# Experiential Design of Shared Information Spaces

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## 5.1 Introduction: Bodies in Space

This chapter outlines an approach to designing information spaces that we call experiential design, and illustrates the approach with examples of our recent work. The main virtue of this approach is that it claims to draw on universal primitives in the way people understand things, events, relationships – and information. And because of this virtue, it naturally supports social navigation of information spaces. The basic idea of experiential design is that, because we are embodied beings, meaning ultimately resides in bodily experiences. We have evolved to act in the physical world, and how we are able to understand abstract information is derived from that capacity. If we design for embodiment, understanding comes free; this is the first major benefit of the approach.

The second major benefit of the experiential approach is this: since we all share the same evolutionary history and hence, bodily structures and potential for experiences, we share the same primitives for understanding information. This is what makes social interaction – and social navigation of information spaces – possible. If we design for embodiment, the potential for shared understanding comes free.

A third benefit of the approach is that it is also applicable to the design of mobile – or wearable – computing, a line of research currently being followed here in Umeå by Daniel Fällman (see Fällman, 2001). However, that aspect of designing for embodiment will not be discussed in detail here.

We experience the physical world as a three-dimensional space, with gravity holding our bodies, other people and things onto horizontal surfaces. To benefit from these characteristics, the most obvious idea is to create three-dimensional, spatial visualisations of information. The World Wide Web (Web) is by far the most popular shared information space around, and an increasingly popular approach to the representation of information on the Web is to use 3D rendering techniques to convey a sense of space and apparently solid structure. This means that information explorers can bring their innate skills for spatial navigation into play, in addition to those few sensori-motor abilities utilised by the familiar direct manipulation (WIMP) interface. However, because no-one is designing the Web, and because of the simple linking mechanisms underlying its evolution, there is no way to make sense of its structure as a whole. There can be no 3D representation capturing its whole structure which, as is implied by our approach, means that people simply cannot make sense of its structure as a whole.

However, space is powerful as a means of representing the structure of designed environments, such as personal file systems and the intranets of organisations. Personal environments can be happily represented as Personal Spaces - 3D structures apparently containing stored and current items of interest to the individual user (e.g. StackSpace; Waterworth, 1997).

In the following sections, we describe work to design information spaces that capitalise on the embodied nature of cognition. The virtual worlds constructed for these studies were based on the general approach to information spaces described by Waterworth (1996), which allows for alternative virtual realisations at three architectural levels:

- *structure* - the underlying information organization
- *world model* - the interaction model or UI metaphor
- *user view* - the customized presentation for a particular audience or task

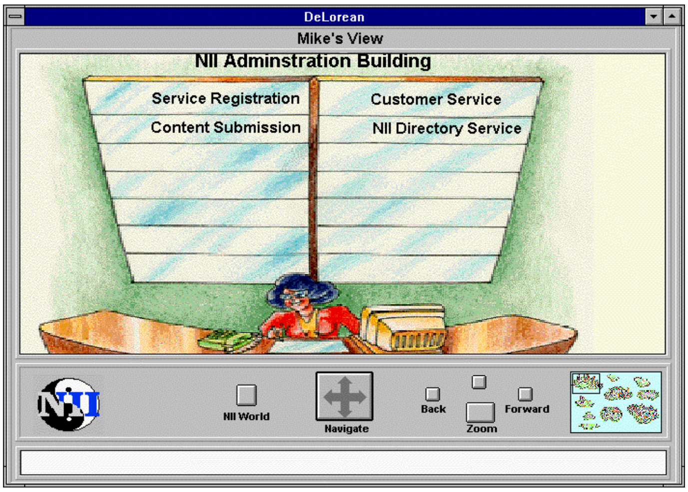
## 5.2 Information Cities, Islands, Vehicles and Views

About 13 years ago, the idea of a virtual 3D Information City - a world model for presenting sets of information to tap people's skills in urban navigation, was raised in Singapore, itself a highly "wired" city aiming to deal largely in information in the future. A later development of the basic Info City idea was the "Information Islands" model for the Singapore National Computer Board's National Information Infrastructure Project; this work was carried out in 1993/94 and aspects of the model were published soon after (Waterworth, 1995; Waterworth, 1996; Waterworth and Singh, 1994). Again, this was a natural idea to arise on the self-styled "Intelligent Island" in close proximity to the giant archipelago of islands that is Indonesia.

Under the "Information Islands" world model, the world (through which the structure of a set of information is presented) is seen as a group of Archipelagos, each composed of Information Islands. Each Archipelago represents a set of broadly related entities, providing a clear, top-level classification of what is available in this world and where it is to be found - an overall orientation that is easily accessible to both the novice and the experienced user. Each major class of service or application exists as an Archipelago. Examples might be Entertainments, Government Services, Information Services, Communications, Medical, and Financial Services. Archipelagos are collections of Information Islands. The size of an Archipelago depends on the number (and size) of the Islands of which it is composed.

Each Island generally contains only one subclass of service. Users will become familiar with this world mostly by learning the location of Islands with the kinds of services they use or are interested in. Each Island contains one or more Buildings. Some Islands may be representations of the services offered by particular providers - Provider Islands. An example might be a particular information provider's Island located near other Information Services Islands.

Each Building contains a set of information sources or services related to a particular topic or application focus. Examples might be Weather Building, Sports Building, Stocks and Shares Building. Buildings on a particular Island will have distinctive appearance (shape, colour, graphics, text). All Buildings have common features including a Store Directory and an Information Counter (see Figure 5.1). The Store Directory allows users to browse and select from what is available in a Building. The Information Counter is a public agent that searches for information in response to requests from users.



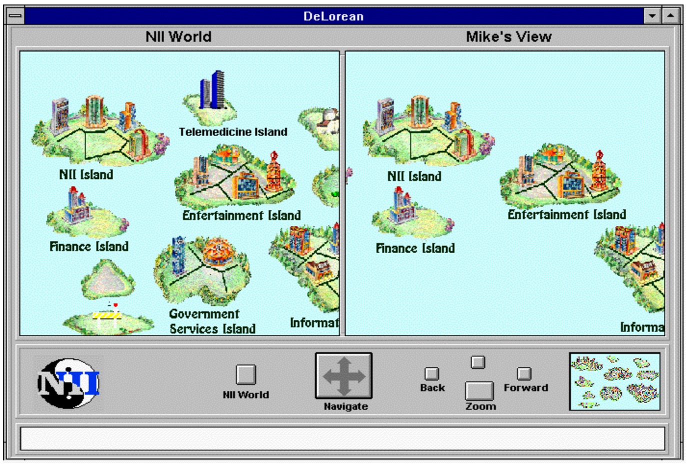

*<Figure 5.1 - Store Directory and Information Counter>*

An important part of interacting with this world of information is the exploration, selection and collection of items of interest to the individual user. These items may be services, information or particular configurations of applications. One common way of catering for this need for a personal selection from a public world (a set of public places) is to demarcate part of the world as personal, and allow the user to collect items and configure that private area. This is one of the key ideas behind the well-known Rooms concept (Henderson and Card, 1986). However, such an approach is limiting. Users must navigate to their own area frequently, bringing back items they want to collect, then venture out again into the world-at-large. In such a case, the disadvantages of a spatial metaphor can outweigh the advantages: because the users' personal space is part of the global information space, they frequently have to move around to switch between their own perspective and the higher levels of organisation. Use (which always involves a user) is confounded with level of structural organisation (which includes a User level). Use should be possible at any level, at any time. A private area at a particular location in the informational world may not be the best way of supporting individual customisation.

### 5.2.1 Vehicles with Views

To overcome these problems, the concept of private Vehicles was developed; these can be thought of as transparent, mobile, personal workspaces. They combine the idea of a private collection of information and configuration of services (customised workspace) with that of multi-level navigational device and customised information viewer. The user is always in his (or her) Vehicle, and therefore always has access to both public and private worlds. Items can be transferred between these two without navigating space. A key aspect of the model is that the user has a filtered way of looking at the same spatially-arranged world that occupies public space. The private "world" is actually a manipulable way of viewing rather than a specific place (cf. Nagel, 1986). It assumes that there is no one true view of the world, but always many possible ways of looking at things.

In the original Information Islands model, the user in his Vehicle had two Views of the world outside - a public "God's Eye" View that includes everything that is available, and a personal View showing only those items that the user has selected as of interest or use (see Figure 5.2). Although there are two Views, there is only one world. The private View and the God's Eye View are different perspectives on the same world; the former is filtered and limited, the latter is a complete display at the level of detail on which it is focused. The user can choose to have a split screen showing both Views simultaneously, or alternate between the two. Views have some similarities with the idea of 'Magic Lenses' (Fishkin and Stone, 1995). However, a key aspect of Views is that the 3D structural integrity of the world model is always maintained (the philosophy of "one world, many views").




*<Figure 5.2 - Two Views of the same part of the world>*

Views become more interesting when applied in the social sphere. I may want to see only items visited by members of my research team recently. Or I might want to compare one View I have (or my agent has) compiled of interesting sites, with the View a colleague (or his agent) has collected. My View is a way of looking where only things of interest to me exist, and the same applies to him and his View. We can combine these two into another View that shows only those items that are of interest to both of us, or we can create a difference View that shows only those things chosen by only one of us. So the collection of public places that currently comprises cyberspace is filtered to give a socially-shareable and customisable View. This is arguably quite close to the way different groups and individuals hold different views of places such as cities in the physical world.

### 5.2.2 Parallel Worlds

Research on navigation in virtual spaces could be said to have begun with studies conducted by urban designers in the physical world. Classic research (Lynch, 1960) on urban legibility (imageability) concluded that the efficiency and enjoyment of residents can be enhanced by certain design elements arranged in a strongly hierarchical pattern - landmarks, paths, districts, nodes (focal points), and edges (boundaries). Psychological research confirms that people use hierarchical representation for spatial data (Chase, 1983; Stevens and Coupe, 1978). Later work analysed wayfinding – the conceptual aspect of navigation – into three iterative stages: mental mapping, route planning, and plan execution (Passini, 1984). Lynch's work concerned primarily strategies to increase the effectiveness of mental mapping. Recent research has concluded that wayfinding design principles from the physical world often apply to large-scale virtual environments (Darken and Sibert, 1996). In this work, global structure was recommended to support good wayfinding. We have used the Information Islands concept as a basis for several experiments examining a range of factors related to information visualisations based on such principles from urban design.

In developing a VR landscape to visualise hierarchical information, a large range of initial possibilities exist. In particular, there is always a discrepancy between semantic and spatial structure that must somehow be reconciled (McKnight et al., 1991). Our initial hypothesis was that varying the strength of spatial cueing would significantly affect searching performance and environmental perception. More specifically, we expected that more spatial cueing would result in better understanding of the spatial structure of the environment and its information objects. That is, spatial cues would aid navigation and prove more enjoyable. Accordingly, a series of three virtual worlds was designed, taking key points on a design continuum between text- and object-based representation of information structure. Each design applied the idea of Information Islands to visualise a filtered subset of a Web index. The three worlds were maximally isomorphic in features (e.g., locations, sizes, and text labels). The data set was chosen for general interest to experimental users and the research community. This data included about 1500 information items over seven levels of hierarchy, which allowed for both rich detail and computational tractability.


*<Figure 5.3 – The Day World>*

The first design was the most naturalistic, with coloured objects and greyscale labels. This design featured strong colour and lighting cues, and it was called the *Day World* for reference purposes (Figure 5.3). Virtual objects were laid out to maximize imageability according to Lynch's guidelines: islands, cities, neighbourhoods, and buildings ("districts"); mountains and rivers ("edges"); rivers, roads, and bridges ("paths"), and geometrical objects ("landmarks" or "nodes"). Objects at each level of scale were clustered around landmarks, according to sibling groups in the data hierarchy. Colour assignment grouped virtual buildings in neighbourhoods with common palettes, while ground and water objects had naturalistic colour. Text labelled each virtual object. To avoid information overload, the distance from which a text label was visible varied inversely with the label's depth (unimportance) in the data hierarchy. In general, the best point from which to survey a virtual data region was its centre. Avoiding indirect navigation, users were permitted to fly freely throughout the virtual worlds, or to use a shortcut gesture to fly directly to interesting objects. Navigationally indirect features such as elevators and hallways were avoided.

At the midpoint of the design continuum between object- and text-based representation of information structure, the *Dusk World* resembles the Day World with changes in colouring (Figure 5.4). In the Dusk World, virtual objects are desaturated 90% (as in twilight) and semi-transparent. Text labels, however, are shown in bright, saturated colours (like neon signs), and grouped according to sibling relationships in the data hierarchy. The design is intended to offer the benefit of some optical illusions, where perception varies between modes of perception, here object- and text-based.


*<Figure 5.4 – Dusk World>*

At the textual end of the design continuum lies the *Night World* (Figure 5.5). This world is like the Dusk World without virtual objects. Here, the user moves in an abstract information space without absolute location or distance. This design was inspired by recent prototypes, including HotSauce and others, that draw on Rennison's work with *Galaxy of News* (Rennison, 1994). The Night World has no directional lighting, only brightly coloured text on a black background.


*<Figure 5.5 – Night World>*

In a first experiment, participants were first trained in the user interface in a sample world for 15 minutes. In each experimental world, participants then explored freely for a couple of minutes. They then performed a 20-minute "scavenger hunt": a participant received a series of paper cards, each showing the context and name of an information item in the virtual world. Participants were to find as many of the ten targets as possible in the available time. A participant could skip difficult targets. The hunt tested search performance, as well as serving to focus attention on the model worlds.

In general, self-reported sense of presence, ease of use, and enjoyment were highest for the Day World, and comparably lower for the Dusk World and the Night World. But world design did not affect search performance on the test task.

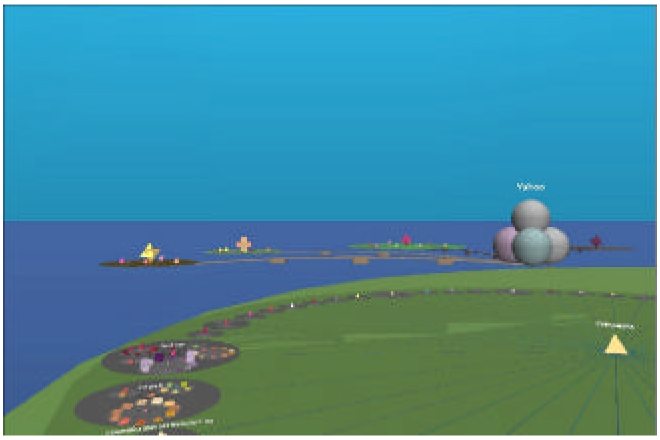
A second experiment compared the Day World with an equivalent hypertext interface (see Figure 5.6). This time, both self-reported ease of use and search performance were significantly higher for the hypertext interface, although the Day World was rated as more enjoyable. This surprising result led to a redesign of the Day World, as described in the next section. Performance with this improved 3D world was not significantly worse than with the hypertext interface. For more details of the study and results, see Modjeska and Waterworth (2000).


*<Figure 5.6 – The Hypertext Interface>*

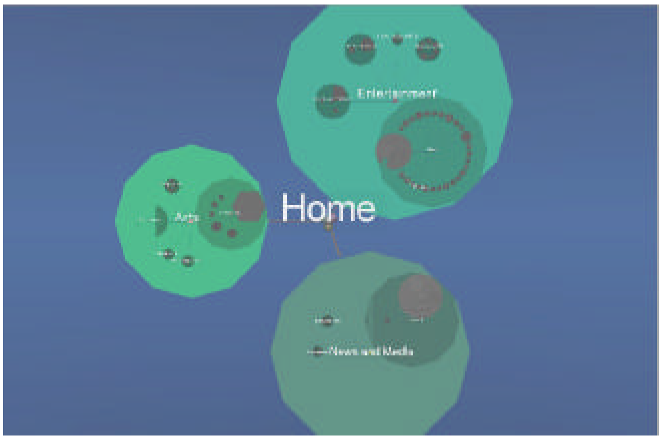
### 5.2.3 Bird's Eye versus Fly Through Views

Navigation can generally be viewed as purposeful movement, or transformation (Zuberec, 1994), using the metaphor that "information occupies 'space' through which readers 'travel' or 'move'..." (McKnight, Dillon, and Richardson, 1991, p. 67). The study reported below was designed to explore how user assets such as spatial ability affect navigation in a virtual world. Virtual worlds can be three dimensional (3D) or they can be implemented as a series of two-dimensional (2D) birds-eye "snapshots" that can be traversed as if they were in 3D using operations such as panning and zooming interactively (i.e., 2.5D). Thus the study also sought to examine how the relationship between user assets such as spatial ability, and outcomes such as information exploration performance, are moderated or modified by the extent to which the virtual world is fully three-dimensional (i.e., 3D vs. 2.5D).

Two different interface designs of the same world were used, one providing "fly-through" views and the other "map" views (see Figures 7 and 8). Both applied the idea of Information Islands (Waterworth, 1996) to visualise a filtered subset of a Web index. The two worlds were isomorphic in all features (e.g., object locations, sizes, and labels). The data set was similar to that used in the early study, described in the previous section. The world was an abstract, urban, daylight landscape, with coloured objects, directional lighting, and greyscale labels. This design had strong colour and lighting cue; Lynch's (1960) guidelines were represented with more salience than in the earlier parallel worlds, partly as a result of applying the the CityScape algorithm (Keshkin and Vogelmann, 1997) for laying out hierarchical data nodes in a plane. See Modjeska (2000) for more details.



*<Figure 5.7 – The Fly-Through Design>*




*<Figure 5.8 – The Map-View Design>*

As in our previous experiments, users could navigate in either discrete or continuous fashion. A user could point-and-click to navigate up or down the data hierarchy, and between sibling data nodes. Users could also navigate continuously between items of interest, even if these items were separated by one or more levels of data hierarchy, or were not located on the same branch of the hierarchy.

The map-view design (Figure 5.8) used the same 3D world as the fly-though design. In the map-view, however, user navigation was restricted to zooming into and out of the model, as well as 2D translation or "panning" with reference to the ground plane. As in the studies described above, participants performed a search task and also gave subjective ratings of their experiences. This time, we also tested each participant's spatial ability before the trials.

The results showed that search performance was significantly better with the map-view than the fly-through design, as was self-rated efficiency. People with low spatial ability performed poorly with both designs. Taken together with our earlier comparison with hypertext, this study raises questions about the benefits of 3D interfaces for information visualization. People with low spatial ability may be selectively disadvantaged when performing tasks within virtual environments. Nevertheless, where virtual environments are used, simplified movement using panning and zooming in a 2.5D environment seems to assist people regardless of their level of spatial ability.

### 5.3 Evolution and Experiential Realism

The work with various versions of Information Islands attempted to capitalise on the kinds of man-made landscape that people find understandable. There is also much evidence that people prefer certain sorts of natural landscape (Zube et al., 1982), specifically, the African savannah. A prevalent explanation for this is that people evolved successfully in similar environments, and so find them intrinsically pleasing at an emotional level. Support for this evolutionary explanation comes from results showing that young children, wherever they live in the world, choose savannah-like landscapes in preference to all others. Adults, on the other hand, will also choose landscapes considered in their culture to be attractive – such as a panorama of Swedish forests and lakes, but will also retain a fondness for savannah-like landscapes (Balling and Falk, 1982). An implication is that cognition is guided by emotional responses to the environment; we find those environments pleasing in which we could function effectively as animals, i.e. survive and reproduce successfully, and we also find them relatively easy to navigate and explore.

There is also evidence from evolutionary psychology that these two distinct activities, navigation and exploration, are facilitated by somewhat different collections of environmental features. Navigation would seem to require coherence and legibility (Lynch, 1960), whereas exploration is more of a response to complexity and mystery. How people react to mystery depends on what causes it – a degree of physical mystery raises preference scores for an environment and invites exploration, but social mystery usually reduces preference and tends to be equated with danger (Hertzog and Smith, 1988). The experiments described in the previous section looked only at navigation, and suggested that while some features of 3D spaces can aid navigation, 3D may not be optimal for navigation – even for people with good 3D spatial skills. Preferences for natural landscapes seem to reflect some combination of these factors. We are currently investigating the extent to which we can design information spaces to capitalise on evolutionarily-determined cognitive biases in particular types of environment.

Research in evolutionary psychology, relating the information processing characteristics of people to their evolutionary significance (see, e.g. Kaplan, 1987), is one strand of evidence supporting the overall claim that the evolutionary nature of our embodiment produces specific regularities in the way we tend to deal with information. In several publications over the last twenty years or so, linguist George Lakoff and philosopher Mark Johnson have presented a theory of meaning they call “experiential realism”, which also suggests that the way humans make sense of their experiences is largely dependent on basic, bodily interactions with physical environments, as well as on social and cultural interactions with other humans (see for instance Lakoff, 1987; Johnson, 1987; Lakoff and Johnson, 1999). More specifically, they argue that abstract concepts are processed in terms of metaphorical relationships to experiences in physical environments.

Consider for instance the concept of relevance. Although relevance is an abstract concept in the sense that we never can see it, hear it or touch it, we think and talk about relevance without difficulty. The main thrust of Lakoff and Johnson's argument is that we can do so because humans have a capability for unconsciously making sense of relevance - and other abstract concepts - by means of conceptualisation in terms of other less abstract concepts. Consider for instance the following sentences: (1) ‘A central issue concerns the role of inheritance’. (2) ‘Of peripheral interest for our purposes is the recent development in China’.

These sentences are examples of how we actually talk and think about relevance, and seem unremarkable. However, a closer examination shows that relevance in these sentences is construed as something spatial, something that can be more or less central in relation to an observer. This is just one example of metaphorical projection, where we project unconsciously from that of which we have concrete experience, to concepts of a more abstract kind. Similar projections are pervasive in everyday language and thought.

The capacity for doing this kind of projection is, according to Lakoff and Johnson, based on our recurrent bodily and perceptual interactions with the physical and social world that surrounds us. Our constant bodily interaction with the physical world is embodied as image schemata, which are recurrent structures of our experience, based on the evolutionarily-determined nature of our bodies.

### 5.3.1 Designing Experientially-Real Information Landscapes

One of our recent approaches to information landscape design (Lund and Waterworth, 1998; Lund and Wiberg, 2001), based on this experiential realist account of meaning rather than the usual objectivist cognitivism of the traditional "mental model" approach, rests on the fundamental premise that *to design HCI is to design the conditions for possible users'* *experiences.* Taking an experiential realist view of interface design suggests that a meaningful interface is one that is experienced in a way that supports the metaphoric projection of image schemata. If the experientialist designer is primarily a creator of user experiences, the traditional interface designer is primarily a communicator of mental models, using metaphor as a useful device.

We are not arguing that all traditional interface metaphors should be replaced, but we do suggest that for several application areas - and these are areas that are at the forefront of current HCI research and development - an experiential approach to HCI design may be more appropriate. A notable example is that of information visualisation and exploration. If we revisit the Information Islands interface wearing our experiential realist sunglasses, we see that what matters is not so much the metaphor itself, as the experiential features we chose to take from the real world and incorporate in the virtual.

In adopting the experiential realist approach, a valuable source of design insights is that of language. How do users talk about their experiences? Utterances can be gathered at two stages of the design process: user requirements analysis early on and, later, as corroboration that a particular design is producing the kind of experiences the designer intended. It could be argued that we cannot effectively describe experiences with words but, as Samuel Beckett remarked, they are all we have. The approach to understanding these words is somewhat akin to psychoanalysis; we are looking for the unconscious structures (image schemata) that lie behind the chosen way of describing an experience.

The traditional approach to HCI design uses metaphor to communicate the functionality of the system to the user. The designer draws on users' experiences in another domain to assist their understanding of the system. As Erickson (1990) has pointed out, this implies that designers know what the system really is. Despite its problems this approach has been successful in encouraging the widespread use of computers, at least for certain classes of application. The experiential realist approach to design also draws on users' prior experiences, but there are several fundamental differences. Firstly, for the traditional perspective, metaphors are useful (usually) but not essential. A traditional user interface metaphor can always be paraphrased into a literal interface. From the experiential realist perspective, however, metaphoric projection is essential to the way people make sense of the world, including a user interface. Secondly, that metaphoric projection is essential to sense-making does not mean that we live in a world of metaphors. If we design from an experiential realist perspective, this does not mean that the interface need be a virtual world of metaphoric objects. Such a world is more likely to be the outcome of the traditional approach. Experiential realism can, however, provide the basic elements of a natural and flexible HCI design pattern language (cf. Alexander et al., 1977).

This approach has its critics. Although he recognises some merits of experiential realism, Coyne (1995), for example, claims that Lakoff and Johnson put too strong an emphasis on the primacy of bodily experience and that there are non-embodied and non-spatial uses of concepts like containment and balance. However, Coyne's criticism seems to illustrate, rather than contradict, Lakoff and Johnson's main point; that is, that we project our spatial experiences (embodied as image schemata) to abstract, non-spatial domains of experience.

### 5.3.2 SchemaSpace: an experiential realist environment

How should a personal information space (Waterworth, 1997) be designed? If we try to answer the question from an experiential realist point of view we first have to reformulate the question as: *what kind of experiences does the user want to get from the interface?* By posing the question this way we put emphasis both on the designer's role as a creator of meaningful experiences and on the role of the user interface as a source of meaningful experiences.

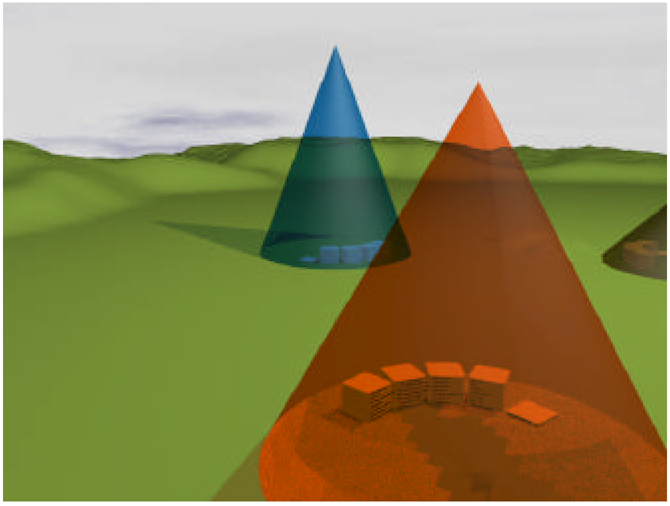
The intention of SchemaSpace was to design a personal information space in such a way that it allows the user to have four different kinds of experiences that each informs the user about different qualitative aspects of the information:

- *Distinctiveness* - which of the information references belong together, e.g., fall under the same subject or category?
- *Quantity* - how does the number of references in a sub-collection compare to other sub-collections found in the information space?
- *Relevance* - given that a collection of information references belong together, of what relevance is each individual reference in relation to the subject or category?
- *Connectedness* - how do different sub-collections of references relate to each other?

A vital step in the design process is to identify image schemata that are associated with the qualitative aspects of the information space we want the user to experience. This identification is by no means arbitrary, on the contrary it ought to be informed by empirical enquiries.

### *Distinctiveness through containment*

In the particular instance of SchemaSpace pictured here we have about three hundred different Web-references to information on very disparate subjects, ranging from modern literature, via architecture, to computer graphics. Even such a relatively small collection calls for some kind of categorisation, a way to organise and order the information in sub-collections consisting of references belonging to the same category. Put differently, we have to provide for the possibilities of experiencing *distinctiveness*, that is, an experience which informs the user that some information references are in some respect different from other references. In order to provide such an experience we have to identify an image schema that is involved in our general understanding of ordering objects and activities in our everyday life.



*<Figure 5.9 - Distinctiveness through containment and quantity through verticality>*

Our encounter with containment and boundedness is one of the most pervasive features of our bodily experience. We are intimately aware of our bodies as three-dimensional containers into which we put certain things and out of which other things emerge. Not only are we containers ourselves, but our everyday activities in general - and ordering activities specifically - often involve containment in some respect: we live in containers (houses, shelters, etc.), we organise objects by putting them in different containers. We travel in containers, often in the company of others. Our frequent bodily experiences of physical boundedness constitute an experiential basis for a *container schema*.

One plausible way of providing for the experience of distinctiveness is to present the information references that belong together in a way that encourages metaphoric projection of the container schema. There are countless ways of visualising containment, and folders and rooms are probably the most familiar user interface containers. However, in our design of SchemaSpace we have as much as possible avoided elements which are - like folders and rooms - heavily metaphorically laden, in order to stress the experiential realist features of SchemaSpace. The elements of SchemaSpace consist largely of simple geometric shapes not closely associated with a specific source domain. We have chosen to visualise containment by means of semi-transparent cones (see Figure 5.9). A cone contains information references visualised by stacks of slices (based on StackSpace; Waterworth, 1997) each with a descriptive textual label. By using semi-transparency it is possible to see that a cone actually contains information references, and it is also apparent that they are bounded by the cone and are thus distinct from other references.

### *Quantity through verticality*

Each cone contains a sub-collection of the information references in SchemaSpace. Some of the sub-collections will contain more or fewer references in comparison to other sub-collections. Even though the cones are semi-transparent, viewed from a distance in the three-dimensional environment it will be difficult to judge the quantity of each cone. In order to provide for a meaningful experience of the quantity of each cone's contents we have to identify an image schema which is involved in our general understanding of quantity. Our basic experiences of quantity are closely associated with verticality (examples from Johnson, 1987).

"Whenever we add *more* of a substance - say, water to a glass - the level goes *up*. When we add more objects to a pile, the level *rises*. Remove objects from the pile or water from the glass, and the level goes *down*."

Spatial experiences of the this kind constitute an experiential basis for a *verticality schema*, a schema which by means of metaphoric projection plays an important role in our understanding of non-spatial quantity. Our tendency to conceptualise quantity in terms of verticality reveals itself in everyday language used to talk about quantity:

"The crime rate kept *rising*. The number of books published *goes up and up* each year. The stock has *fallen* again. You'll get a *higher* interest rate with them. [...]".

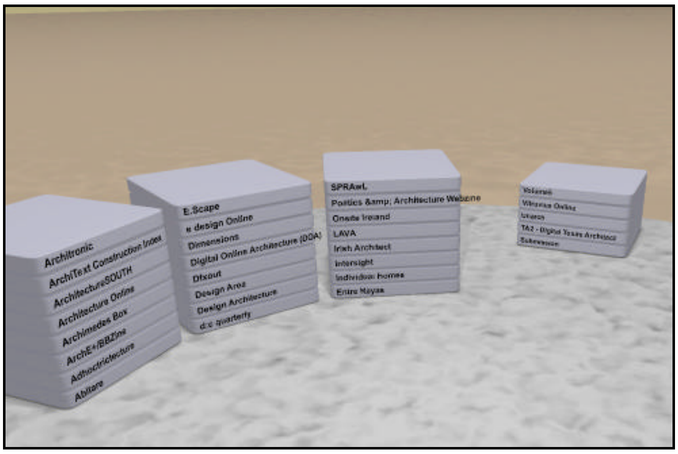
In our design we have tried to exploit this verticality aspect of quantity. As shown in Figure 5.9 the cones in SchemaSpace vary in height. The larger cones have a larger number of references inside compared to the shorter cones. Our intention has been to combine the container and the verticality schema in order not only to express quantity, but also to strengthen the experience of cones as containers of information references.

### *Degree of relevance through centrality*

As already mentioned, one of our goals has been to provide for the experience of distinctiveness. Even if a sub-collection constitutes a unity by virtue of belonging to the same category or subject, different references within a sub-collection may be of different importance or relevance in relation to that particular subject.

As pointed out by Johnson (1987):

”our world radiates out from *our bodies* as perceptual centers from which we see, hear, touch, taste and smell our world”.




*<Figure 5.10 - Degree of relevance through centrality>*

We also have very basic spatial and physical experiences of centrality as a measure of importance and relevance. Not only is that which is near the centre (the body) within our perceptual reach, but we also experience our bodies as having a centre and periphery where the central parts (trunk, heart, etc.) are of greatest importance to our well-being and identity (Lakoff, 1987).

For a potential user of SchemaSpace to experience some references as more important and relevant in relation to other references within a cone, we exploit a *centre-periphery schema,* which has its experiential grounding in perceptual experiences of centrality mentioned above. As shown in Figure 5.10, stacks of information references are organised along an arc. In those cases where there are a lot of references within a cone, the arc will eventually be closed and form a circle centred around the vertical axis of the cone. Information references can, however, be placed at varying distances from the centre; that is, some references will perceptually be closer to the centre and some will be more peripheral (see stack to the right in Figure 5.10). Our goal with this arrangement is to invoke a metaphoric projection - on the part of the user - of the centre-periphery schema in order to experience those references that are perceptually central as conceptually central.

### *Connectedness through linkage*

Finally, we want the user to experience that some sub-collections of references are related to each other, even though they are distinct from each other. The link schema is often involved in our understanding of relations and connections of different kinds, not only physical connections, but also more abstract, non-physical connections like interpersonal relationships.

*<Figure 5.11 - Connectedness through linkage>*

In SchemaSpace cones are connected with a path-like link if the sub-collections contained in the cone are connected in some abstract way (see Figure 5.11). As with the centre-periphery example above, our goal with this arrangement is to provide the user with perceptual cues that allow for structuring by means of projection of a certain schema, in this case the link schema. Of course, linking to show connectedness depends on some knowledge of what is connected and why, knowledge which is often lacking in constructing information spaces.

## 5.4 Experiential, Shared Visualisation of Events

Social navigation of information is often useful, as when someone directs us to information relevant to our current interests or needs. But when is it necessary? When do even contentedly-introverted and excessively self-reliant individuals find they must navigate information spaces with others? Perhaps only when scheduling of resource-dependent events is needed, for a work-related project schedule, for example. An understanding of the dynamic development of a project calls for a visualisation of events in the project (primarily meetings), resources related to events (people, documents, notes, etc), and event relationships. How should these be visualised?

### 5.4.1 Experiential Understanding of Time

I am *looking forward* to the summer vacation. Stop *looking back* and concentrate on what's *ahead* of you.

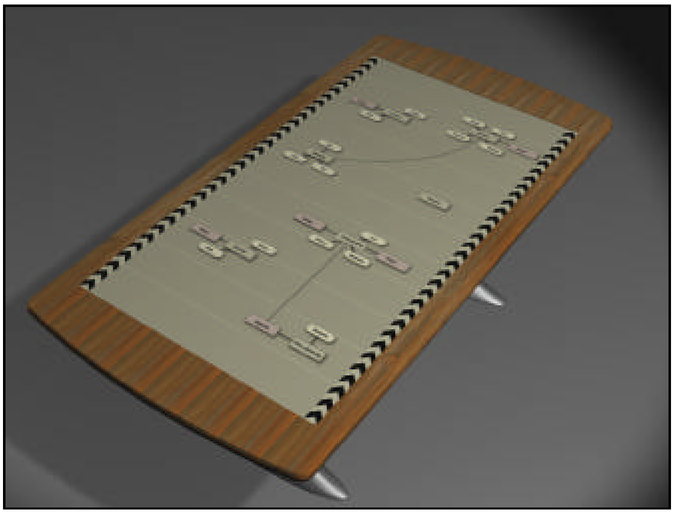
These linguistic expressions reveal the spatial-perceptual nature of everyday conceptualisations of time. Lakoff and Johnson (1999) refer to this conceptualisation as 'The time orientation metaphor' (ibid. p. 140). As shown in the examples, time is spatially orientated in relation to an observer so that the future is in front and the past is behind. Consequently, the present is at the location of the observer. How is it that this particular orientation is the case in many languages and cultures rather than, say, an orientation where the future is to the left and the past to the right? The experiential realist explanation is that this particular way of conceptualising time is grounded in embodied, concrete interactions that pertain to temporal aspects of experience. For instance, what someone will encounter is typically in front of the person; what someone has encountered is typically behind the person; what someone is encountering is typically in the closest proximity to the person (ibid. p. 152).

The time orientation metaphor provides structure to make sense and talk about the temporal location of events and also to compare the immediacy of different events. However, orientation alone does not provide enough structure to account for the change of time. Lakoff and Johnson present two major metaphorical conceptualisations of time that surface in linguistic expressions, the moving time metaphor and the moving observer metaphor. Consider for instance the following two sentences: (1*) The deadline is approaching*. (2) *We are approaching the deadline*. The sentences are very similar in that they both describe the decreasing distance between observers and an event (the deadline). However, a striking difference is that in the first sentence it is the time – or rather the event – that is moving in relation to the observer, whereas in the second sentence it is the observer that moves in relation to the event. Thus, both ways of conceptualising time involve the structure of spatial motion with the same time orientation, but differ in terms of what is figure and what is ground.

As is the case with time orientation, the reasons for conceptualising time using the structure of these two metaphors can – according to Lakoff and Johnson – be explained by the embodiment of recurrent experiences of what they refer to as "motion situations". For instance, the conception of time as a moving agent in relation to a fixed observer is partly grounded in recurrent experiences of moving objects in the visual field that approach the observer. Similarly, the conception of time of something spatially fixed that the observer moves in relation to correlates to the experience of moving the body in relation to fixed objects. In both types of conceptualisations, motion of – or in relation to – external objects stands for the 'passage of time'.

### 5.4.2 RoamViz: Visualising sustained and dynamic projects

Mobile workers especially may benefit from a shared visualisation of events that occur in ongoing projects. In this context, we are primarily interested in events such as meetings. Meetings may be physical in the sense of face-to-face meeting but may also be virtual in the sense of being mediated by communication technology and involving physically remote participants. Events may also have explicit relationships through association with certain documents or other resources. And events have relationships by virtue of being temporally situated in relation to each other. In this section we present a design for event visualisation based on the experiential realist framework.

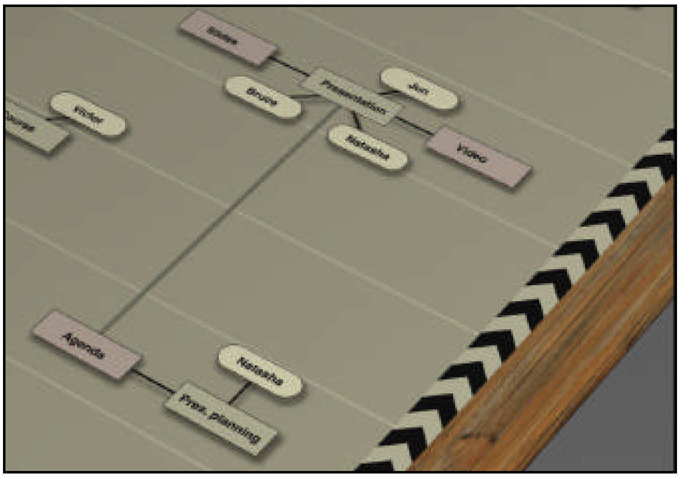


*<Figure 5.12 - Conceptual design of RoamViz>*

Our design, called RoamViz, is influenced by a recognition of the importance of co-location even in the context of mobile work. Consequently, it is intended to serve as a physical meeting place for making sense of otherwise dispersed meetings and events that occur in mobile project work. We have chosen a table-like device for our visualisation prototype. As shown in Figure 5.12, events are depicted as clusters of objects, laid out on a tabletop. For more details of RoamViz, see Lund and Wiberg (2001).

In the illustration in Figure 5.13, there has been an event at some point in time in the form of a presentation. A number of people (Jun, Bruce and Natasha) are connected to this event. Also linked to the event are a video recording and some slide materials. The notion of linkage is also applied to visually express relations between events. Presentation clusters of event related objects are also linked to another cluster of event objects. This cluster represents an event that occurred some time prior to the presentation event and is related to the presentation by being a meeting to plan an agenda for the presentation.

Following the experiential realist account of different time conceptualisations, our visualisation design embodies the notion of time orientation. By introducing the chevron stripes at the margins of the interface we suggest a spatial direction for the events in order to make temporal order distinguishable.




*<Figure 5.13 – Events in RoamViz>*

RoamViz is based on the moving observer metaphor requiring an active user to ‘travel’ across a project landscape of related events in order to experience time segments of the project. In addition to its value as an artefact for planning and conflict resolution, a table may be arranged in ways to invite and encourage social interaction (see Borghoff and Schlichter, 2000, for a discussion of the social role of different table arrangements). Our intention is to make the RoamViz table a computer enhanced, physical meeting place where project members can interact socially and navigate information that pertains to their work.

Of course, the mobile workers who might gather around the table from time to time would not want to carry a table with them on their travels! But the same shared visualisation could just as easily be displayed on a laptop PC, or even a PDA. The tabletop visualisation can be seen as an attempt to transform an abstract and cognitively demanding information navigation task into a concrete, perceptually rich and shared activity. This focus emphasises our view of embodiment as the foundation for shared signification.

In this first attempt to incorporate the dimension of time, we have not included other image schematic elements to convey the non-temporal relationships between displayed items. An obvious next step is to create a landscape akin to SchemaSpace on the tabletop, and include a representation of time passage as already described.

## 5.5 Conclusions

According to the experiential approach, the design of information landscapes and features can be based appropriately on notions of meaning as experience, rather than ideas of meaning as functionality conveyed through traditional HCI models. This is partly because we can never fully know what the function of shared information landscapes might be. But such a situation is biologically natural for us, since we don't know what the function of the natural world is.

Information spaces are a powerful way of presenting collections of information because they allow people to explore virtual worlds of information using cognitive processes similar to those with which they explore the real world, whether this is an individual activity or in groups. These cognitive processes have developed to be run unconsciously and to interfere minimally with conscious attention. The landscapes that encourage them are pleasing to us.

Views of spaces can serve as a powerful mechanism for social interaction because they can be compared, contrasted, shared and exchanged. Groups interacting in real time probably require a sense of co-presence in a shared space, and groups interacting asynchronously required a shared world of information to navigate (and explore). For co-ordinated activities, time must also be represented within a navigable information space.

Although we have all evolved with similar bodies and emotional responses to environments – responses that are indicative of their likely navigability - we are not all equally competent navigators. People in the lowest quartile of spatial ability have serious trouble navigating in 3D environments, including 3D virtual worlds. Even so, we believe that investigations of the influence of our shared evolutionary background on preference and performance in different environments may provide a rich seam of knowledge for our future work with the experiential design approach.

An argument is sometimes heard, along the lines of "if bodily experience guides our understanding, how can we ever not design experientially?". One answer is that we don't know what our bodies know; there are different types of knowledge. What "we" know is explicit, conscious, externalisable and individual. What our bodies know is implicit, often unconscious, not easily externalisable in words, and universal. If a theory claims to explain everyone's behaviour, that doesn't mean that everyone knows the theory and can apply it in design. We all know instinctively what makes a pleasant dwelling, but architects still design buildings in which nobody would like to live – and sometimes win prizes for them.

Experiential design captures basic, unconscious, animal reactions to physical environments and introduces them to shared virtual landscapes. We can design appropriate tools and environments, just as we can design churches, cinemas and houses, but we do not design societies or social behaviour, just as we did not design our own bodies. We are social (and spatial) by nature, not design. Having a body means that things, and information, can have meaning for us. We all have the same types of body, designed by evolution, and this allows us to share meanings. Bodily experience is the only universal medium for understanding.

### 5.6 Acknowledgements

Mark Chignell of the University of Toronto has contributed in many ways to this chapter, especially the experimental comparisons of alternative virtual worlds and views, without knowing it. Mikael Wiberg of Umeå University worked closely with Andreas Lund on the RoamViz concept. Eva Lindh Waterworth made several valuable suggestions to improve the chapter, many of which we have adopted.

### 5.7 References

Alexander, C., Ishikawa, S., Silverstein, M. (1977). *A Pattern Language: Towns, Buildings, Construction.* New York: Oxford University Press.

Balling, J. D. and Falk, J. H. (1982). Development of Visual Preference for Natural Environments. *Environment and Behavior, 14* (1) 5-28.

Borghoff, U. M., & Schlichter, J. (2000). *Computer-supported Cooperative Work*. Berlin, Heidelberg, New York: Springer Verlag.

Chase, W. G. (1983). Spatial Representations of Taxi Drivers, in Rogers, R., and Sloboda, J. A.. (eds.), *Acquisition of Symbolic Skills*. Plenum Press, New York NY.

Coyne, R. (1995). *Designing information technology in the postmodern age: From method to metaphor*. Cambridge MA: MIT Press.

Darken, R. P. and Sibert, J. L. (1996). Wayfinding Strategies and Behaviors in Large Virtual Worlds, in *Proceedings of CHI '96* (Vancouver BC), ACM Press, 142-149.

Erickson, T. D. (1990). Working with Interface Metaphors. In Laurel, B (ed.), *The Art of HCI Design*. Menlo Park, USA: Addison-Wesley.

Fällman, D. (2001) "Where's the Interface?" Enhanced Use Models for Mobile Interaction [Doctoral Consortium Paper], In *Proceedings of INTERACT'01*, Eight IFIP TC.13 Conference on Human-Computer Interaction, Waseda University Conference Centre, Shinjuku, Tokyo, Japan, July 9-13

Fishkin, K. and Stone, M. C. (1995). Enhanced Dynamic Queries via Movable Filters. *Proceedings of CHI'95*. New York: ACM.

Henderson, D A and Card, S K (1986). Rooms: The Use of Multiple Virtual Workspaces to Reduce Space Contention in a Window-Based Graphical User Interface. *ACM Transactions on Graphics*, 5 (3), 211-243.

Herzog, T. and Smith, G. A, (1988). Danger, Mystery and Environmental Preference. *Environment and Behavior, 20*(30) 320-344.

Johnson, M. (1987). *The Body in the Mind. The Bodily Basis of Meaning, Imagination, and Reason*. Chicago: Chicago University Press.

Kaplan, S. (1987). Aesthetics, Affect and Cognition: Environmental Preference from an Evolutionary Perspective. *Environment and Behavior, 19* (1) 3-32.

Keshkin, C., and Vogelmann, V. (1997) Effective visualisation of Hierarchical Graphs with the Cityscape Metaphor, in *Proceedings of the Workshop on "New paradigms in information visualisation and manipulation*" , ACM Press, 52-57.

Lakoff, G. (1987). *Women, Fire and Dangerous Things*. Chicago: Chicago University Press.

Lakoff, G., and Johnson, M. (1999). *Philosophy In The Flesh: The Embodied Mind and Its Challenge to Western Thought*. New York: Basic Books.

Lund, A. and Waterworth, J. A. (1998). Experiential Design: Reflecting Embodiment at the Interface. *Computation for Metaphors, Analogy and Agents: An International Workshop*, University of Aizu, Japan, April 1998.

Lund, A. and Wiberg, M. (2001). Situating events in RoamViz: Using spatio-temporal dimensions to visualize sustained and dynamic mobile projects. In *Proceedings of IRIS24*: S. Bjørnestad, R. E. Moe, A. I. Mørch and A. L. Opdahl (Eds.). Ulvik, Norway: Vol. II, pp. 99-114.

Lynch, K. (1960) *Image of the City*, The MIT Press, Cambridge MA.

McKnight, C., Dillon, A., and Richardson, J. (1991) *Hypertext in Context*. Cambridge University Press, Cambridge England.

Modjeska, D. (2000) *Hierarchical Data Visualization in Desktop Virtual Reality*. Ph.D. Thesis. University of Toronto, 2000.

Modjeska, D. and Waterworth, J. A. (2000) Effects of Desktop 3D World Design on User Navigation and Search Performance. *Proceedings of IV2000, International Conference on Information Visualisation*, London, England, July 2000. IEEE Press.

Nagel, T (1986). *The View from Nowhere*. New York: Oxford University Press.

Passini, R. (1984). *Wayfinding in Architecture*. Van Nostrand Reinhold, New York NY.

Rennison, E. (1994). Galaxy of News: An Approach to visualising and Understanding Expansive News Landscapes, in *Proceedings of UIST '94* (Marina Del Ray CA), ACM Press, 3-12.

Stevens, A., and Coupe, P. (1978). Distortions in judged spatial relations. *Cognitive Psychology 10*, 422-437.

Waterworth, J. A. (1995). Viewing Others and Others' Views: Presence and Concealment in Shared Hyperspace. Presented at *Workshop on Social Contexts of Hypermedia*, 16-17 February 1995, Department of Informatics, Umeå University, Sweden.

Waterworth, J. A. (1996). A Pattern of Islands: Exploring Public Information Space in a Private Vehicle. In Brusilovsky, P, Kommers, P and Streitz, N (eds.) *Multimedia, Hypermedia and Virtual Reality.* Springer Verlag Lecture Notes in Computer Science, 1996.

Waterworth, J. A. (1997). Personal Spaces: 3D Spatial Worlds for Information Exploration, Organisation and Communication. In R. Earnshaw and J. Vince (eds.): *The Internet in 3D: Information, Images, and Interaction*. New York: Academic Press, 1997.

Waterworth, J. A. and Singh, G. (1994). Information Islands: Private Views of Public Places. In *Proceedings of MHVR'94 East-West International Conference on Multimedia, Hypermedia and Virtual Reality.* Moscow, September 14-16, 1994.

Zube, E. H., Sell, J. L., and Taylor, J. G. (1982). Landscape perception: research, application and theory. *Landscape Planning, 9*, 1-33.

Zuberec, S. (1994). Visualization of Text Based Information. *Master's Thesis.* University of Toronto.