Chapter 13

Navigation In Graphical User Interfaces

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Current work on navigation in electronic worlds is based on the assumption that geographic and electronic worlds are similar enough to make it possible to use results from work on environmental psychology and related areas in the design of electronic information spaces. The present paper is an attempt to analyze the underlying assumptions behind this approach in some detail, as well as an attempt to describe a number of different dimensions on which these spaces can differ. We also discuss how these differences might influence user behavior and design.

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Graphical user interfaces can be thought of as information cities (Dieberger and Tromp). In such an environment users may seek to complete a given task in which they are in essence travellers moving towards a given destination. This paper will focus on the spatial aspects of GUI’s and how support for navigation already exists or can be built in. The aim being to support as quickly as possible the users move from route to survey knowledge and wayfinding to transportation. To support the move emphasis is placed on task based interfaces which support the creation of spatially based mental models. In order to support task based interfaces emphasis is also placed on contextually based interfaces which support transparency.

Introduction

In the real world we seek to find our way around in an environment. The environment can be within a building a city, the narrative in a film (Persson 1998)or even finding a document on a desk.

This paper will summarise some aspects of navigating within computer based environments in this case graphical user interfaces. The purpose of this is to focus on GUI’s and see how aspects of navigation from real world and other computer environments such as hypermedia, MUD's MOO's and virtual reality etc. can provide theories which are relevant to GUI's. Further to this the concepts outlined here may be included in a navigational instrument, which it is hoped will provide a method for designers of GUI's and other computer based environments to build-in navigation and also assess it's existence within an interface system.

Background

Related Aspects of Cognitive Maps, Hypertext and City Form.

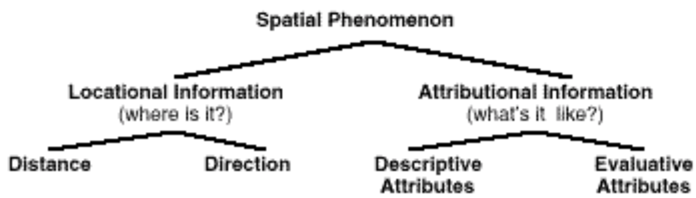

Figure 1:The contents of a cognitive map containing two types of spatial information (locational & attributional) from Shum.

The cognitive map in figure 1 illustrates some of the properties which may be required to navigate within an information (or hypermedia) environment. A spatial phenomenon in the example given could be a building or a sign. These can also be made broadly applicable to GUI type environments. For example distance and direction can both be applied to using the Wizards found in many Microsoft products i.e.

Distance: the number of dialogue boxes which I have to travel through in order to get to the one which contains the action I require to change from the default.

Direction: Direction already exists to some extent within GUI’s. It can be found to a limited degree in the use of previous and next buttons within Wizards. The next button gives the idea that the user is travelling towards an intended destination, conversely back gives the idea of re-tracing previous steps. In addition to this some Wizards or dialogue structures have selection mechanisms which alter the ultimate path or direction through the dialogue structure. For example selecting a specific option may allow the user to enter a section of sub-dialogues on a specific option.

Descriptive attributes: a button of 40*50 pixels consisting of red text and right facing arrows.

Evaluative Attributes: By selecting an item from a dialogue using a series of check boxes the user is making an evaluative decision based on their own personal preferences.

Spatial navigation not only requires the consideration of physical attributes (distance, direction and descriptive) but also the context in which the user is working and also their preferences (evaluative). Hypermedia systems such as Sepia (Streitz, Haake et al. 1992) illustrate some of the evaluative aspects which can impact the decisions taken by users. The Sepia system is largely based on the concept of information triage where social and temporal aspects play a part in constructing and navigating within information environments. In essence therefore the Sepia system illustrates some of the properties found in the ”information city” (Dieberger and Tromp). Where people are carrying out tasks in an ever changing and information rich environment. The precise way they carry out a task is dependant on the dynamic and environmental context in which they are placed. This follows in to the ideas advanced by Lynch (Lynch 1982) of layout of buildings within cities. The concepts advanced by Lynch can in part be seen as the physical aspects of the environment, for example landmarks, districts, paths and edges. Where landmarks are visible from a distance thus allowing the traveller to locate a desired area visually. The landmark may also lead to a district, an area which contains related buildings which have similar purposes are grouped. The interaction and activities which occur in a city are due to the evaluative attributes (Shum 1990) which are implicit in the physical form of the city. This followings directly into the ideas being advanced by the information city (Dieberger and Tromp 1996) where interaction within the environments is dependent upon the social context and preferences of the traveller. Hence while the work of all three (Shum 1990) (Dieberger 1996) (Streitz, Haake et al. 1992) remain distinct and separate in many respects there are several similar aspects. In essence therefore the ideas proposed by Shum (figure 1) can be thought of as integrating in with the ideas of Lynch. The Lynch concepts are the wider principles (districts , boundaries etc.) and those advocated by Shum, direction, description etc. are the more finite aspects. For example the traveller in the city is aware of the districts and boundaries but constructs a map in order to move within that environment. The map may consist of a spatial phenomenon as an example a church with a tall spire which acts as a landmark.

Landmarks and Districts in Graphical User Interfaces.

Navigating in computer environments (MUDS's VR, GUI's and hypermedia) requires the use of spatial knowledge and awareness. The required spatial knowledge is not unlike that required for non-synthetic environments. Spatial awareness is a key property of everyday life as people seek to navigate in towns and cities. Within cities people seek to use various cues as a means of finding their way around. In the urban planning context (Lynch 1982) here exists a number of elements which all aid in navigation such as districts, landmarks, nodes, paths and edges (boundaries). Navigational properties such as these can be seen to arise in graphical user interfaces, and can be found in common applications such as Microsoft Word. An example of districts exists in the toolbar layout which groups related icons together such as print, open and save. Further to this paths can exist, for example when a user resorts to using Wizard in an application. The previous and next buttons as well as the other widgets used for options provide direction and create a path through the given task. Further to this the precise path taken through the dialogues may change as different options are selected. Landmarks are also an important feature of graphical user interfaces, for example the default GUI layout in Word® offers several landmarks where users can approximate what they are likely to find in a given interface location. For example the interface offers several sub-menus (or districts), where each menu holds related options. Further to this a menu may also be seen as a landmark due to the fact it can be used by the user to locate a given district. Further to this using a Wizard (as found in many Microsoft applications) as an example, a landmark may also exist in the form a series of options which the user regards as critical. The critical options may provide the user with some sense of the level of completion within the Wizard, thus acting as a landmark or goal which they move towards. It is not being suggested that Word is the ideal interface, but rather it does exhibit some aspects which may be regarded as navigational cues.

The Role of Language in Navigation

A graphical user interface is an information rich environment, somewhat similar to the information city idea as proposed by Dieberger (Dieberger and Tromp). In another paper on enhancing the ability to navigate on the web by using text based VR, Dieberger (Dieberger 1996) also illustrated the value of using a rich language to aid in communication. The use of a rich communication language permits improved interactions between tools, agents and perhaps other users, therefore introducing a level of social navigation (Svensson 1998). An example of social navigation in a real world environment is when a traveller asks a native language speaker for directions. Frequently this interaction will take place using only the name of the area of interest, then the local person will have to attempt to feed back the instructions using the native language, where large chunks of the conversation may be simplified. The result is often a slower process of communication which can also be quite confusing for both parties. Therefore in order to permit social navigation both with other users, the interface in general and agents a language must be used which permits easy and effective communication.

Transparency and Contextual Awareness with the Interface

Interfaces which use grouping of menus and buttons are in essence imposing a map upon the user. In doing so these interfaces are attempting to encourage the user to think in terms of an overview (survey knowledge) of the interface. Extending this further the navigational cues must in essence move away from supporting purely atomic interaction (Gentner and Neilsen 1996) which is a by-product of direct manipulation interfaces. The reason for moving away from direct manipulation is that by forcing users to stick with an atomic style of interaction, they are frequently dividing attention away from the actual activity to dealing with the interface. In doing so attention being divided among the activity (e.g. changing the style of a document), conceptual interface view (i.e. where is the reformat option) and also the atomic actions required to carry out this task. By constantly dividing the user attention they are likely to remain in *wayfinding* (Svensson 1998) mode. Whilst *wayfinding* in itself is not inherently bad it may take longer and places a greater mental load on the traveller than transportation. This is due to the fact that not only are they having to navigate around within the environment but are also having to deal with minute levels of interaction which may be of minimal if any interest to them. Downs and Stea (Downs and Stea 1973) provide four steps which exist within wayfinding:

1. Orientating oneself in the environment.
2. Choosing the correct route.
3. Monitoring the route.
4. Recognising a destination has been reached.

These areas can broadly be related to GUI's as follows:

1. When the user examines the interface in order to find out where they are in relation to the tools they need in order to complete a task. For example looking round Word in order to find the group of tools related to type face style.
2. In a wizard selecting the correct options to get to the desired end results.
3. The ability to review and check the correct route has been taken. This can partially be achieved in document wizards by providing a stage by stage view of what has been carried out so far.
4. Using a document as an example, providing a view of the finished result. This result should correspond to the users desired intentions.

A system which exhibits support for wayfinding will hopefully also provide strong enough navigational cues for the user to move from *wayfinding* to *transportation* mode as soon as possible.

In order to support the move from a purely atomic interaction several areas pertaining to "being lost in hyperspace" are of potential relevance. Therefore for wayfinding to be adequately supported it is imperative for the user to be aware of their location. A number of hypertext systems already do so by the use of maps, directional links, use of well worn paths and history enriched cues (Svensson 1998) etc. These all provide simple cues which can aid the user in their ability to prevent being "lost in hyperspace" these can all be parallel to areas of GUI design, for example in Wizards buttons such as previous and next are used, which link the various dialogue boxes, in addition some interfaces support the changing of colour of buttons once selected.

Xerox proposed the rooms system, where related applications or facets of information could be grouped into so called "rooms". This concept has been widely adopted in X-Windows type environments through the use of the virtual desktop. The virtual desktop concept falls neatly in to the related field of focus spaces. Focus spaces can apply equally to the physical grouping of related applications or related pieces of information. Focus spaces allow users (or system designers) to layout information in a way which allows them to easily interpret the information, whilst retaining the ability to focus on the areas of interest to them. In essence the idea of a focus space is to allow the user to focus attention on what is important thus reducing problems of information overload and divided attention. The rooms idea also broadly fits in with the idea of on and off screen space in films (Persson 1998) and preservation of context which is discussed to some extent later on in this paper.

Presenting Opportunities, Emergent Behaviour and Extensibility.

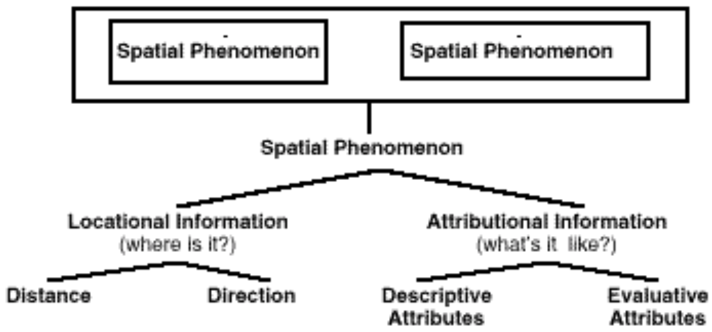

Figure 2: An interface (a spatial phenomenon) consisting of two other spatial phenomenon (e.g. two buttons placed in close proximity).

Utilising space as the underlying principal method of interface design another series of properties also emerge (Erikson 1993). Grouping in essence promotes the idea of spaces for particular tasks and relates to the Lynch concepts. Further to this objects encourage incidental interaction. In essence if the user already has a predefined task, if the interface suggests an appropriate alternative action they may take that option instead. Again using word as an example the **bold,** *italic* and underline operations are all situated together in a group, and the user is presented these three opportunities.

A graphical user interface as has already been highlighted is a spatial environment consisting of the basic layout of components however these considerations take no account of the context in which the user operates. In merely placing objects in an interface we take no account of any emergent properties which may arise either from user or the information. In MUD'S "[the environment is] extensible by the participants", by reducing the ability of the users to adapt the interface we are therefore reducing their ability to interact in a spatial fashion as information and cognitive maps rarely remain static. Extensibility could include the ability to provide functions to allow aspects such as overview maps, annotations (e.g. pop-up context help written by the user) or the ability to redesign the interface. These all parallel with aspects of hypermedia systems which often provide the ability to generate information maps (Baldonado and Winograd 1997) and annotations. Research (Andrews 1997; Baldonado and Winograd 1997) (Card, Robertson et al. 1997) from hypermedia systems would appear to suggest the users ability to customise information is critical to their ability to navigate within the environment. This level of customisation may simply be annotations, or may extend to the ability to re-organise the way in which the knowledge is structured (from the users point of view).

Providing the user with the ability to extend or amend the interface draws into the next area the need for user/system defined focus spaces. The issue of need to support focused and divided attention has already been mentioned to some extent. Novice users frequently encounter problems with information overload both in graphical user interfaces (Nielsen 1993) and in hypermedia systems. However the use of focus spaces can aid in reducing this problem. Focus spaces are somewhat related to the issue of grouping which has already been mentioned.

Transparent Interfaces, Automaticity and Mental Models

The discussion thus far has primarily existed on the level of abstracting the interface from the information environment. However as has been indicated earlier on and in other studies, if the user has to grapple not only with the interface but also the information, there is a risk of introducing divided attention. In order to reduce the problem of divided attention research has been carried out into transparent interfaces (Harrison, Ishii et al. 1995) (Zhai, Buxton et al. 1995) such as menus (Harrison and Vicente 1996) and toolglasses (Bier, Stone et al. 1993).This it was hoped would reduce the amount of divided attention suffered by users, as they no longer have to look from information to application control tools (e.g. in Word). Also by introducing the transparent toolglass system proposed, a number of other issues could also be addressed. Firstly the toolglass system could include some form of contextual awareness. The behaviour of the tools, and layout would change in accordance with where the toolglass was positioned on screen. This allows interfaces to become contextually aware. In film based environments although the viewer only sees the given camera angle they are aware of the context in which that particular scene or shot is placed (Persson 1998) .The screen display on a computer system sits in part in a wider working context. This may be the relationship between different pieces of information on screen or the real world environment. The toolglass can be thought of as the screen which sits within the wider environment, where the tools sit over a specific information artefact. The tools then adapt the information or adapt to the information. This adaption takes place within the wider environmental context. It should be noted that transparency can be thought of as existing on two levels, physical (as in the case of the toolglass) and metaphorical. At the metaphorical level transparency can be said to exist in the MS-Word 6 interface, where by using a right mouse click a contextually aware pop-up menu appears. Further to both the contextual awareness of the tools and reducing divided attention the issue of screen clutter can also be partially resolved.

Following on from the issue of interface transparency, research (Altman, Larkin et al. 1995) has indicated the difficulty experienced by users when using scroll bars to navigate within large documents. Clearly this is unsuitable as the entire point of the user interface is to permit them to work with the information. This can perhaps equally apply to the problem of them retaining mental models of how to complete a given task. Therefore the interface structure should permit the ability of the user to retain the information they work with as well as how to complete the task. In essence therefore the emphasis is on minimising cognitive load by allowing the activity to become (Norman 1986) automatic. Automatic activity (automoticity) arises when a user is familiar with a task and can abstract the level of interaction to the goal of completing that task, where as with less familiar tasks where the abstraction is at a very granular level. Norman's model (Norman 1986) can in part be paralleled with the idea of travellers who initially use route knowledge then eventually through time start using survey knowledge. As has already been indicated we are in essence trying to get users to the use of survey knowledge as quickly as possible, thus lessening the time taken for the task to become automatic. However as can be seen in Sjolinder (Sjölinder 1998) users are a diverse group of people and a number of individual differences arise such as age and sex. Therefore other non-spatial forms of navigational support should where possible also be included.

The idea of automaticity fits in with the concept of allowing travellers to *transport* themselves to a given location and also with the "black box in a glass box" (Höök 1996) view of hypermedia. The "black box in a glass box" approach is aimed at reducing information overload to the user in order to prevent users from getting "lost in hyperspace". This concept can perhaps also broadly be applied to GUI's where "we hide the complex behaviour of the adaptive system in a black box and show a fairly simple model to the user in a glass box". Adopting this idea in GUI's we could perhaps see the interface as being adaptive to some extent. The glass box approach can be applied to both the metaphorical and physical aspects of interface transparency. Firstly we provide enough information as to allow the user to gauge what the tool does, secondly however only a limited amount of information is presented. In doing the latter we seek to prevent overloading the user with information and thus resulting in them getting lost in the interface.

In order for users to commit to memory the mental models of information and tasks, it is important that the number of steps required to complete a task are kept to a minimum. Therefore this raises the issues again of direct manipulation and see and point both of which encourage large numbers of atomic interactions. If we are to assume that the user has no interest in certain tasks (Gentner and Neilsen 1996), then clearly some form of intelligent interface agents may be of value. These agents could take over the running of routine tasks or highly complex but non critical tasks, however there would be a need to retain a high degree of transparency from the users point of view.

Consistency

Consistency in a user interface is widely regarded as an aspect which aids the user ability to learn a piece of software or environment. An example of how this is achieved can be found in Netscape where a single interface style allows interaction with various different types of information. Consistency also applies to real world navigation systems such as road and tourist information signs. An excellent example of easy to understand signs which are laid out according to what is appropriate to usage and work patterns can be found at Amsterdam Schipol airport. Here the language used in the signs is very clear allowing speakers of different languages to understand the meaning. In addition they are positioned at various locations within the buildings most likely to be of benefit to the travellers and with minimal interference to the rest of the environment. Although the signs may be physically located in different locations in the environment, they often adhere to certain layout and style guidelines. The approach adopted by town planners to consistency is one which could be used within computer environments. For example consistency exists in the style of signs, however their positioning is related to the effect it will have on the cosmetic and work patterns of the environment in which they are situated. Consistency is a contested subject while advocates it others such as Gentner (Gentner and Neilsen 1996) would argue that a dynamic environment which is tied down with static guidelines may be unsuitable in some respects for the tasks it were intended. Therefore whilst traditional GUI guideline suggest consistency as being a key component, in order to promote effective navigation within the environment perhaps it should be relaxed in order to allow the use of more effective navigational cues.

Supporting Navigation in GUI’s

As already mentioned there are four broad categories which can apply to the list of navigational assessment criteria which follow later on in this paper. However in many cases the assessment criteria applied to more than one of the four. The latter two areas (contextual awareness and support for user behaviour) are largely supersets of the support for physical navigation guidelines. The criteria listed are based on the background information review. The following lists consists of a number of points which are found in traditional HCI methods. In addition however here the focus is on adapting them where possible to support navigation. For example supporting task based interaction can be in part paralleled with the idea of transportation in real world environments. For example a traveller with experience of a specific geographical area has a general view of where they want to go. A traveller with such knowledge can do so without having to concern themselves with the very minute physical details such as placing one foot in front of the other and can focus instead on going in the desired direction.

Support for Physical Navigation

- Strong set of navigational Cues.
    - use of landmarks, paths and districts in GUI.
    - use of colour and suitable icons etc.
- Adhere to certain level of consistency. However consistency should not be at the expense of loss of strong navigational cues.
    - e.g. users of Netscape can in the main interact with a variety if different data types and structures by using a similar or identical interface.
- Transparent interface both to the user and also in terms of the required task.
- Use a rich language for communication both to and from the computer.
    - an example of a basic widget being enhanced is the ability of newer applications scroll bars to be moved up and down by using right or left mouse button. Rather than using the arrows positioned at the bottom of the scroll bar.
- Support Incidental activity.
    - group related icons/menu options near each other.
- Allow user to customise the interface in various ways
    - support customisation of interface layout.
    - annotations in the interface (e.g. user defined pop-up context based help).
    - support for user defined wizards.

Support for Learning Survey Knowledge

- Increase the ability for the task to become automatic thus speeding up the time taken for the transfer from route to survey knowledge.
- Support for task based interaction.
    - make it clear when a task has been completed (a destination has been reached).
- Provision of maps and other navigational support structures within the interface.

Support for Contextual Awareness

- Provide adaptive interfaces which change based on the context of the user or information.
    - e.g. pop-up menus in Word or Internet Explorer.
- Support user in constructing interfaces which are based on their working context.
    - e.g. Xerox Rooms or similar for organising applications into groups.
- Support users ability to retain information.
- scroll bars used in large documents do not support this as users frequently have problems retaining any awareness of the structure of the document.

Support for User Behaviour

- Support for focus spaces (focused and divided attention).
- Reduce need for performance of routine and complex tasks.
- Support customisation of interface and information.
    - e.g. short cut keys.
- Support for task based interaction.
- Support for emergent interest in the aspects of the interface or information.

Conclusion

As is evident from the previous sections in this paper the focus has primarily been on supporting spatial awareness within GUI systems. However this is not always the most appropriate way of providing navigation within environments as many potential users may have poor spatial ability (Sjölinder 1998) . Therefore further work is required in order to examine non-spatial methods of supporting navigation within computer environments. Further to this it is evident that adaptive systems may provide methods of enhancing the users ability to navigate spatially however it is clear from some research (Höök and Svensson 1998) that users frequently have problems with adaptive systems. In summary therefore supporting navigation where the aim is to get from route to survey knowledge as quickly as possible whilst also supporting the move from wayfinding to transportation may require certain trade-offs.

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