

Providing spatial navigation for the World Wide Web

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Abstract

The World Wide Web (WWW) is a rapidly growing distributed hypertext on the Internet. This paper presents a way to enable users to navigate the WWW spatially by providing a spatial user interface metaphor in a textual virtual environment. This may help users to orient themselves in the masses of information available. The term "spatial navigation" stresses the fact that the structure of the information space is made explicit in this type of navigation whereas hypertext itself, and especially the WWW tend to hide this structure. We review common navigational strategies on the WWW and point out how these strategies indirectly make use of the underlying structure of the information space. Whereas hypertexts hide their structure, virtual environments explicitly show it. We outline navigational differences between hypertexts and (textual) virtual environments and describe a way to combine the advantages of both. In our system, presently implemented at the Georgia Institute of Technology, a textual virtual environment is combined with the WWW to create a mirror space to a part of the WWW. Navigating this virtual environment users also navigate the WWW, but in a spatial way. The system supports interaction between users and therefore collaborative navigation. This allows conducting guided tours and describing paths to information vaguely, like in real environments.

1. Introduction

The World Wide Web (WWW) is a distributed hypertext system based on the Internet. Like in ordinary hypertext a WWW page consists of information and (hyper) links, objects containing a reference to another WWW page. When activating the link the corresponding page is fetched and displayed. As the WWW is a distributed hypertext the fetched page does not have to be available locally; instead it can be located on any WWW server worldwide. The linking process is transparent and the user does not need to know what server the information comes from. This transparency, the relative ease of use of most WWW browser programs and the rapidity of the access is the main reason for the popularity of the WWW.

The World Wide Web - sometimes also simply called "The Web" - presently is the fastest growing man-made construct. The larger the Web gets, the more obvious navigational problems become. Many of these problems are typical hypertext problems, others are typical to the Web.

In the hypertext field it is generally assumed that navigation in hypertext is not difficult per se but that it can be easy when the structure of the information space is made explicit [SHUM90]. See also [KiHi94] for a study that transfers way-finding knowledge to the hypertext field.

Ironically the most popular feature of the WWW -- the transparency of the linking process -- works against making the structure of the information space explicit. It is easy and pleasurable to browse or "surf" the Web, which means to navigate it in an undirected fashion. Locating information *quickly* is more or less impossible however. Besides this impossibility of goal-directed navigation there are other navigational problems which will not be covered here.

In section 2 of this paper we describe typical navigation strategies on the Web and show how users often try to supply navigable structures for the Web themselves. In section 3 we describe textual virtual environments (MOOs), their space concept and how they are navigated. Section 4 presents how the MOO and the WWW can be combined to create a spatialized Web and how navigation in this system works. Section 5 describes a particular example of a spatial navigation metaphor for the Web -- a URL shipping mall metaphor. A few other possibilities are outlined in section 6. The paper concludes with a summary of navigational problems of the Web and how we think the MOO/WWW combination can solve some of them.

2. Navigation in the WWW

Hypertext is nonlinear information, which means that the author does not have complete control in which order users access it. Instead the author provides a set of nodes that are linked by hypertext links (pathways). Reading hyperdocuments is a task of navigation through an information space defined by the linking structure.

2.1. Navigation in hypertext

Parunak compared real world navigation to hypertext navigation and found 5 main navigation strategies in hypertext [PARU89]:

- The identifier strategy permits the searcher to identify the target upon encountering it.
- The path strategy uses a procedural description to get to the target.
- The direction strategy depends on two characteristics of the space navigated: texture and comparability. Texture is the existence of a distinguished point relative to which directions can be established, whereas comparability is the existence of a relation between two points of the space.
- The distance strategy tries to reduce the distance between searcher and the target.
- The address-strategy requires knowledge on how to resolve an address and then navigates directly to the address of the target.

The usefulness and availability of these strategies for hypertext navigation relies on the topology of the hypertext (see also section 2.2.). Hypertext essentially defines a topological information space where the hypertext pages are nodes connected by links. The presence or absence of links between pages defines a connectedness or distance relation. Pure hypertext defines no other concept of distance between nodes.

It was mentioned that hypertext navigation is assumed to be easier in an explicit structure. Such a structure would define concepts of location, distance and direction.

"A possible way to localize a user in a hypertext is to impose a structure on the hypertext and to identify the user's location within that structure" [RiBO94] (p.88) (see also [NiWe80]).

Such a structure helps users to develop a structural understanding of the information space based on spatial metaphors most users use anyway: "(...) Users tend to make heavy use of spatial metaphors: they report feeling "lost", speak of going "up" and "down" between levels or going "in" and "out" of situations. Users often spontaneously construct spatial mental models or mental "maps" in order to move easily from one context to another. This has obvious implications for design. Reducing the memory load on the user is one benefit of making these mental "maps" explicit." [SeNi90] (p. 150)

2.2. Navigational strategies used on the WWW

Most hypertexts, and especially the WWW hide concepts of location and structure from the user. This lack of navigational structure in the Web lead to an interesting social behavior: Users freely provide the necessary structure for themselves and for other users. We see this behavior as a signal that a more explicit structure is needed so badly on the Web, that users start to generate this structure themselves.

Many navigational strategies rely mainly on this structure provided by users and therefore they are significantly different from strategies in single-user hypertexts. Of the five strategies described by Parunak only the address strategy is commonly used on the Web whenever a node is referred to directly by its address. Such an address is called Uniform Resource Locator or URL. The distance, direction, and path strategies are nonexistent on the Web as the necessary structural concepts are not available.

The only way to make use of the identifier strategy is by employing "Webcrawlers", programs navigating the Web and collecting keyword-information in databases. These services blur the structure of the information space even more as all contextual information is lost. Both the address and the identifier strategy ignore all structure on the Web. All other strategies (except for free browsing which is no "strategy") rely on the Web's hidden structure.

2.2.1. Navigating using other people's knowledge

Navigation strategies on the Web often rely on the expertise of other users. As it is difficult to *re-find* information users collect lists of addresses (URLs) of interesting pages. These lists are called hotlists. Many users invest much time and effort to create well structured Web pages from these lists and make them available to other users by linking them to their home-pages¹. When looking for information it is therefore a useful strategy to look at home pages of people with related interests [ERIC95].

Another possibility is to consult a web directory, most of which are again maintained for free by web users. An example is the Yahoo List². The WWW has reached a state where the important issue for information providers is not to have information on the Web but to have a pointer to this information in a Web directory or many hotlists.

¹ Home-pages are Web pages associated with individuals or institutions.

² The Yahoo list is at <http://www.yahoo.com/>

2.2.2. Navigation using an existing structure on the Web

The Web has also a geographical structure, even if the browser programs try to hide this fact from the user. This geographical structure allows employing a navigational strategy that is tied to the location of the institution running the Web server -- this strategy is particularly useful when looking for university or company related information. When looking for specialized information it is a good start to look at the server of a university strong in that field, or at the company selling the product interested in. These servers often carry also pointer lists to related information providers. Whereas university servers are geographically localized this is not necessarily true for large companies. So this strategy makes use of a geographical structure in the former and a more abstract structure in the latter case.

While these strategies use an existing structure of the WWW without making it explicit, there are URL-lists that are organized only according to geographical structure. Using such a list makes the geographical structure visible to the user.



Fig. 1. The Virtual Tourist map for Europe.

An example is the Virtual Tourist page, that allows people to navigate from a global view to continents (see Fig. 1) and further to countries (see Fig. 2), regions and cities³. Navigation is geographical till the user reaches a list of servers in a selected region or city. This list often contains a summary of the server contents. The Virtual Tourist page therefore combines a geographical strategy with using "somebody else's knowledge".

A similar approach is realized in the City.Net pages⁴. Again the user can navigate geographically but City.Net present countries and regions as sorted lists and therefore might be better suited for geographically less proficient users.

³ The Virtual tourist can be found at: <http://wings.buffalo.edu/world/>

⁴ The City.Net can be found at: <http://www.city.net/>

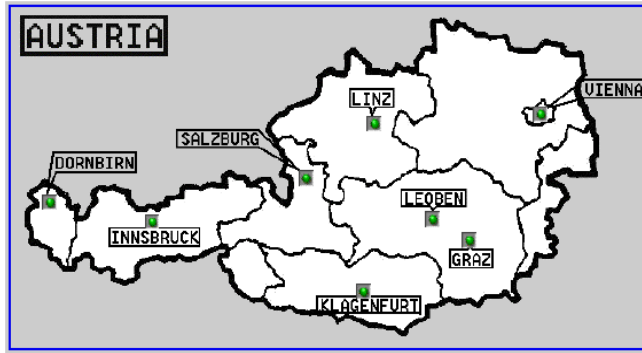


Fig. 2. The Virtual Tourist map for Austria.

2.2.3. (Re-) defining structures on the Web

Instead of relying on existing structures it is possible to create virtual geographies for the Web [DiBo95]. An example was the now defunct WebWorld system, which defined a virtual landscape (see Fig. 3).

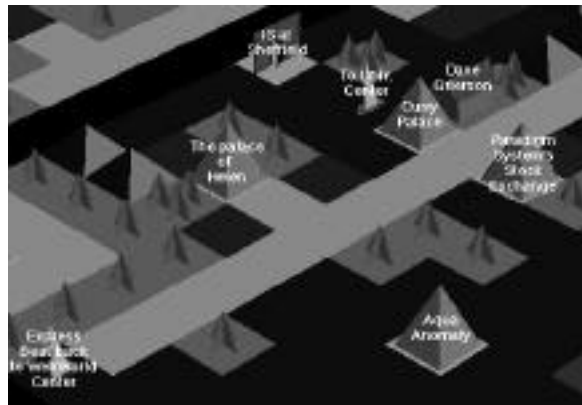


Fig. 3. A screen shot of the now defunct WebWorld system. Spatial grouping in this system was done by the users and often signified topical closeness.

In this landscape users could place objects that represented links to WWW pages or transitions to other WebWorlds. Users with related interests or work areas often gathered their objects in an area. Closeness therefore indicated relatedness to a group topic even if the object names didn't directly hint at a relationship.

Another approach to handling hypertextual information spatially is realized in the VIKI system. VIKI detects structures in the arrangement of objects manipulated by the user. VIKI has been used to organize WWW hotlists but it is not available on the WWW [MaSC94], [MaSh95].

2.3. Give the user what she needs

Web pages essentially are user interfaces for information access. The designer of these interfaces (the authors) have to anticipate navigational needs to provide useful

information pathways. In this respect Web pages are similar to real life spaces, where the "author" (city planner or architect) also has to anticipate the navigational needs of the users (inhabitants) to provide useful pathways.

To support navigation well it is not only necessary to define a useful, visible structure but also to give additional information about locations (link destinations). Most Web browsers show if a user has visited a link already ⁵. Examples of useful additional information are the size of the object reached through a link, the speed of the network connection (often related to geographical distance) and so forth. The Audible Web system, for example, is a WWW browser, that tries to communicate such additional information using sound cues [AlBe95].

The discussion so far ignored approaches of visualizing hypertext structures as overview maps or fish-eye views. These approaches rely on a discernible structure in the hypertext and it is this lack of obvious structure we are concerned with. The entire Web also is far to big to be visualized this way. For information on these approaches see for instance [MuFH94], [MuFH95], or [SaBr94].

3. Navigation in textual virtual environments

Textual virtual environments differ from graphical ones in their text-based representation. Locations, objects, users, and their interactions are described textually [CuNi93], [ERIC93]. The textual interface provides descriptions of a rich and detailed virtual world. Typical examples of such systems are textual adventure games played over the Internet, often called MUDs (Multi-User Dungeon) or MOOs (MUD Object Oriented). For the sake of simplicity we refer to all types of these systems as MOOs in this paper.

3.1. How do MOOs work?

In a MOO the user is located in a textually described "room" with other objects and other players. The concept of the MOO room is a metaphor for "location" or "mode". Exits from a room act as links between these locations. Because of the similarity to the hypertext node and link model MOOs are sometimes considered a special case of hypertext.

MOO users may communicate by talking using the say command. A line of text "said" is displayed to all other players in the same MOO room. There are also other forms of communication in the MOO. Players can also interact by giving objects to each other, by manipulating objects and by moving through the MOO space.

Navigational command like "go north" or simply "north" move a player character through the north exit of the MOO room to the next room. Typically MOO rooms provide rectangular exits like up, down, north, west, east, south but other directional exits like southwest occur as well. Non-directional exits use the name of a location or a direction in a different reference frame -- for example "shop" or "out". While directional exits are associated with directions in the environment the direction of these non-directional exits has to be inferred by the user from knowledge about the

⁵ Revisiting nodes is sometimes considered a sign of disorientation in hypertexts. However it is also a necessary prerequisite for learning paths and landmarks in an environment. See also [LYNC60], [DIEB94] and [KiHi94].

environment. Exits can also be realized using special commands like "climb rope" or "enter tramway", which are also non-directional exits. It is up to the designer of the virtual space if these exits follow the same conventions as in a real environment (see section 3.3.2.).

Here is a short example of a MOO session that shows how users can interact with objects and other users. User input is shown in bold letters. The liana described in one rooms is a non-obvious room exit and can be used with the command "climb liana".

```
You are in the local pub.
(...)
> west
A small town yard surrounded by houses.
To the west you can see a small break in the buildings.
North street starts here.
    Obvious exits: north, south, west and east.
> south
A long road going east through the village. The road
narrows to a track to the west. There is an alley to
the north and the south.
You see a liana hanging down from the sky.
    Obvious exits: north, south, west and east.
    Juggler is here.
>say hello Juggler!
You say, "hello Juggler"
>emote smiles
Andreas smiles
Juggler gives a book to you.
>look at book
This is a heavily used address book. It contains pointers into the
WWW. The book belongs to Juggler.
```

Because of the rich interaction possibilities in the MOO the space of the MOO is also a social "place". Many MOOs on the Internet evolved to virtual communities and in these communities similar social behavior as in real environments can be observed. For a discussion of how such spatial interfaces evolve to "interplaces" see [ERIC93]. The rooms in these systems can also be interpreted as sites or modes of a spatial user interface as it was described in [NiWe90]. Navigation between such sites and modes is possible along paths or trails which again stresses the spatiality of the system.

3.2. The space concept of the MOO

Directions in the MOO are often given directly in the naming of exits. which does not define a location for a MOO room. Locations are inferred from the naming of exits, from the room contents, and from how the transitions between room are described. MOO rooms possess neither size nor form and the player character does not inhabit a certain location inside the room. They are described as if the player would perceive the room as a whole. Users therefore assume the rooms to have a size and shape that "fits" their mental model of the area described. This allows to create spatial structures that do not occur in real environments (see section 3.3.2.) and that allow novel types of spatial navigation. Most users are surprisingly flexible in coping with unusual spatial structures [DIEB94].

3.3. Navigation in MOOs

Most MOO areas are designed to represent virtual cities or landscapes and navigation in these areas is similar to navigation in an unknown city. Users always log in at the same location and explore from there. They first find a few interesting places nearby and learn how to get there and back, which comprises basic route knowledge. From these few known locations they explore further till they gain overview knowledge of a limited area of the MOO. Almost nobody ever learns the entire environment because it is far to large. Many MOO systems contain over 10.000 rooms.

As in real environments navigation in the MOO relies on learning landmarks, that is places with a "distinct look" or "functionality". In a set of informal interviews (described in [DIEB94]) people described rooms as distinct, when they contain many objects or people, are described as having a special layout, are often visited, have many exits, are near to another important place and so forth. In this respect MOO rooms function similar to locations in real environments, see also [LYNC60], [DIEB94], [TrDi95]).

One of the problems in MOO navigation is how to communicate this distinct "look" to the user. It may seem a good idea to describe MOO locations in much detail but large textual descriptions tend to look similar on first glance. Also most users will not bother to read a long description. Drawing on genre knowledge a lot of information can be given in a few words however, as in the following description:

```
You discover a secret chamber in the pyramid. Wherever you direct
your torch you see gold gleaming.
    Obvious exits: out.
```

Even this short description manages to evoke a strong mental image which would be difficult to evoke using graphics alone. Whereas most users are able to perceive a picture in one glance MOO users have to *read* the whole text. Very few users perceive the formatting of a room description as a "picture" [DIEB94]. Also when several rooms are described using similar text they cannot easily be perceived as different. Despite all these problems navigation in MOO environments works surprisingly well after a short period of getting used to the system.

3.3.1. Navigation strategies in MOOs

Most MOO users learns only a small part of the MOO but they are able to navigate this part quite effectively. They often reach a location by executing a series of walk commands like "s, e ,e ,open door ,down ,n ,e ,e" without even looking at the screen. Such a series of commands acts as a relative address for a location. For destinations outside the well-known set of rooms users refer to other people by asking them for directions.

People refer to rooms by their names, their functionality, keywords (objects) in the description or by relative location ("it is s,e,e from the shop"). Like in a real environment it is possible to describe a path to a location using incomplete and even slightly incorrect information.

MOO navigation often is a collaborative task. Players are not restricted to communication within the same room. Instead they can communicate also with players in other MOO rooms. It is therefore possible to guide players by giving

instructions remotely. Should a player get lost in the environment there often are also teleport features that transport them to a landmark [DIEB94].

3.3.2. Peculiarities of navigation in virtual space.

If a MOO is designed with an overall consistent spatial concept any deviation from this concept is perceived as something magic and called a magic feature. When magic features are not well designed and when their effects are not described well they may be more hindrance than help. Especially in MOO systems designed to access information well designed magic features often make navigation much more efficient.

Most MOO designers try to create a more or less realistic environment and they even design areas on maps before coding them. Spatial discrepancies in the environment like overlapping rooms or exits that tunnel through the MOO space therefore occur by intent. These features often make the environment easier to navigate. Several magic features have been described in more detail in [DIEB94] and [TrDi95].

4. Combining the advantages of the WWW and the virtual environment

In a system we currently build at Georgia Tech we combine the navigational facilities of a MOO with the WWW. Such combinations have been realized for gaming purposes already - however, as far as we know, all these systems used Web pages to navigate the MOO (for example the htMUD system⁶), whereas we use the MOO to spatially navigate the Web.

We provide a MOO environment that represents a spatialized version of parts of the WWW. The spatial navigation in the MOO does not replace the pure hypertextual navigation in the Web, but enhances it. The MOO actually serves as a spatialized hotlist containing landmarks in the WWW and as such a spatial environment in which the user can reach important entry points into the Web by navigating spatially.

The discussion so far seems to state that the spatialization of hypertext essentially will help in navigation. Although there is evidence that making the structure of information explicit helps people using it there is little evidence that all spatial structures are equally helpful. Therefore we based the design of our system on navigational research on MOO spaces as reported in [DIEB94], [TrDi95].

4.1. The MOO client - combining the MOO and the WWW

In our MOO environment we associate URLs with rooms, objects and activities. Activity in the MOO (for example entering a room) retrieves the associated URL and causes the corresponding Web page to be displayed in a Web client. Navigation in the MOO-space therefore results in navigation in the Web-space. For the user this creates the impression of moving through *one* information space on which she has two different views⁷. This illusion is particularly strong when MOO objects contain also a textual description of the Web page. Especially when Web pages are large (like in the case of video files) or when the connection to the Web browser is temporarily disabled this double occurrence of information makes the system more usable.

⁶ Information on htMUD is available at <http://www.elf.com/~phi/htmud.html>

⁷ The association of information in the WWW to objects in MOO space realizes a mnemonic space like it was used in mnemotechnics by Greek rhetoricians as described in [YATE66].

Well-designed information spaces require the designer to separate structure information describing space from content information. In a textual virtual environment this separation is a difficult design problem as structure and content both are described using text. It is possible to convey both types of information in a MOO room description but this approach requires a strong enough visual separation, for example separating lines [DIEB94].

For the sake of simplicity our system uses two separate windows. This solution is less than optimal, but it allowed us to create a usable prototype of our MOO client within a few days. The client is implemented in HyperCard 2.2., a rapid prototyping tool for the Macintosh, and we use the Netscape WWW Browser as the Web client. The two clients act as two windows into separate but related information spaces (see Fig. 4).

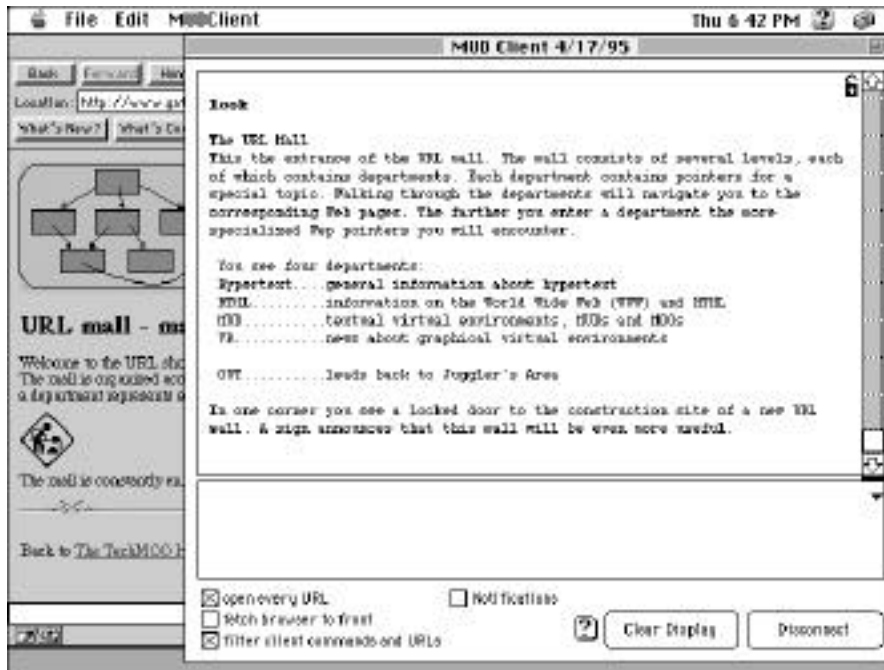


Fig. 4. The combination of MOO and Web client shows two views of a single space.

Presently we explore various possibilities of spatial navigation in the Web. In the summer '95 quarter we will try to hold a telecourse in technical writing using this system. We hope to gain valuable insights in how people make use of the spatial environment to organize and exchange information.

4.2. Navigating the WWW by navigating the MOO

What are the advantages of the MOO/WWW combination over using a Web client alone? One way to see this combination is as a spatialized WWW hotlist that also allows to interact with other users. The spatialization can be done either by an administrator or by the user community. The structures we represent in our system are only small subsets of the Web. Representing the whole Web or even large parts thereof is impracticable as it changes its contents and its structure too rapidly. A spatial environment that changes its spatial structure that fast would be impossible to

navigate. Therefore we use mainly quite stable Web pages or Web pages that are likely to exist for a longer time. These pages represent landmarks in the WWW that can be found easily using spatial navigation in the MOO. The spatial structure in the MOO mirrors a logical structure of the material on the Web.

Our system is also a useful tool to design fixed paths through the Web. As MOOs allow guiding other users it is also very easy to conduct a guided tour through the WWW using this system. According to Zellweger "Users are less likely to feel disoriented or lost when they are following a pre-defined path rather than browsing freely, and the cognitive overhead is reduced because the path either makes or narrows their choices." [ZELL89] Such a type of path structure can be easily defined in the MOO as a pathway through the MOO/Web.

The focus on spatial navigation in our system does not hinder users to switch to the Web client and to use hypertext-style navigation. While using the Web client the player stays stationary in the MOO. In case she should get lost in the Web she simply switches back to the MOO client and updates to the corresponding Web page. This feature is similar to teleporting back to a known landmark.

5. Example - a shopping mall metaphor

In this section we describe a simple shopping mall metaphor implemented using our system. The mall is used to spatially navigate a hotlist by topic.

5.1. How to navigate structured lists

The "URL Mall" is arranged according to subject and to level of detail inside a subject. The mall itself uses a spatial metaphor but the subsections of the mall (departments) presently make use of a more abstract space concept by using "next" and "previous" exits. An elevator (not visible in the log) connects several levels of the mall (see Fig. 5). Each level contains specialized departments and each level houses related topics. The rooms in the departments are arranged so that the user navigates to more specific information the more she enters the department. Note how the problem of separating structure and content re-arises in this area as each room is designed to contain a short description of the corresponding Web page (see section 4.1.).

```
> look
```

```
The URL Mall
```

```
This the entrance of the URL mall. The mall consists of several levels, each of which contains departments. Each department contains pointers for a special topic. Walking through the departments will navigate you to the corresponding Web pages. The farther you enter a department the more specialized Web pointers you will encounter.
```

```
You see four departments:
```

```
Hypertext....general information about hypertext  
HTML.....information on the World Wide Web (WWW) and HTML  
(...)
```

> **hyper**

The Hypertext 1

You are in the hypertext department. The link [mall] leads back to the mall entrance, whereas the links [next] and [prev] lead to the next or previous room in the sequence respectively. [first] leads to the first (this) room in the sequence.

This room contains the URL of the "World Wide Web FAQ". This FAQ (Frequently Asked Questions) answers most typical beginner questions.

> **next**

The Hypertext 2

(...)

This room links you to introductory information about how to create you own Web pages. The rooms further ahead provide links to tools that make this task easier.

> **first**

The Hypertext 1

You are in the hypertext department. The link [mall] leads back to the mall entrance,
(...)

Other conceptual directions are easy to realize inside departments. An example is the use of "up" and "down" exits for linking more or less detailed information. We plan to create several departments that contain the same Web pointers but differ in the use of directions to learn how users react to these differences.

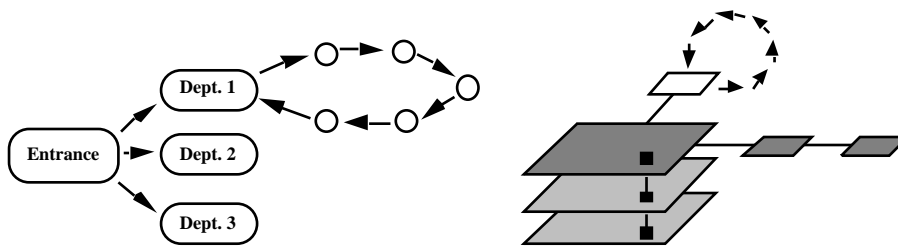


Fig. 5. The conceptual space of the mall metaphor. The left figure shows the essentially hierarchical information space. The right sketch shows that these structures can easily be connected using additional pathways leading up or down or in any other fixed direction to create pathways between spatially separated but related rooms.

6. Further adventures in spatial Web navigation

Even if the mall itself is a useful spatial structure the full potential of the MOO/WWW combination comes from the rich interaction possibilities with the spatial environment and other users. MOO essentially are social places [ERIC93] and the combination of the MOO and the Web therefore can such a social place as well.

Typical interactions in MOOs include (almost) real-time or asynchronous conversation between users and direct interaction between users or between users and the environment. Complex types of Web navigation therefore can be realized easily. Examples are automatic presentations of Web page collections, address books that

provide sorting and updating of URLs, or robots that wander through the MOO and monitor changes or provide navigational services.

More interesting is direct support for spatial navigation. As users can give directions in the MOO so can virtual users (programmed characters or robots). An example for a useful virtual user is a tour guide who leads novice users through the MOO giving a guided tour and pointing out major landmarks in the MOO (and the Web).

Other navigational tools are transport systems connecting locations in the MOO (which essentially means "locations in the combined MOO/Web space") either by navigating along regular paths or by teleporting there. Possible metaphors for these two types of navigation are a tramway system in the first and a subway system in the latter case. For a detailed description of these metaphors see [DIEB94].

Presently the connection between the two clients is a one-way direction. Movement in the MOO reflects in the Web client but not the other way round. In section 4.2. this was described as a positive feature. A bi-directional connection allows more flexible and less textual navigational features however, like a map of the shopping mall, which the user can click on to navigate to a certain department.

Another interesting possibility is to use the MOO system itself as a Web server. Output from the MOO can then be displayed as Web document in the Web-client. Examples are objects collecting information about the use of the MOO system, or MOO areas with a dynamic layout.

We are only beginning to understand the capabilities of the MOO/Web combination. One of our planned projects is to use a modified version of the client to navigate an interactive movie or to create a navigable auditory space as an art installation. However our main objective in the near future is to study spatial navigation in the Web in more detail.

7. Conclusions

The WWW is difficult to navigate because it not only suffers from the typical problems of hypertext but makes these problems worse by hiding the structure of its information space. Many WWW pages act as badly designed user interfaces for accessing information. The system we present makes use of a textual virtual environment to create a mirror space to parts of the WWW. This space makes structures in the Web explicit and provides spatial navigation, and user interaction. It can be structured in a way to define new structures on the WWW space that are tailored to the users needs and can be enriched with additional information to help in navigation. The rich interaction possibilities in the MOO allow to give lectures, to create automated presentations, and to guide users through the information space. Locations in the MOO are associated with Web pages and act as landmarks in the Web space. Using the combination of MOO and WWW the same types of interaction can be performed in the Web. This even includes the possibility to describe paths in the Web using incomplete information. We see many possible applications for such a system including further research of navigation in spatialized hypertexts.

Acknowledgments

This work is made possible by a research grant from the Austrian "Fonds zur Förderung der wissenschaftlichen Forschung" (Dr. Erwin Schrödinger Stipendium), Grant J01021-MAT for which we are very grateful. We further wish to thank Prof. Jay D. Bolter and Dawn Chapelle Jones for their continuing support and Sabine Timpf, Werner Kuhn, and Christian Unfried for valuable comments on drafts of this paper.

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