links, which can be further splitted into several subclasses, as shown in Fig. 1.

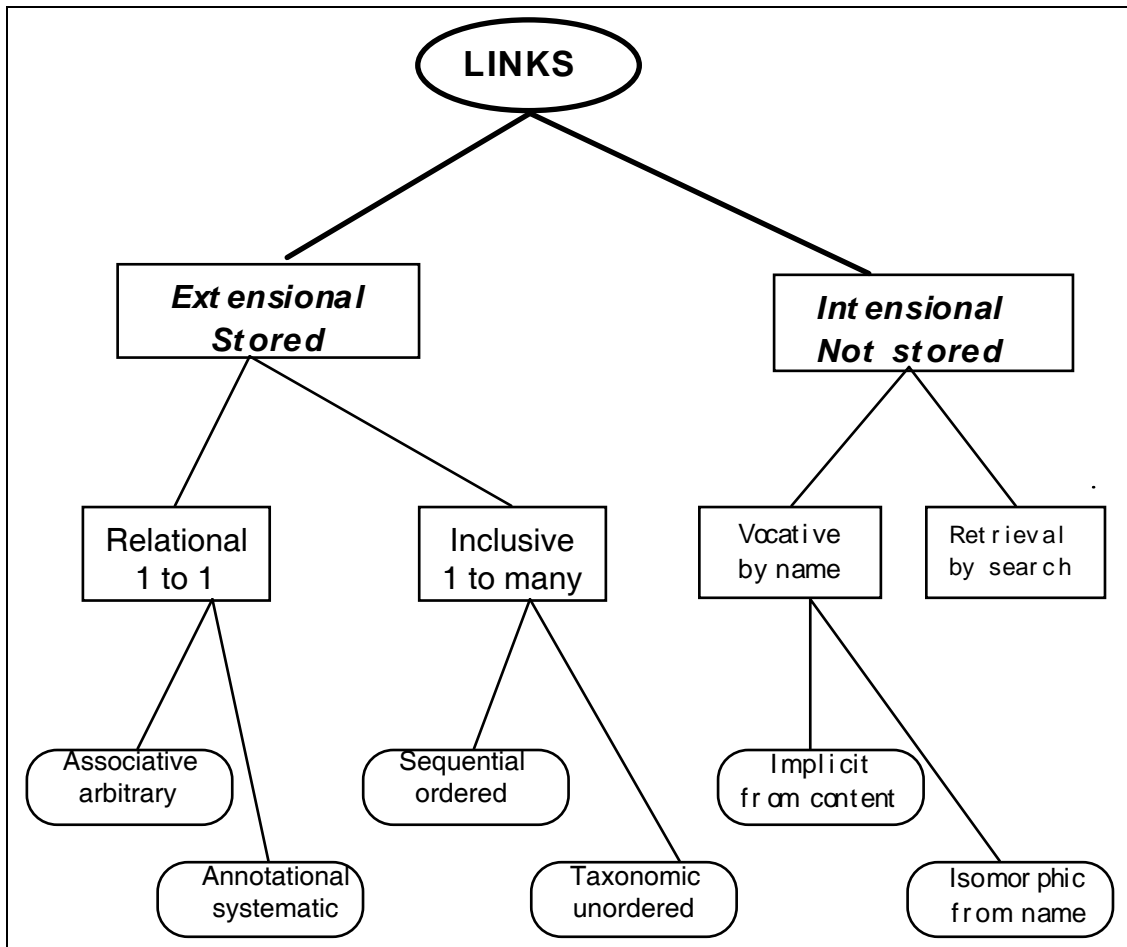


Fig. 1.A Taxonomy of Links according to (DeRose 1989)

In more detail, the *extensional links*, that must be stored individually, can be subdivided into:

- *Relational (or referential) links*: extensional links that connect single nodes (or specific section of nodes) together. Each of the two ends is one conceptual unit.
- *Associative links*: absolutely unpredictable relational links. Normally they are labelled according to type. It must be noted that this can lead to an excessive number of arbitrary types.
- *Annotational links*: relational links that represent connections from portions of text to information about the text.
- *Inclusive (or organisational) links*: extensional links that represent super-ordinate/sub-ordinate relationships between document elements.
- *Sequential links*: inclusive links with multiple, ordered target locations (structure-representing links are a typical example).

- *Taxonomic links*: inclusive links with multiple target locations , but no order on them. Associate list of properties with particular document elements. (cross-reference between words is a typical example)

On the other hand, the *intensional links*, that follow strictly from the structure and the content of the documents they link, can be subdivided into:

- *vocative links*: invoke a particular document element by name.
- *Implicit links*: vocative links whose target element's name appears within the content of the source document.
- *Isomorphic links*: vocative links whose target element's name appears as an element name in the source document (different documents share much or all of their logical structure).
- *Retrieval links*: intensional links that invoke a process to search a portion of the document for something. The search process may be of arbitrary complexity.

## 1.2 Hypertext: pros and cons

As we pointed out in the previous section, hypertext supports computer based links among documents. This gives rise to many interesting features, as the link activation gives *immediate access to the relevant information node*.

Therefore, we can get the advantage of *non-linear data organisation*, so that the user can follow any associative path connecting two nodes of information.

In turn, the necessity of accessing the right piece of information has lead to the necessity of implementing *different mechanisms of access to the data*. It is customary to identify three different ways of accessing the information nodes: navigation, browsing and querying. The navigation on the hypertext simply is following the links that connect a node to others, while browsing gives an indication of the nodes that have been visited or that can be reached from the current one, so allowing the user to choose the target to reach. The selection of an appropriate entry point in the hypertext, or the identification of the possible reachable nodes, can be made issuing a query, too.

It is evident that these features make the hypertext a very powerful and interesting environment. However, it is important to stress some counterparts, related to the complexity of the associative mechanism that is the basis of the hypertext itself.

The '*lost in the hyperspace*' effect is one of the most known problems that the user can experience, as he/she is pushed to follow the links that connect the nodes, so reaching destinations that may be totally unrelated with the originating one.

The multiplicity of links originating from a single node, and therefore the difficulty of following so many paths provided by the hypertext designer, are the cause of the ‘*cognitive overhead*’ problem.

The query mechanism is affected by the complexity of formulating an effective query, namely the identification of the right concept to search for (see Signore 1992), and the necessity of evaluating the whole set of the retrieved nodes.

### 1.3 Hypertext: Design Issues

A fundamental problem that arise in designing any application is outlined in Fig. 2, and is very clearly explained in (Norman 1988). Briefly, it can be stated as follows: the designer builds a mental model of the application. This model must be communicated to the user by the interface, that acts as a mediator between the user’s mental model and the design model as it is presented by the system’s image. It is evident that the application can be satisfactory only if the two models agree.

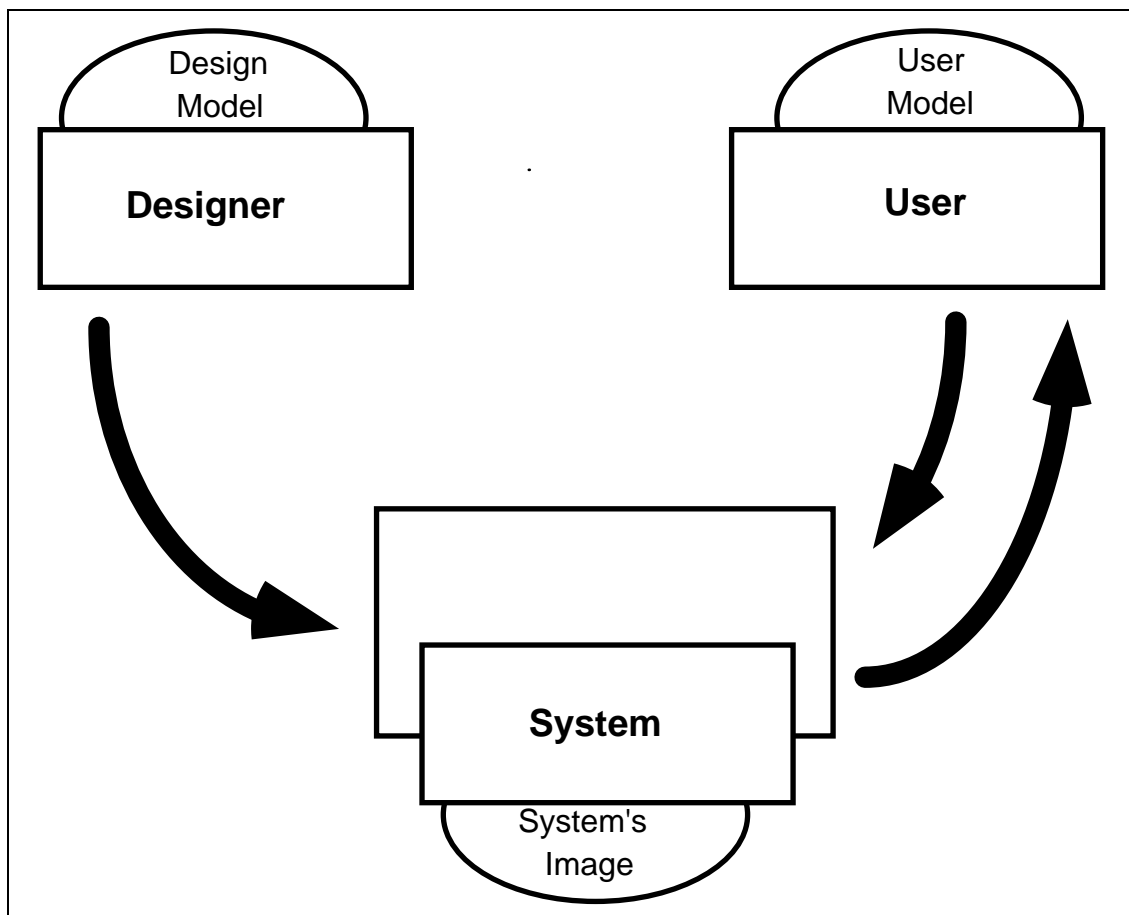


Fig. 2. The Role of the Interface in a System’s Design

This kind of problems is common to every design object, as it can be experienced by everyone in the everyday life, but is much more evident in the implementation of hypertext applications, due to the variety of the possible way of interactions and the number of possible effects that they can produce.

To improve the effectiveness of the matching between the design model and the user's model, we propose to supply *multiple and interchangeable interaction paradigms*. This means that the user should be allowed to interact with the system using the metaphor that he/she feel to be the most appropriate: a map, a classification scheme, the physical contiguity, a local browser. As the user moves in the hypertext, all the information must be kept consistent, so that he/she can freely switch from one paradigm to another.

It has been emphasised as the links constitute a fundamental component of the hypertext, helping in the representation of the semantic richness of its content.

Therefore, we think that much effort must be put in the implementation of different types of links, so that each link type can visibly carry a specific kind of information. To help in preventing the 'lost in the hyperspace' effect, the designer must supply some mechanism for the visualisation of the links, so that the user could have an idea of the destinations of the available links. Furthermore, we think that not all the links can be considered to have the same importance, and for this reason every one has a weight, accounting for the relevance of the connection between two nodes. The weight should be calculated dynamically on the basis of the content of the nodes, and modified according to a 'user profile'..

In the following section we describe the 'Ipertecne' hypertext, as a case study where we have tried to find a way out of the problems arising in the implementation of a hypertext, focusing our attention on two aspects: the interaction paradigms and the links.

## **2. The 'Ipertecne' Hypertext**

**Ipertecne** is a hypertext built to permit the 'intelligent' and interactive visit to the 'Fondazione Scienza e Tecnica' a museum located in Firenze, documenting the 19th century science and technology (Gravina 1991). Subject areas cover natural and artificial goods used in industrial processes, botany, palaeontology, zoology, geodetic instruments, chemical laboratory, plants and seeds. One of the most relevant parts is the physics laboratory, which contains more than 1500 instruments, produced by several European firms in the 19th century.

The case study has been developed in the context of a co-operation between Regione Toscana and CNUCE.

Presently the hypertext covers a small portion of the physics instruments.

The implementation of the hypertext has to be considered an enhancement of the previously existing information system. In fact, a data bank about the content of the museum was already in existence and therefore the first step has been the extraction of the data from this database and the automatic insertion into the appropriate hypertext nodes. However the links, that constitute one of the most relevant aspects of the hypertext, have been introduced manually. In fact, some of them could have been identified automatically on the basis of the indexes used by the Information Retrieval System previously adopted.

## **2.1 Basic design issues**

The hypertext has been designed making use of methods and techniques coming from other areas pertinent to data management. In fact, the basic architecture has been derived directly from the conceptual schema, as is common in the database environment. Generally speaking, every entity has been mapped into a specific type of node, whose structure accounts for the properties (or attributes) of the entity. The links between the nodes are both extensional and intensional, and map the associations among the entities, the implicit references to the dictionary terms, the user annotations, and so on.

The hypertext revolves around the 'Objects', each of them, in turn, may be related to other objects, or 'Persons' (the maker, the inventor, the discoverer of its physical principle) which can be related one to another. Quite obviously, every object has some related 'Documentation': bibliography, photos, original ancient drawings.

Description of the instruments is made understandable thanks to a dictionary of technical terms, which can be linked.

The information nodes have been implemented as 'cards'. Most attention has been paid to the design of the layout of the cards, in the aim of helping the user to maintain his/her orientation. Therefore, the cards have a clearly distinguishable layout, so that the user can immediately realise which type of information node he/she is dealing with. (Fig. 3)

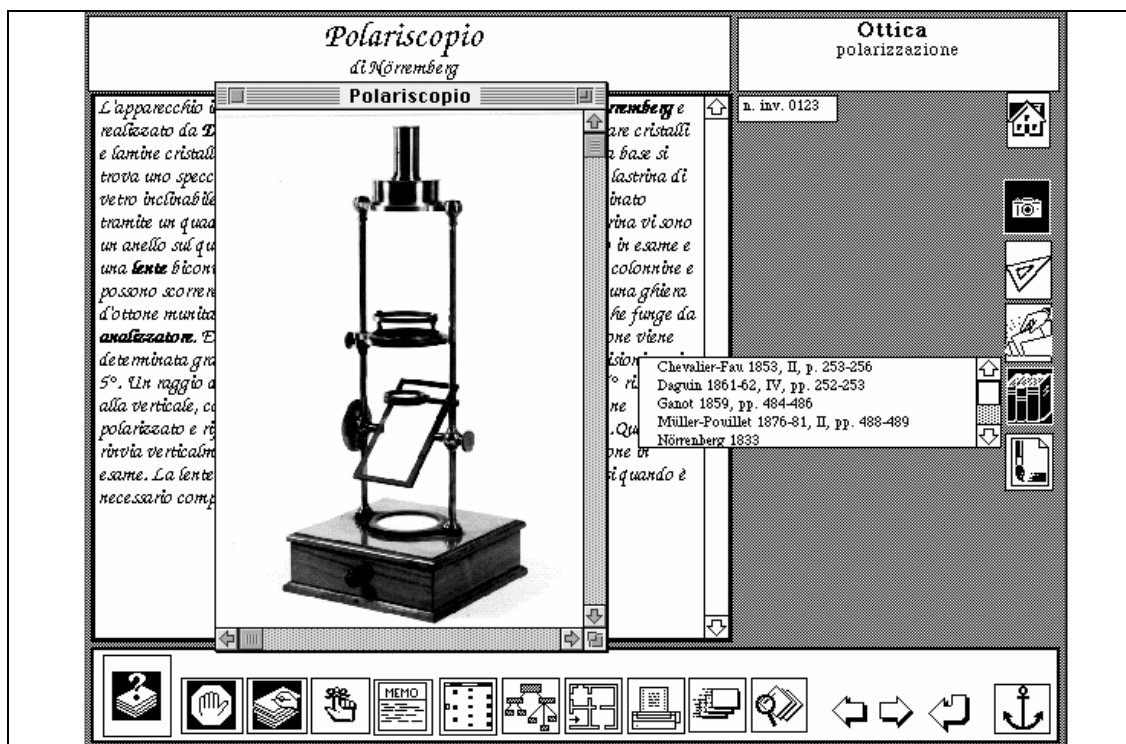


Fig. 3. A Sample 'Object Card'

It is well known that one of the peculiarities of the hypertext/hypermedia applications is the fact that the user is stimulated to be 'active', by a 'point and click' interaction style. Therefore, a precise choice has been made: on every node only a limited amount of information is automatically displayed. The user can obtain any additional information simply by clicking on the relevant icons. This choice certainly stimulates the user to follow his/her interests, avoiding the overload of information, that may sometimes obscure the relevant items that act as associative links between the information nodes.

The previous choice is emphasised by the decision of avoiding any text on the card buttons: their functions should be understood simply by the icon. This choice makes the user more interested in their functionalities and can help in case we wish to implement a multilingual version of the hypertext. It is obvious that a help function can be activated, so that the user can be aware of the effects of the several buttons present in every card. We have to notice that the positions and functions of the buttons are kept coherent in all the card types, and, even more important, they have been placed taking into account some ergonomic factors. More precisely, we grouped together the buttons that display additional information, the navigation buttons, the buttons that allows the user to select an interaction paradigm (map or classification) or

to formulate a query. Finally, we grouped together help, exit, annotation and other service buttons.

As far as the user interaction is concerned, we have to note the possibility of making annotations and marking the relevant information. This mechanism can be used to define 'guided tours', that can be stored and followed, afterwards, by other people.

Finally, it is possible to search an information node by its content, making use of the traditional operators available in any information retrieval system based on inverted lists of term extracted from the free text.

## 2.2 The Implemented Links

Referring to the previously presented taxonomy of links, we may affirm that it has been possible to implement all the types of links, with the only exception of the isomorphic links, that were not applicable in the case study. More precisely:

- *associative links* have been implemented via '*hot words*'. The different types have been visualized making use of a multiple link browser, as shown in Fig. 4.
- *Annotational links* have been implemented by a card with a pre-defined layout and an appropriate button
- *Sequential links* are supported by the appropriate button which displays information about the object (images, bibliography, measures, etc.).
- *Taxonomic links* are supported by the concept of 'class' of the object and classification thesaurus.
- *Implicit links* give origin to the links originating from any card that go to the dictionary or relevant persons cards.
- *Retrieval links* are established making use of a special '*search card*' (Fig. 5) supplied by HyperKRS™, a product that performs a single word indexing on Hypercard™ background fields.

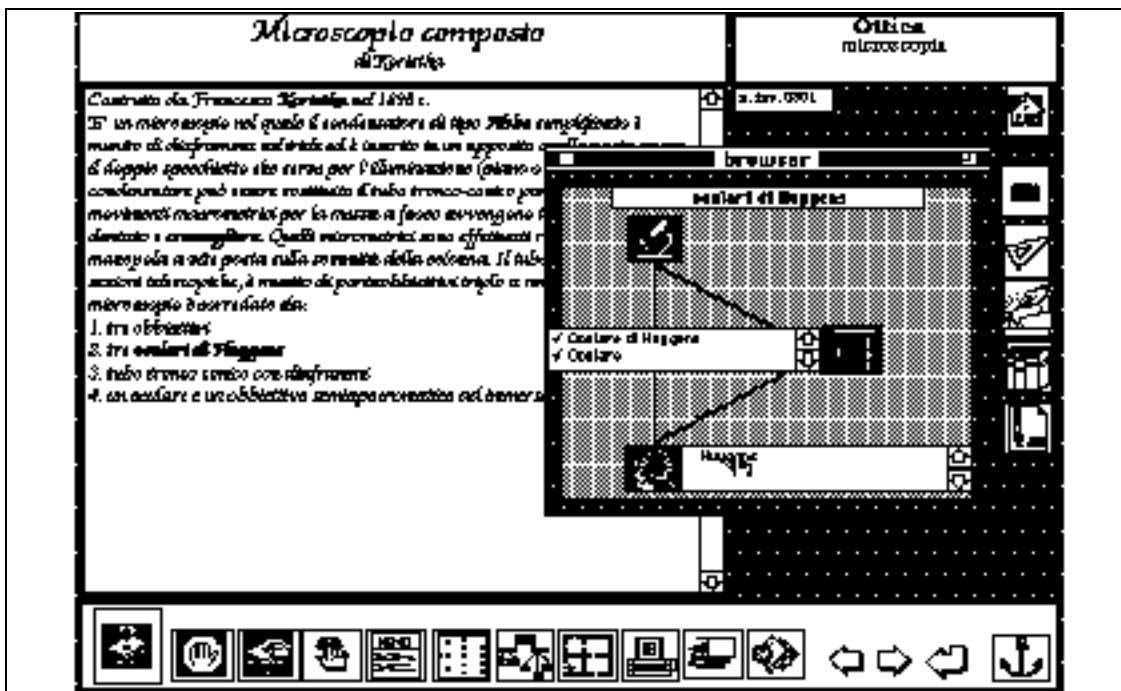


Fig. 4. The Multiple Link Browser

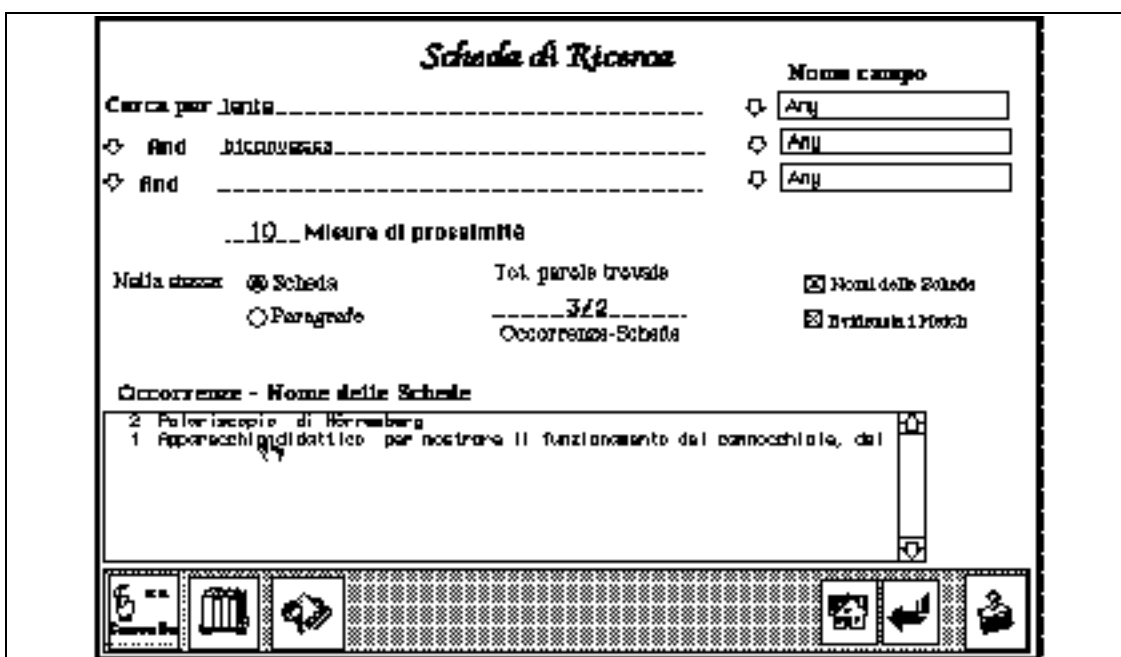


Fig. 5. The Search Card that Implements the Retrieval Links

### 2.3 Local Browsers

In addition to the multiple link browser (Fig. 4), two more have been implemented. The *references browser* is activated when the user asks for the bibliographic references: the browser contains the tag of the references. Clicking on one of them, the

user can see the extended reference, while the browser is maintained visible, so allowing the navigation through the relevant information (Fig. 6).

The *link map browser* shows all the nodes connected to the current one by a referential or relational link. Node types are identified by an icon, while the distances from the current node are calculated on the basis of the affinity between them.

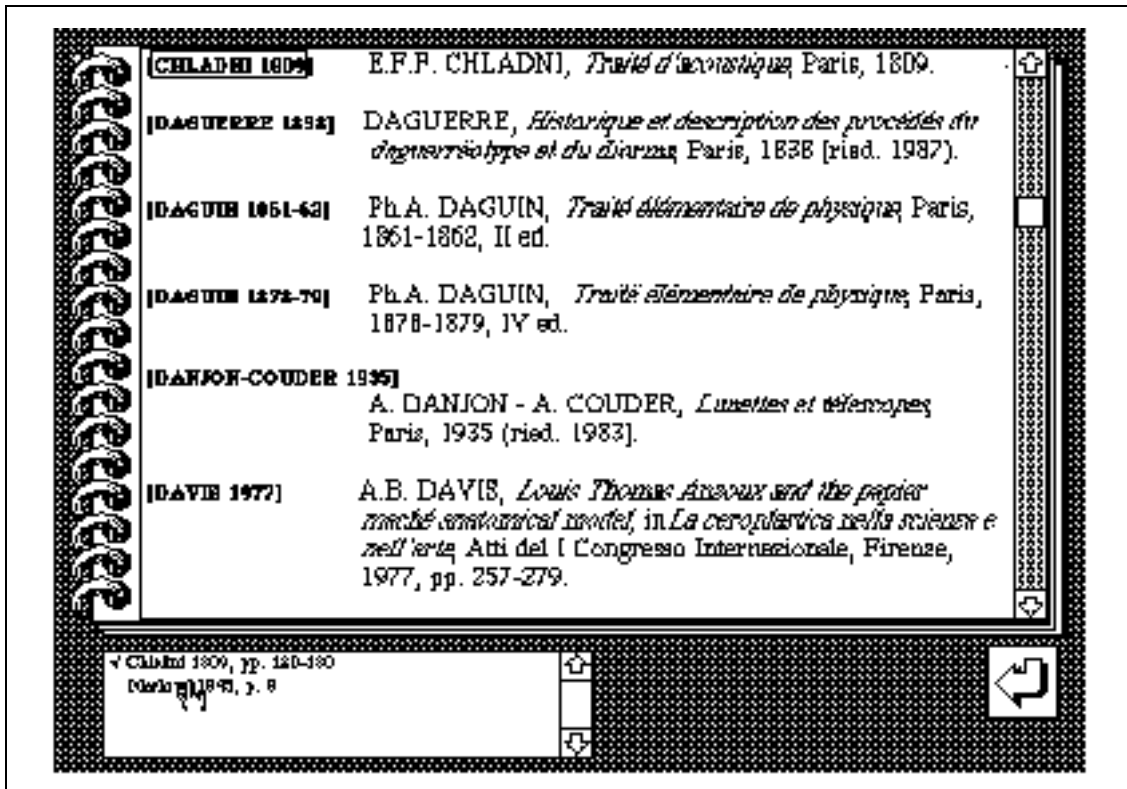


Fig. 6. The Local Browser of the Bibliographic References

## 2.4 Interaction Paradigms

We pointed out that the availability of appropriate interaction paradigms can avoid the ‘lost in the hyperspace’ effect and contribute to the usability of the hypertext guaranteeing an easier navigation.

The characteristics of the application and of the potential users lead to the definition and implementation of a Topographic (Fig. 7) and a Classification browser (Fig. 8).

The Topographic Browser shows a map of the museum, so that the user can have a look to the content of the rooms and chose the most interesting object to look at.

The Classification Browser shows a classification tree of the objects according to the category they belong to. The user can select any object and go directly to the appropriate information node.

In both case, the selected object can be used as a starting point for further navigation.

All the browsers are constantly kept up to date, so that the user can easily and safely switch from one to another metaphor, according to his/her interests.

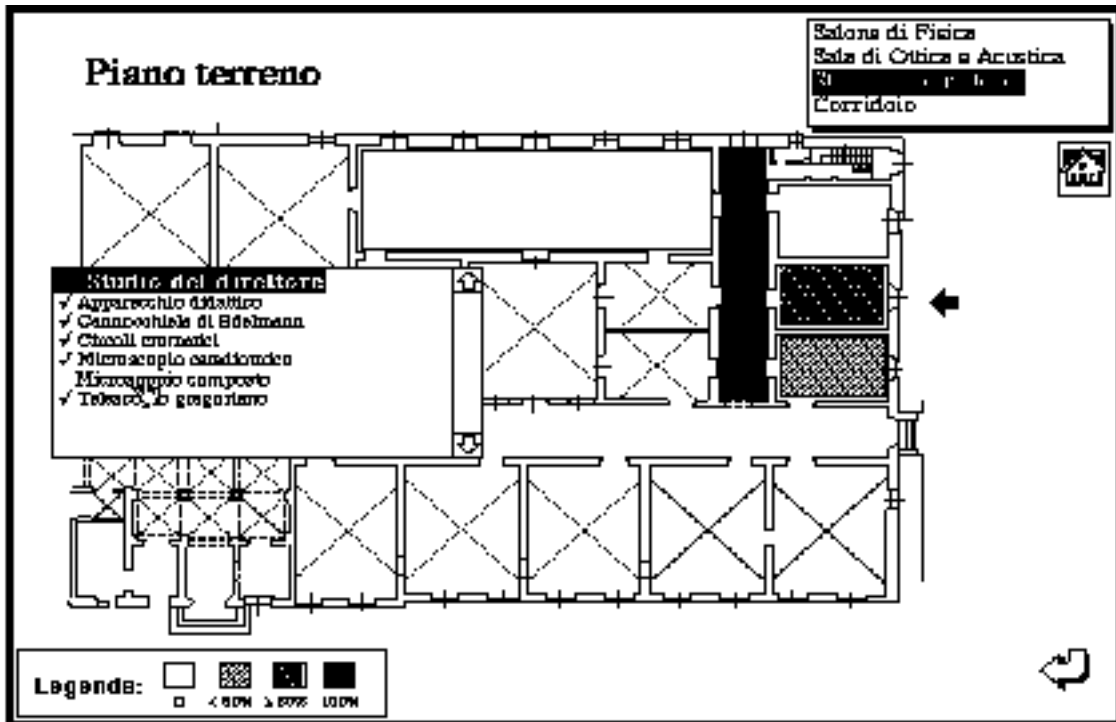


Fig. 7. The Topographic Browser

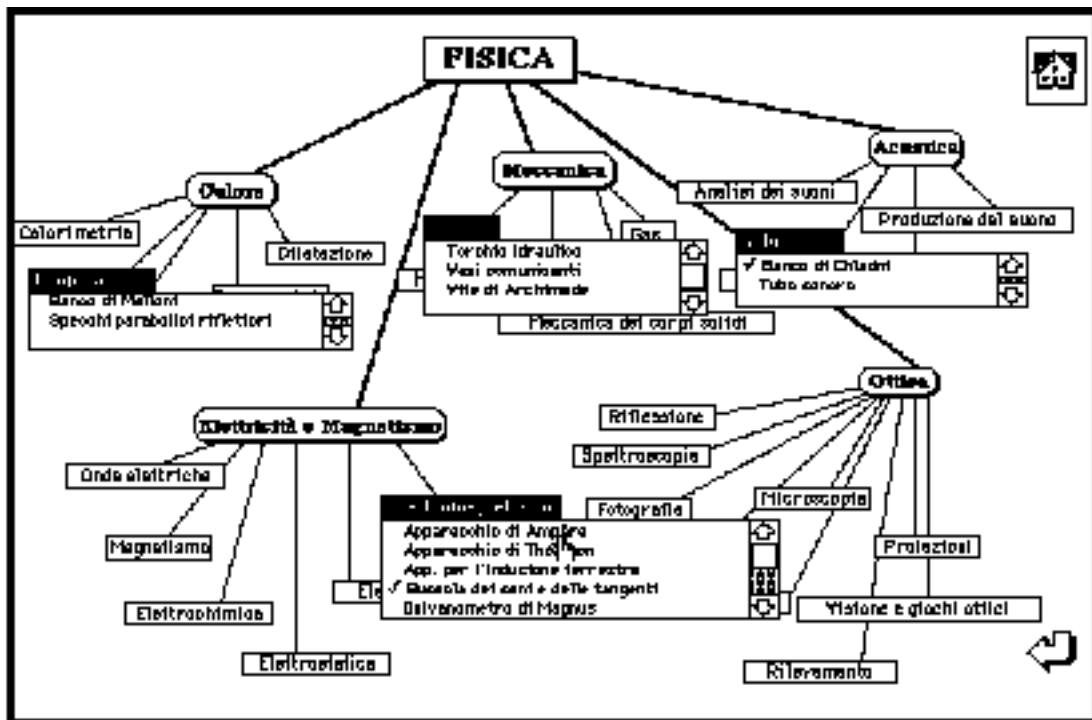


Fig. 8. The Classification Browser

## **2.5 Guided Tours**

Guided tours can be defined rearranging the cards that have been visited and marked. The user can follow the tour in automatic or manual way.

## **3. Conclusion**

In this paper we considered some general issues concerning the hypertext design, identifying the difficulties the user can encounter when navigating through the hypertext. We identified some features that could be included in a hypertext to overcome these problems, and presented as a case study a hypertext/hypermedia for the interactive visit to a Science and Technology museum. It must be stressed that the architecture of the hypertext/hypermedia, and the implemented facilities, aimed, in this first development phase, at some general methodological aspects, especially the navigation and the organisation of the information. Little attention has been paid to other mere technical aspects, like images (that, anyway, are presently managed in black and white and colour). Other aspects, essentially animation and sound (that can be easily added making use of the appropriate software extension), are presently going to be added.

At present, we are considering some improvements, both technical and methodological.

From the technical point of view, we are improving the management of the images. As far as the methodological aspect is concerned, it is worthwhile to mention the implementation of a new interaction paradigm, based on the display of the images, with the aim of increasing the usability and user friendliness. In this interaction paradigm, the user will no longer see a simple list of object names, but also a sequence of related images. A click on the relevant one will bring it directly to the corresponding node. The displayed images will be associated with the particular class, or related to the specific room, depending on the interaction paradigm he/she is currently using.

As future work, the map of links will be 'active' in the sense that the affinity of the nodes, and hence their distance in the map, will be affected by the type of links followed by the user during the navigation through the hypertext.

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