Task-Oriented Design for Interactive User Interfaces of Museum Systems

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Abstract

In this paper we discuss how task models can be useful in the design and development of interactive user interfaces for museum systems that are characterized by the possibility of different types of users. We use ConcurTaskTrees to graphically express hierarchical structures of concurrent activities. We provide examples taken from an application developed for the Marble Museum of Carrara in Italy.

Keywords

Task Models, User Interface Design, Interactive Museum Systems

Introduction

Task analysis has proved to be a useful support for the design of easy-to-use interactive applications. A description of the activities that have to be performed to achieve the user's goals should drive the design, development and evaluation of user interfaces in order to make them correspond more directly to the conceptual model of the user.

Museum systems represent a typical application which can have many types of users, each with their own requirements, tasks and interaction preferences. Such systems benefit particularly from the application of task-oriented approaches since each possible user role (expert, student, tourist, etc.) has a specific task model which provides requirements for the most suitable multimedia presentations, sequencing of interactions, navigation styles, and other aspects.

We have developed a graphical specification language, ConcurTaskTrees [PMM97], to support the work both of building task models and of discussing possible solutions in the design of user interfaces. This notation allows designers to develop a hierarchical representation of the possible tasks to perform and their temporal relationships which have to be satisfied by the corresponding user interface. In the task specification we can add many kinds of information which may be relevant for the user interface design.

Developing task models to design hypermedia documents implies a clear understanding of the possible tasks which each multimedia presentation should support. In addition, the task model indicates how to structure the components of the hypermedia and the related links in order to support the semantic temporal relationships among tasks. The hypermedia design can be further improved by the use of metrics which address different aspects related to presentation and navigation: layout should facilitate frequent tasks, links should be consistent and support compact navigation, and multimedia presentation design should enable the end user to work efficiently.

This paper presents the first results of our method applied to the design of a hypermedia that provides information related to the Museum of Marble of Carrara (Italy). This museum is dedicated to the work in the white marble quarries in Carrara along with works of art made in such marble.

Task-based Approach

Model-based approaches [FS94] [SSCMS95] have been recognized as a useful way to structure the development process. By using models which capture relevant aspects that are semantically meaningful, the increasing complexity of interactive applications can be dealt with better during their design and development and when they have to be modified.

In the area of model-based approaches to the design and development of user interfaces, task models [D89] have been recognized as an important contribution. Task models describe the set of activities that can be performed to reach some specific goals which are some desired state modifications or inquiries about the current state. Since we are considering Interactive Systems, which are character-

ized by the relevance of user interaction, it is important to structure their dynamic behavior so as to reflect the conceptual model that the end user has of the application. This means designing interaction techniques that can map the actions directly at the user interface level with the logical actions in the application domain.

Another important element is to identify a structured method for designers of effective user interfaces. In real applications the complexity of the user interface can become very relevant and thus systematic methods which provide rules for managing such complexity by incorporating solutions to recurrent problems can be very useful.

CONCURTASKTREES

Often the design of a user interface is the result of a discussion which involves many people and roles: the designer, the developer, the expert in the application domain, end users, and so on. This is particularly true in museum applications which are often interdisciplinary applications used by people with a poor background in programming.

We believe that to obtain effective user interfaces the first step is to agree on a task model for the application which is being developed. The task model is a useful specification of how the activities should be performed given a certain context of use. In our approach task models are hierarchically structured. The higher levels describe media independent activities, then further levels take into account the media and devices which have been chosen for use.

Task models allow the people involved in the user interface design to remove ambiguities in their discussion. The resulting specification is a useful document for illustrating the behavior of the application and for localizing what parts of the application have to be modified when new tasks have to be added or the modality of the performance of a task has to be modified.

In ConcurTaskTrees we indicate how the performance of a task is allocated: to the user, the application, to their interaction; or we can say that we are considering an abstract task and it is too early to identify its allocation because it needs to be further refined before making similar decisions. Different task allocations are presented by using different types of icons.

Another useful representation in ConcurTaskTrees specifications is a clear indication of the temporal relationships among the tasks. Unlike GOMS [CMN83], a rich set of temporal relationships can be indicated including concurrent tasks. Thus designers can indicate that one task must be performed before another, or can be performed concurrently, or that one task can disable another. Tasks can exchange information. We can have optional and iterative tasks and so on. Thus we have a flexible set of operators which allow designers to describe many possible dynamic behaviors.

ConcurTaskTrees specifications can be developed by a graphical editor, implemented in Java, which is in the public domain <verdolo.cnuce.cnr.it/task.tgz>.

THE MUSEUM OF MARBLE

The Museum of Marble is located in Carrara (Italy) and it is promoted by the local City Council. It is located in an area where a lot of unique white marble is quarried. This marble has been used for some very important works of art including Michelangelo's *Pieta*. Since Roman times this material has been used in many applications: architecture, handicraft and so on.

The Museum of Marble is thus an interdisciplinary Museum with different sections homogeneously divided according to types of artefacts and subjects: Modern Sculpture, Roman Archaeology and Local History, Industrial Archaeology, Technical Application of Marble, and the marmoteca (Collection of Marble). There are many sculptures around the town and these works can be considered as a natural extension of the Museum of Marble.

TASKS IN OUR CASE STUDY

To develop task models for our application we decided first to interview experts in the field and possible end users.

We soon recognized that we would have to design slightly different task models for different types of users because people with different backgrounds and

purposes interact with the same information in different ways.

The task model may also depend on the tool used to interact with the museum information. Users expect high quality information and presentation from the CD-ROM they buy, whereas a web site may have a lower quality yet it can be dynamically updated, for example to provide information about temporary exhibitions. Similarly, users expect museum kiosks to provide additional, complementary information to what they can see directly.

This paper considers three types of users: tourists, students in artistic heritage and experts. In the next sections we describe the requirements highlighted by interviews with groups of users from these three categories.

REQUIREMENTS FOR TOURIST TASK MODEL

Tourists are characterized by a low average knowledge of the topics considered. Thus the basic idea is to provide a guided tour through the rooms of the museum and the town with pictures and information about the works of art. Since tourists sometimes already have some information about the museum that they want to visit, linear pre-defined tours alone would be too restrictive so some degree of navigational freedom is important.

Tourists want general information on the artistic works, and this information has to be presented clearly and in a limited number. Thus a work will be presented by an image, the title, a short description, the name of the author, the material and technique used for its creation, and when it was made.

Additional information can be provided on request such as the path to get to the museum from the closest railway station or airport, information (title, data, location) on further exhibitions, and historical information on the town and the museum.

REQUIREMENTS FOR STUDENT TASK MODELS

The student in the artistic field who visits a museum already has some basic knowledge. The presentation of some images and related texts often stimulates a request for more detailed information. In this case providing pre-defined tours is not the right answer. Instead, we let such students choose from different types of information which may concern not only the works of art but may also involve a wider spectrum of topics, so that students can improve knowledge.

Usually students that consult a web site of a museum are interested in:

- the life of an artist and so:

  - the artist's works including in depth information on the topic of the work, its relationships with other works, the state of conservation, etc.;

  - possible related artists, and how they are related. This information should be general (like an identity card) but it should be possible to go in depth.

- main events in a specific historical period, plus the artists who characterized it;

- history of the town and the museum.

Videos can also be used to make the information more attractive.

REQUIREMENTS FOR EXPERT TASK MODEL

Expert users generally know exactly what information they want and should thus be allowed, right from the beginning of the session, to make more and more precise requests.

In this case the information required may concern:

- an artist: at the beginning a critique is presented (not a simple biography as an expert is presumed to know this already). From here it should be possible to reach the following information:

  - artist's work;

  - lists of texts which discuss the artist, plus a short summary;

  - list of Internet sites which concern the artist;

  - technical glossary;

  - information on the artists who lived in the same period and in the same area as the artist selected.

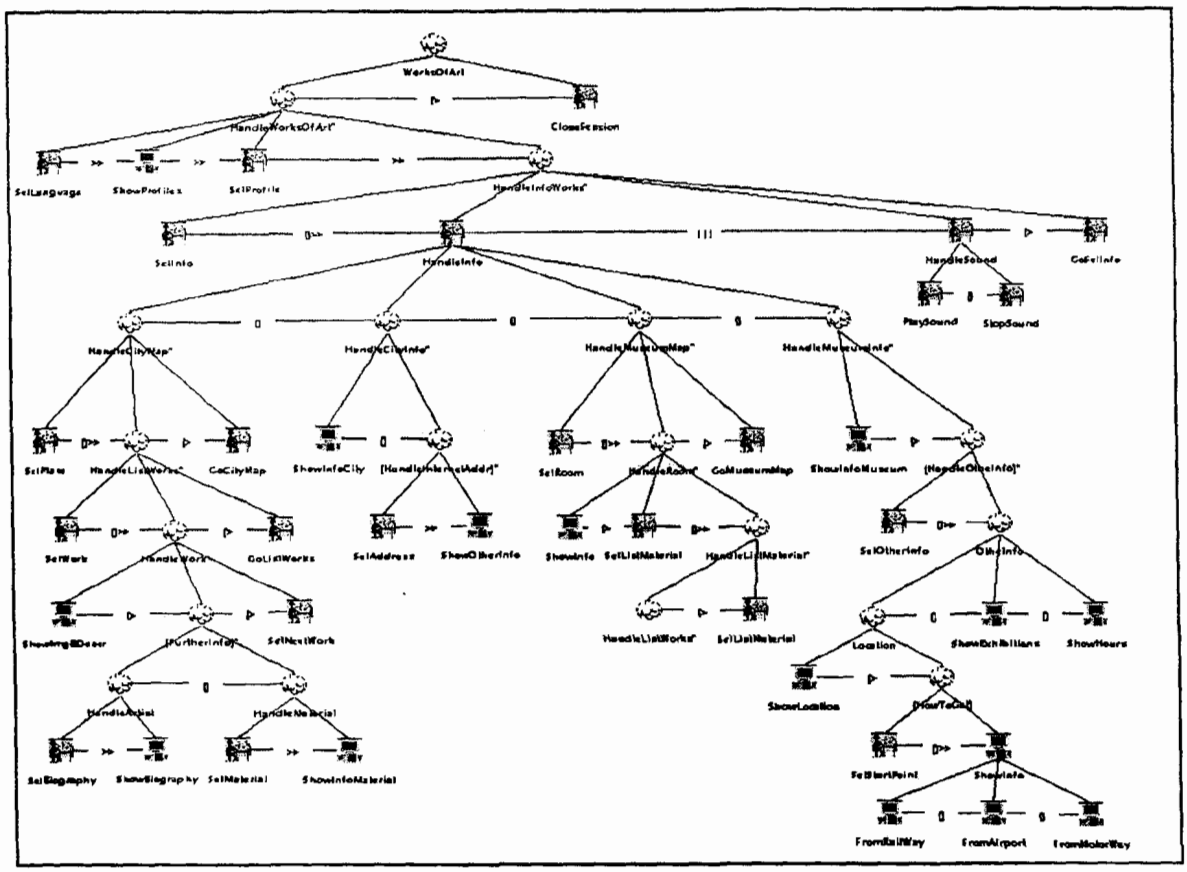

Figure 1: An example of graphical representation of a task model.

- a specific work which is presented from the point of view of the critique and not purely descriptively. From the work presentation it should be possible to reach information concerning the artist who created it and also to receive in depth description (for example providing information concerning its dimension, type of existing documentation and so on);

- a specific historical period allowing the user to reach the artists who characterized it.

EXAMPLE OF TASK MODEL

Figure 1 shows an example of task models and describes the activities related to a tourist user session. At the first level there is an iterative task (iteration is indicated by an *) *HandleWorksOfArt* which will be terminated ([> operator) by explicit *CloseSession* task. Next in the session is the user interaction for selecting the language, followed (>> operator) by the presentation of the possible user profiles. After the user has selected a profile there are the tasks associated with the user session (*HandleInfo*). The user can choose either general information or the map of the area of interest (the town or the museum) and then navigate in the related information. During the navigation at any time (|||| operator) the user can activate or deactivate some music (*HandleSound* task) and interrupt the current session to go back (*GoSelInfo* task) to the initial choice.

On the city map it is possible to select places in order to present the works which are located there. divided according to type of artifacts and subjects: Modern Sculpture, Roman Archaeology and Local History, Industrial Archaeology, Technical Application of Marble, Marmoteca (Collection of Marble).

There are many sculptures around the town and these works can be considered as a natural extension of the Marble Museum.

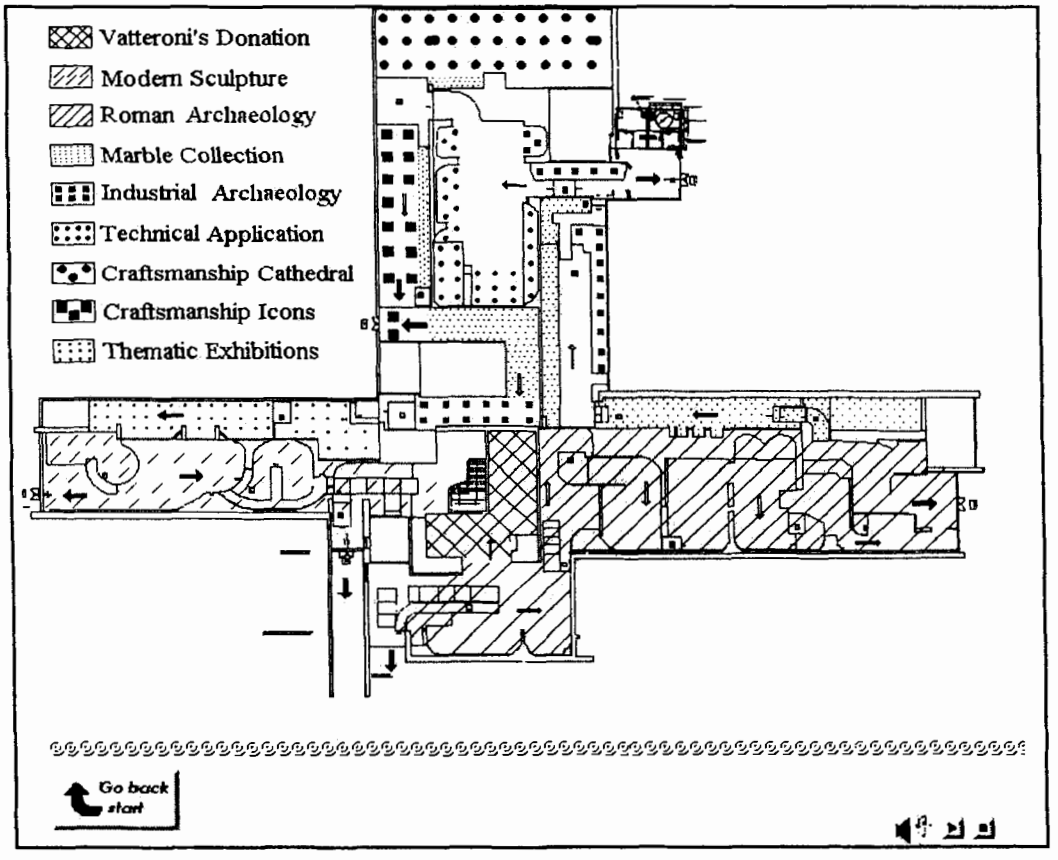

Figure 2: The interactive map of the museum.

When a work of art is selected then it is possible to get information on the artist who developed it or on the related material. It is possible to ask for general information on the town and to access sites with more detailed information.

Similarly users can select a specific room (*SelRoom* task) in the Museum map (Figure 2) and then get information about the works which are in it (an example is in Figure 3). These works are grouped by the type of material and finally the user can select one specific work (an example is in Figure 4). By selecting Museum information the user can ask for information such as how to get there from the railway station, airport or motorway, details of the planned exhibitions and opening times.

As you can see the task model is characterized by a hierarchical structure. It is possible to stop its development at different abstraction levels depending on the aspects that designers want to analyze (they can vary from high-level conceptual elements to low-level action sequencing which should be supported by the implementation).

FROM TASK MODELS TO HYPERMEDIA MODELS

The task model can be used to drive the design of the hypermedia structure underlying the user interface which will be used to communicate with the user. More specifically, the task model is useful for designing more user-oriented interactions because they will be structured according to the user's conceptual model of the possible activities, including navigation in the multimedia data.

We have developed a method which allows designers to use the task model to identify the elements of a hypermedia and their relationships.

The tasks at the high and intermediate levels are useful for structuring the main elements in the

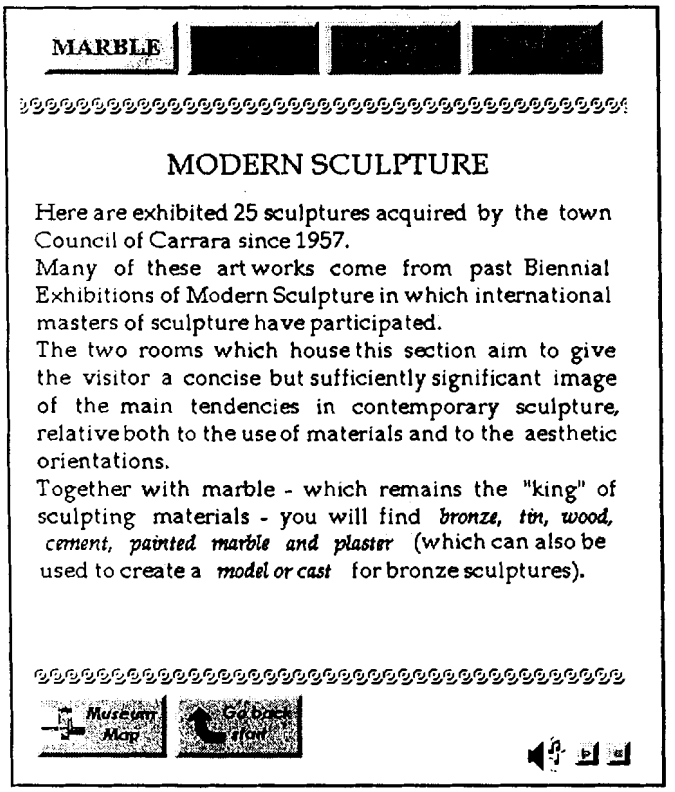

Figure 3: The presentation of a section of the museum.

hypermedia. Thus by a top-down analysis of the task tree it is possible to determine the structure which has to be given to the multimedia data, trying to avoid inconsistencies between what has been specified in the task models and what can really be done in the implementation. For example, if at the task level it is specified that after presenting one work it is possible to pass to the next work (according to a given order) at the hypermedia level we must have a link between the two works.

The basic tasks (the leaf nodes in the task tree) are used to identify precisely the interaction techniques and detailed aspects in the hypermedia structure. The design choices at this level are deeply affected by the features of the tasks considered, the type of user who performs them, and the type of interaction environment used.

Thus we have further subdivided the basic task categories. In application tasks the type of presentation depends on the type of information which has to be provided. Thus we have identified the following application type tasks: description, visual, spatial, and alternative.

Description tasks are used when descriptive information has to be delivered and thus require textual presentation. More specifically, if the user is a tourist and a work of art has to be presented a simple caption will be used whereas if historical information (on the town, the museum, etc.) have to be presented short summary schemes will be used with a limited number of characters. In both cases it is important to use fonts that help to make the information presentation clear. If the user is a student and information on works, artists or historical periods have to be presented, long well documented texts or videos should be used.

Visual tasks will be used when visual information (such as an image of a work or a picture of the town) have to be presented. Spatial tasks are used when the location of some item has to be indicated. In

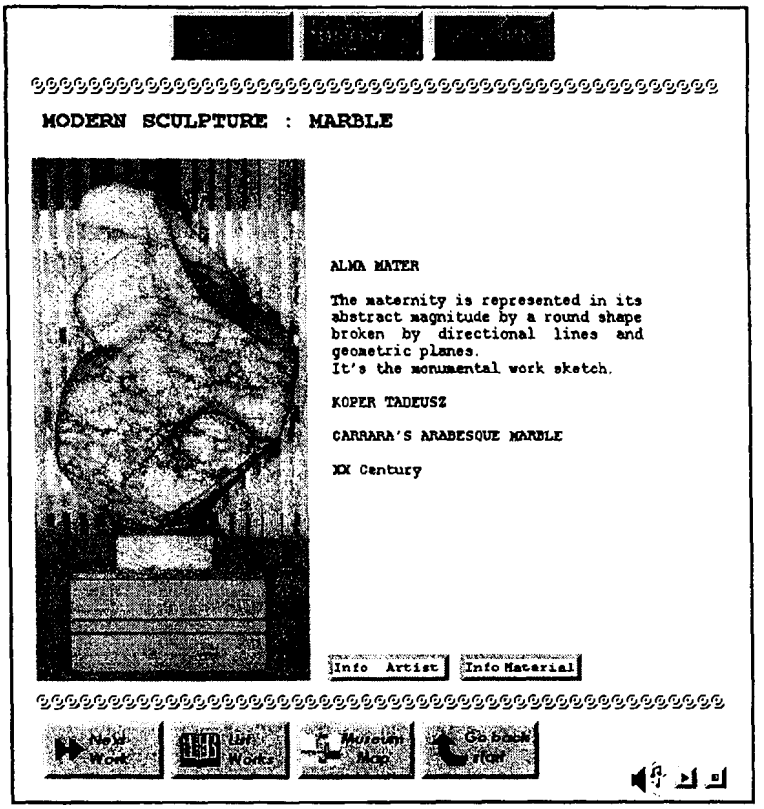

Figure 4: An example of presentation of information about a work of art.

this case we will use images with some specific areas highlighted (for example museum maps with different rooms colored differently).

Interaction tasks in a hypermedia environment require the use of links or other interaction techniques. There are different types of interaction tasks too: selection, control and editing. The selection task allows the user to make a choice. If the user is a tourist the various possibilities should be presented by well distinct objects and areas (using clear labels or images to highlight them). Whereas if the user is student or an expert, then embedded anchors or lists with selectable items can be used as well. Control tasks gives the possibility to generate events which activate related processing (for example playing audio).

The task model can also give useful information on how to design the dynamic behavior of the user interface of the hypermedia document. Depending on the temporal relationships among tasks we can decide when some interaction techniques will be available to the end user.

If a task T2 disables a task T1 then the related interaction techniques should be available at the same time. At the beginning the user will perform T1. When the first action associated with T2 occurs then the presentation elements associated with T1 will disappear. For example T1 can be the *ShowLanguage* task which indicates the possible languages which can be used to present the museum information, and T2 is the *CloseSession* Task. When T2 is performed the information associated with T1 will disappear.

If there is a sequential enabling relationship between two tasks then the presentation of information associated with the second task can be performed only after the termination of first task. For example, if the first task allows the user to select the preferred language to present information and the second task allows the system to show a set of already defined

profiles and there is a sequential enabling relationship between them, it means that possible user profiles will only be presented after the user has selected the preferred language.

It is possible to have information communication between the terminated task and the task enabled. Another possible relationship is the choice among tasks. This implies that at the beginning the user is allowed to make at least the first action associated with the possible tasks. Then depending on the user's choice, the interaction techniques associated with the chosen task will be made available and those associated with the other tasks will disappear completely. For example, the user can decide to get information on the town or on the museum. Depending on the choice only town-related or museum-related information will appear.

If two tasks are concurrent (the first action of one task can be performed before the last action of the other task) then the related presentation techniques can be available to the end user at the same time. For example, it is possible to show a video and manage the sound concurrently so that during the video presentation the user can enable or disable the sound.

THE RESULTING HYPERMEDIA

This section outlines the structure of the resulting hypermedia using concepts similar to those of the HDM model [GPS93] to describe it. The information concerning the Museum of Marble is organized into entity types such as Town, Street, Museum, Room, Artist, Work, Material, and Historical Period. The applicative links are associated, for example, to the relationship in terms of contents between the Room entity and the Work entity. Some entity types have been structured as collections. For example, collections of works have been created that are associated with a given material. There is an index from where it is possible to get direct access to a member of the collection or all the members can be visited sequentially, for example in alphabetical order.

The existence of different user typologies each with their own specific requirements stimulated us to design the nodes, the elementary information containers, in such a way as to allow different views of them (each related to the user's role). This means that the basic information is the same for the different user types but it is communicated differently. For example, a work type node can be presented as a schema if the information is for a non expert user whereas it can be a detailed text if the user is an expert in the field.

Besides having different perspectives on the same node, we also have to take into account that a component can be composed of multiple nodes and it is not necessary to allow all the users to access all of them. Consequently we have links in the data structures which are sometimes not presented. For example, an entity of work type can be composed of two nodes, the first of work description type and the second of technique of development type: the information contained in the second node will only be presented to users who selected the expert profile and who are most likely to be interested in this information.

CONCLUSIONS

We have presented the first results of a research which applies a task-based method to the design of an interactive user interface for supporting navigation of museum information. During this part of the work we often realized the utility of using task models especially when we had to discuss the design solution with possible end users and people managing the museum, since they represented a precise description of what the interactive system behavior should be.

The resulting task models have been used for developing a hypermedia so as to obtain an interactive implementation consistent with the requirements expressed at the task level.

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