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Had we but world[s] enough, and time?

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Abstract

This paper presents ongoing research into user requirements for 3-dimensional "virtual worlds" to be used as a means of information retrieval. There is a brief review of the literature in the fields in which design of 3-dimensional virtual spaces has been carried out, and the conclusion is reached that this design has usually been done without regard to user preferences. This study has used grounded theory to establish user preferences, initially amongst a group of about fifty postgraduate information management students. Initial results of open coding of these interviews are described, and the next steps in the study are laid out. The Virtual Reality Modelling Language (VRML) will be used as a world design medium.

Introduction

The research question addressed in this piece of ongoing research is, what are user requirements for a 3-dimensional "virtual world" modelled on a computer, to be used as a tool for information retrieval? The purpose of the paper is to report on the progress of the research to date, and to describe some preliminary findings.

The objectives of the research were:

- To conduct user interviews, based on a "grounded theory" approach, which will elicit user perceptions of useful designs for 3-dimensional "virtual realities" for information retrieval.
- To draw from these interviews conclusions as to common elements and recurrent designs.
- To construct "worlds" which will be used to test t he usability of different designs.
- To draw conclusions as to the best procedures for designing such worlds.
- To examine communities where users can design worlds, and draw relevant conclusions.

Background

The original plan was to construct "worlds" using VRML (Virtual Reality Modeling Language), and to ask users to perform information retrieval tasks using the worlds. VRML permits the representation, on a computer screen, of arbitrarily complex 3-dimensional spaces. However, it was realised that the designs had been chosen without any real justification for using those particular designs, and that no very good reason could be found for favouring a small test set over others.

The literature review appeared to reveal that this question had not received much attention, and that the approach previously taken in studies in this area had been to construct worlds, then test user performance. It does not appear that user preferences have been considered in the design stages.

1. Literature

There has been a wide range of attempts to design information space, particularly in the field of information visualization (this spelling

is by far the most common), many of which are summarised by Gershon and Eick (1995) and by Card and Mackinlay (1997). Card and Mackinlay propose a categorisation of visualisation techniques in the literature, and provide a tabular encoding to describe significant features of each. The major types they identify are Scientific Visualization, GIS, Multi-dimensional plots, Multi-dimensional Tables, Information Landscapes and Spaces, Node and Link, Trees, and Special Data Transforms.

They provide useful definitions of the terms *information landscape* and *information space*. Where Q denotes data having quantitative values (values on which arithmetic can be performed), Q_{xy} denotes intrinsically spatial variables, and Q_{lat} and Q_{lon} spatial variables that are actually geophysical coordinates,

> Landscapes lay information out on a surface, typically the XY plane.
> Landscapes may be of several sorts: real geographical coordinates, real spatial variables, or completely abstract mappings
> $\{Q_{lon}$ or Q_x or $Q\} \rightarrow X$
> $\{Q_{lat}$ or Q_y or $Q\} \rightarrow Y$.
> If the mapping extends to
> $Q \rightarrow Z$,
> We call it an information space.

Here is the interface, or the meeting point, or the common ground – the surface where the information visualization literature borders on the area of current research. As indicated, the concept of information space uses mappings of quantitative data onto all three dimensions of a space. The worlds under consideration in this research need not be limited by this requirement, however, and could well include elements of the other types identified by Card and Mackinlay. It might be that a user would find it appropriate to represent documents as points in a "formal" information space, defining their position by frequency of occurrence of selected terms. A clustering algorithm could then be used to measure "similarity". However, it might well be that a user would find it more natural to work with documents in a 3D representation of a real desktop, with piles of papers arranged according to personal whim, or filed neatly into categories.

Chen's 1999 study, *Information visualization and virtual environments* (Chen, 1999), leads us away from the more graph-like 3D representations favoured in the information visualization community, towards a kind of shared "world", but the world's structure is still pre-imposed.

There are other fields bordering on this area – for example, Dillon (2000) looks at user difficulties in navigating 3D information spaces, and concludes that "interfaces for shaping information should be built on an increasing analysis of users' semantic processing". This might be called the Human-Computer Interaction approach. There is also literature from the field of cognitive psychology, concerned with wayfinding (Darken, 1996), and from cognitive ethnology (Hansen, 2002). This latter approach is concerned with social interactions in the "inhabited" worlds in the 3D cyberspace system ActiveWorlds. Active Worlds are constructed by their "owners" to their own design, and could be seen as complementary to the area of this study – they are not primarily used for information retrieval, but have a definite social role. The designs are limited by the "toolkit" available to designers, and by the rather limited movement and interaction of the "avatars" representing users of the system. The Active Worlds browser must also be installed as a prerequisite of using the system.

2.Literature review conclusions

A common factor in all the literature studied was that users did not appear to have been consulted in the design process – much, if not most, of the work carried out in the design of "virtual environments" is undertaken with little input from the end-users of the systems. Whilst designs may be usability tested on completion, there is little evidence in the literature for a user-based approach to initial design. Studies of existing worlds, other than those by their designers, appear to concentrate on the use of these worlds as "social spaces". There is, however, evidence in the literature to suggest that techniques of information visualization can be used to exploit cognitive abilities normally associated with a spatial context, in the perception, apprehension and use of

information. For example, a human performing an everyday activity, such as crossing a street, might be engaged in information-gathering across a wide spectrum of inputs: there are visual data supplying information on shape, size, distance, and motion, sound data relating to surrounding spaces and objects, both moving and stationary, and other data, such as olfactory and tactile, which are not, as yet, commonly mediated by computer. The advent of the "force-feedback" joystick and mouse in the world of computer gaming mat herald the opening of one of these remaining channels. The point is that humans are capable of assimilating information through many more "channels" than those exploited in a list of hits from a search engine, for example. This is perhaps a relic of our prehistory as hunter-gatherers, but it could nonetheless be exploited in the very topical context of improved information retrieval systems.

Though the research plan had proposed user testing of different 3D models, and a small pilot was run on this basis, it became clear that this type of approach was, in fact, typical of the literature, and it was decided that it would be more useful to explore the question, "If users could design such a world themselves, what characteristics would it have?". This approach was intended to take account of the possibility, indeed probability, that user responses would specify models not considered by the researcher. As an example, the prototype worlds originally developed had no elements of motion, sound, or colour (as a significant "dimension") included, yet all of these features were to appear in "user-generated" worlds.

Methodology

It was decided that a Grounded Theory approach (Strauss and Corbin, 1990) would be more valuable, in that it could be used to elicit users' own images of what their "information space" might look like, and these findings could be used as a basis for further examination of the "information space" concept, grounded in user-originated data.

The first group of interviewees was made up of postgraduate students at Aberdeen Business School, Robert Gordon University. Most were undertaking courses in the area of Information Management, but had come from a very wide spectrum of undergraduate subjects, life experience, and national and cultural origin. The first round of interviews was conducted before there was the possibility of them acquiring from the course content any notions of a "proper" way or ways of organizing information, as is indeed clear from the interview transcripts. However, it must be conceded that the concept of "information retrieval "did not require further explanation, although the sophistication of the system was deliberately unspecified, in order to draw out from interviewees the models which occurred to them most readily. Some had very classical systems for the entire universe of information, some considered only personal information, or that related to a particular job, or field of study. Some also pointed out that the model chosen would depend to a great extent on the type of information to be retrieved. These were all considered valid points of view, but it was felt that the broadest perspective would be achieved by placing the fewest constraints on interviewees' imaginations. A case can certainly be made in this context for "form should follow function", but it remains to be seen if that is what the user prefers, in this quite personal and rather abstract context.

Interviews were preceded by a short talk to groups of interviewees, explaining the concept of 3-dimensional "virtual realities", and showing some pictures of models from the literature, ranging from a perspective wall, to an information landscape representing term occurrence in a body of medical literature. It had been determined during the early stages of testing that, lacking some visual examples, many interviewees did not grasp the concepts involved. It was therefore decided to provide a number of examples, both in order to demonstrate the range of possibilities and to stimulate individuals to develop their personal models, rather than feel constrained to one of a few examples. It is perhaps characteristic of any specialised field, that it seems perfectly

commonplace to those involved in it, but can appear utterly alien to a non-specialist, and it appeared that this factor should be acknowledged, without seeming to patronise the interviewees. Many, as it turned out, were quite comfortable with the idea, having read fiction or played computer games which made use of 3D "worlds", but there was a sizeable minority to whom the idea was completely novel.

1. Interviews

Interviews were with individuals, except in one case where two interviewees arrived together. It was decided that there was too much mutual influence between the interviewees in this case, so the scenario was not repeated. Interviews were recorded and transcribed, and the resulting transcripts were checked for accuracy with individual interviewees who were still contactable at that time. One interviewee complained about transcription errors, and provided corrected information, but all others were satisfied with the transcriptions. Most interviews were of short (five to ten minutes') duration, although some lasted considerably longer, when an interviewee had a well-developed idea and was prepared to discuss it at length. Fifty-one individuals were interviewed in the first round of interviews. Some individuals had more than one model, and in these cases all models were recorded.

Findings

The transcripts obtained were analysed first by the type of image, or "world" which was described. The following models appeared. Some interviewees presented more than one image (indicated by slashes, /), and one interview was conducted with two interviewees (2 and 3), a method which it was decided was less satisfactory than single-person interviews.

1.	brain
2&3	connected blocks
4.	desktops
5.	molecules, mental maps
6.	library
7.	floating documents
8.	shops
9.	My house/office
10.	car park/forest
11.	library
12.	room made of blocks of text/ city of words
13.	timeline
14.	like the office
15	office/building
16.	forest
17.	coloured transparencies
18.	clouds
19.	aquarium/music
20.	library
21	hierarchy/tree
22.	solar system/wormholes
23.	hierarchical mansion
24.	library
25.	card catalogue
26.	town
27.	bubbles
28.	town
29.	rivers/map
30.	space/underwater/tree/
31.	card catalogue
32.	multi-dimensional wheel
33.	car park
34.	library
35.	lollipops
36.	touch screen/Google/OPAC
37:	nothing
38.	nothing
39.	PARC wall
40.	car/road/Monopoly
41.	brain
42.	trees
43.	jungle/ deep sea
44.	zoo/safari park
45.	universe/library
46.	theme park/fairground
47.	game
48.	house
49.	office building
50.	town
51.	street market
52.	memory palace
53.	planets

Table 1: interviewees and concepts

A first rough grouping of the concepts produced this:

Concept	No.	Concept	No.
Library/catalogue	7	memory palace	1
Forest/tree	5	molecules	1
Town (inc street market)	4	music	1
planets/space	4	OPAC	1
house/mansion	3	packets	1
office	3	PARC wall	1
brain	2	room	1
car park	2	rivers	1
aquarium	1	safari park	1
bubbles	1	theme park	1
clouds	1	timeline	1
deep sea	1	touch screen	1
desktops	1	transparencies	1
game	1	wheel	1
lollipops	1	Zoo	1

Table 2: first grouping

This was the equivalent of 30 different concepts, from 53 interviews. They appeared to be distinct concepts, at the first attempt to organise them, but when examined more carefully, especially bearing in mind the type of "facet analysis" that can be carried out, it becomes apparent that they should not be grouped without further consideration of possible loss of "richness".

1. Analysis

For example, though all libraries are described as such, there might be a distinction between "a house" described by 47, which has a very fluid structure, and "my house" described by 9, which has a definite arrangement, preferred by a very organised person. Checking keywords is not enough. Similarly, there are distinctions between "my office" (9, again), "like the office" (14, a representation for telecommuting as an avatar), and "office block" (a very rigidly structured environment, which nevertheless bears similarities to 48's very fluid house). The "hierarchical mansion" bears probably more similarity to a library or to the "office block" than to "my house", which is a representation of an actual house. These examples come from the full-text transcripts, but part of their impressionistic nature is due to the fact that the recorded interviews carry cues other than those conveyed by reading the text. Here, again, the high "bandwidth" of human communication comes into play, and it must be acknowledged that factors such as hesitation, "pressure of speech", enthusiasm or lack of it, and body language all contribute to the researcher's interpretation of the interviews. This is perhaps regrettable, and might be normalised by a group consensus on videotaped interviews, but such resources are beyond the scope of the current research.

It seems, then, that the simple structural descriptions picked out here are already failing rather obviously to do justice to the richness of the images described. It is also worth noting that these first interviews were short in duration, and did not examine most individuals' images in any great depth.

However, based simply on the very abbreviated descriptions above, the most popular image is "library", followed by "forest/tree" and "town". There are, in fact, two mentions of "forest", two of "tree", and one of "trees", which leads back to the transcriptions, where it would appear that 10's forest is a means of finding information about trees, 15's is a more typical "IR" forest,

with different sections of the forest, "taller trees, different kinds of trees, different kinds of plants, for obviously representing different things". There's also the possibility of adding to the forest, by planting things, so this is a much more interactive tool. When we examine the jungle image from 43, we find that 43 has come up with several ideas which are superficially attractive to the interviewee, but have not been developed to any great degree.

This is just an example of the dissimilar denotations of similar terms, so must serve as a warning in further analysis. There is much more to the images than a simple label, but it appears that the "person-centred" approach gives a route to pinning down these differences, to a much greater degree than questionnaires, for example. It is also a great advance on the earlier, "build it, and they will come" approach.

2. Groupings

Concept	Interviewees	No of interviews
aquarium	19	1
blocks, connected	2, 3	2
brain	1, 41	2
bubbles	27	1
car on road/Monopoly	40	1
car park	10, 33	2
card catalogue	25, 31	2
city of words	12	1
clouds	18	1
desktops	4	1
documents, floating	7	1
forest	10, 16	2
game	47	1
Google	36	1
hierarchy	21	1
hierarchical mansion	23	1
house	48	1
house, my	9	1
jungle	41	1
library	6, 11, 20, 24, 34, 45	6
lollipops	35	1
map	29	1
market, street	51	1
memory palace	52	1
mental map	5	1
molecules	5	1
music	19	1
nothing	37, 38	2
office building	49	1
office, my	9	1
office, like the	14	1
OPAC	36	1

Concept	Interviewees	No of interviews
PARC wall	39	1
planets	53	1
safari park	44	1
sea, deep	43	1
shops	8	1
solar system	22	1
text, blocks of	12	1
theme park	46	1
timeline	13	1
touch screen	36	1
town	26, 28, 50	3
transparencies, coloured	17	1
tree	21, 30	2
trees	42	1
underwater	30	1
wheel, multi-dimensional	32	1
wormholes, space	22	1
zoo	44	1

Table 3: concept groupings

A few "characteristics of division" arose quite quickly from the simple keywords approach:

Real vs. imaginary
Known vs. unknown
Concrete vs. abstract
Personal information vs. all information
Colour vs. no colour mentioned
Sound vs. no sound mentioned
Motion vs. no motion mentioned

To add to, or refine, some of these:
Are we dealing with a pre-existing, perhaps "real" structure? That mapping is characteristic of the "memory palace" (Yates, 1984), but in simpler terms could be "my house", or "the office", "shops" or "street map". In a memory palace, images of the things to be remembered, or representing passages of text to be memorised, were placed around a recalled image of a building, often, at least initially, based on a real building. Perhaps if a real office or home were used, it would be easier to locate the imaged information sources where the actual items are in real life, for example in a desk or a filing cabinet. This was the case with number 9, who wanted her virtual world to replicate the quite rigorous organisation of her home or office. This might be called the "if it ain't broke, don't fix it" approach.

Conversely, there is a group of ideas which seem quite abstract, although they may be based on "real" things. Bubbles, clouds, neurones and lollipops all made appearances. The reader, privy only to the bare transcript information, might be tempted to ascribe these choices to a more "frivolous" personality type, but this was not felt to reflect the interviewees' perceived characters. Indeed the more abstract models often came from more "serious" and apparently conventional individuals, though it must be conceded that even the more outgoing librarians showed a fondness for the card catalogue model.

Is some kind of classification scheme used, however informal? It became apparent in the course of the interviews that, although the interviewees were usually asked how information might be organised in their image, very few gave considered answers, so that, in fact, the concept of organising information

might be quite unfamiliar to them. A library rather implies the use of some form of organisation, or it is merely a store-room. The galaxy/solar/system/planets idea could be seen as implying a different subject area for each grouping, at whatever scale applies. The street market has stalls for different subjects, a town plan or map also implies organisation, as do shops. It is much less clear what scheme applies to a car park, however, and the interviewees (10 and 33) were not forthcoming on the question. 10 was unused to the idea, and came up with a very representational model of the real world, in which clicking on an image of a car in the car park would retrieve information on the car. Since car parks are not organised by any relevant principle, this does not hold much hope as an IR tool. 33's model is ranked by size – a larger vehicle represents more information on a topic. Organising information by this criterion seems of very limited use. A few interviewees wanted to organise by frequency of use – not a formal scheme, but one which is manifest in the Windows XP start menu, and the management tools for the desktop and Outlook, for example. In this model, sources which are more frequently, or more recently, used, are "closer", in some sense, to the user.

3. Engagement

Another factor, which only comes out incidentally in the interviews, is engagement. Some interviewees were far more expressive than others, and it appeared, subjectively, that they were either more interested in the idea, or perhaps had thought of it before. Again, this was a flaw in the interview procedure, in that this area was not explored, until close to the end of the series of first-stage interviews, when a question was asked about whether the interviewee had ever visualised information in this way, perhaps for a previous degree. It appeared in most cases, however, that the image had been "constructed" especially for the interview.

This could be called something like "depth of visualisation", or perhaps better, "development". Sometimes it appears to be a result of the interviewee having given the matter a good deal of prior thought, sometimes it might be an idea that is developed while talking about it, sometimes the interviewer might spark further development with a timely suggestion, or a request for clarification.

Next steps

To improve on the rough, preliminary "hand-coding" shown above, the interview transcripts are currently being analysed using Nvivo software, which is already allowing interesting correlations to be made amongst different responses.

The next stage in the research will be to develop VRML models for testing by the interviewees. We cannot easily replicate a world of the "my office" type, because we do not have access to the users' image of their own office, home, or other space. It would in any case have to be that such a world would be constructed by, or with close co-operation from, the individual, and would have little utility for anyone other than that individual. However, it is hoped that models could usefully be based on generalisations from the less specific models common to, or derived from, interviews which show some similarity in the models proposed.

Several dimensions emerge from the interviews. It is felt that they are the significant dimensions to consider at this level of model development (for example, there is no consideration given as yet to avatar development or interaction, just to the worlds' design). It should therefore be valid to continue with further groups of volunteers, who may distribute differently around these dimensions, but are unlikely to open up any new ones, though that possibility will continue to be under consideration.

1. Model testing

It is intended that representative models will now be constructed, using Virtual Reality Modelling Language (VRML), and that another group of interviewees will be invited to test them for usability. The unavailability of most of the original group of interviewees is not perceived as a drawback, because it is felt that the range of models emerging from the first round of interviews fall into complementary

groups, and that the factors chosen as significant are those which emerge from the nature of the research question. Because a great variety of models emerged (see Section 4, Findings), it is intended that a smaller number of models will be tested, each of which is an example of one of the emerging themes.

The intention is therefore to construct a "concrete" or "realistic" world displaying a principle of organisation. The library is a popular image, and a good candidate for modelling. The forest is realistic, and can display order, but is not a conventional "information space", and "forest", "jungle", "tree" and "trees" combined give us the second most popular model. Towns, buildings, shops and a market are another example of use of a realistic world as a less conventional information retrieval tool. Finally, the planets/solar system model occurs twice, as do other "space" themes, so this too seems a good candidate for modelling.

The more unusual, imaginative or idiosyncratic models occur once each, and can perhaps be seen as characteristic of individual interviewees, rather than models which might be of wider popularity. It will, however, be possible to pursue these questions further in the next round of interviews, and it may be that further models, perhaps of the more "abstract" type, will be constructed.

Conclusions

It was not apparent that the "worlds" interviewees proposed were influenced by factors such as the age or gender of interviewee, nor by their experience of 3D computer games (very few had such experience, and the models they proposed tended not to be of that type). Indeed the researcher's preconceptions were continually challenged by the variety and "richness" of models from interviewees of all types. It might be, however, that the individual's ability to organise information might be reflected in the structure or complexity of the world proposed, and this would be a potentially fruitful area for future experiment. Another interesting suggestion is that "a successful 3D information landscape [might] have no real world analogues at all and thus people would have a hard time imagining it". Again, difficult to test, but certainly food for thought.

There are implications in the use of virtual environments as tools for the design and organisation of libraries, extending the increasing use of the architect's "walk-through" model to encompass shelf organisation. This is outside the scope of the current research, but practitioners might find it an economical means of testing proposed arrangements in a way which is hardly feasible using physical stock. For example, Hyman discusses many possible shelf arrangements of stock, not only the familiar parallel sequences for different formats or oversize works, but more radical ideas involving physical alteration of the items themselves (Hyman, 1982). The space saving potential is great, but it would be of obvious benefit to explore the practical utility before taking potentially irreversible steps towards achieving it.

The same principle could be usefully applied to signage (Pollitt and Haskell, 1979). There is ample scope in VRML for modelling not only a library, but also different styles and placements of signage, and testing these with users, perhaps by creating simple retrieval challenges.

Because the user's viewpoint in a virtual world can be adjusted, it would be easy to get a child's perspective of a proposed arrangement, or that of a wheelchair user. Issues of physical access could be explored, lighting schemes experimented with, or different colour schemes tried out, all without the need for committing to real-world changes.

Software packages which assist in "world-building" are available, though it might be felt that learning to use one of them in the context of a librarianship course would pose unnecessary demands on the less technically-inclined student. Those interested in library design, however, could find it a useful additional skill, and take inspiration from the fact that the virtual "walk-through" of a

building at the design stage is now an accepted part of the architect's profession.

Whilst the current research concerns itself with electronic documents in virtual environments, it may be that there are useful spin-offs for the more "traditional" facilities also.

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