Rediscovering the Art of Memory in Computer Based Learning—An Example Application

Anders Hedman
Centre for User-Oriented IT-Design (CID, Department of Computer Science (NADA)
Royal Institute of Technology (KTH)
Stockholm, Sweden
ahedman@nada.kth.se

Pär Bäckström
Centre for User-Oriented IT-Design (CID, Department of Computer Science (NADA)
Royal Institute of Technology (KTH)
Stockholm, Sweden
paer@nada.kth.se

ABSTRACT

This paper describes how we applied ancient mnemotechnics, the Art Of Memory (AOM), to build a computerized philosophy exhibition. The AOM is described as having influenced the evolution of museums and it is argued that it could be of importance to consider it with respect to the design of computer based 3D exhibitions. The paper also reports from a user study of the 3D exhibition. It was found that the exhibition worked as means of exploring philosophy, but that improvements should be made along the lines of environmental richness, perspicuity and navigation.

Keywords

Art of memory, computer based learning, virtual environment.

1. INTRODUCTION

In this paper we explore the possibilities of using old memory techniques dating back at least to antiquity. The techniques are collectively referred to as the Art of Memory [1, 2, 3] and were commonly used by educated people in the western world until the late renaissance. The AOM is a visual approach to storing and retrieving information and relies on the mental construction of place like information environments. We believe that the tradition of AOM could provide guidance in producing modern information environments with strong connotations of place. Such information environments can be seen as exhibitions were the underlying purpose is to engage the visitor in much the same way as museum exhibitions. It has been argued that the AOM was influential in the development of museums [4]. We believe that the AOM has value when we consider the place like character of many computer generated exhibitions.

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2. THE ART OF MEMORY

These days, surrounded as we are by information technology in various forms (printed information, electronic media, computers etc) that support human memory, it is easy to forget that life was not always so easy. Up until the late renaissance human memory and how to develop it was a subject of greater concern as the history of the AOM testifies to. With few means of supplementing human memory, the educated looked instead for ways of amplifying it and to discover its nature along with weaknesses and strengths. The central ideas of the AOM are attributed to the poet Simonides in Greek antiquity. Cicero (who himself taught the AOM) tells us about how Simonides was able to recall the names of the guests at a dinner party after the roof had collapsed and mangled their bodies beyond recognition. Simonides used the spatial environment, i.e., the seating arrangements to identify each corpse. This dramatic example encapsulates the essence of the AOM which is to pair information with properties of places. The AOM allowed actors, orators, scholars, educated people and others to store and recall impressive amounts of information through "artificial" means. It was typically used for memorizing long poems, speeches, lists of events and items of information. Over the years, the AOM was developed by various mnemotechnicians and different schools were formed until the AOM went out of style by the late renaissance. By this time, the need to remember vast amounts of information had become diminished as books had become more widespread and readily available.

2.1 Key principles

While different schools developed around the AOM some principles became more prevalent than others and can be said to be more or less general for the AOM. Here we try to summarize these principles. For the sake of brevity we will state them as axioms although we recognize that the veracity of these principles is subject to further discussion. We believe that the principles worked for many people that used the AOM, but not all.

2.1.1 Place-like environments

Information is put into place-like environments. When information is geographically positioned it can be organized and accessed systematically. AOM users stored information in different places or *loci* and could retain the information by

performing mental walkthroughs between loci (e.g., rooms in a building).

2.1.2 Striking imagery

Visual impressions are used to anchor information within loci. The more striking and unusual such imagery is the more easily it is remembered and the better it is for anchoring information.

2.1.3 Association

In order to trigger memory the visual imagery used must be associated with the concept or element of information to be remembered.

2.1.4 Creative use of spatiality

The mental places constructed do not need to conform to places in the physical world, e.g., they do not need to be built according to our common conceptions of space and need not conform to laws of nature. For example, the users of AOM can construct geographies that are not physically possible. A door in one room could, e.g., lead to another room far away or a hallway between two rooms could be much shorter than the distance between the rooms.

2.1.5 Architectural guidance

Environments should be constructed with some measure of architectural variation in order to be more easily remembered. Environments that look the same everywhere are difficult to remember.

2.1.6 Positioning of elements

When positioning information elements in environments the user of the AOM takes great care to make them clearly visible. The user should be able to put himself directly in front of elements and to view them without distraction.

2.1.7 Perspicuity

Memory places should be arranged so as to be structurally clear and simple. It should be easy to obtain a sense of were things are.

2.1.8 Calmness

In order for the practice of the AOM to work without distraction, the environment should be calm and dimly, albeit sufficiently lit. An AOM environment is to be thought of as an environment were it is possible to concentrate deeply.

2.1.9 Groping and order

Grouping is important to the user of the AOM. The user of the AOM typically moves within a single place or between places as the user is accessing information. So, for example, if an orator is to remember the parts of a speech he could tag the introductory sentence to the entrance hall of a building and then relate the various parts of the speech to physical objects such as furniture or statues within the rooms of the house. To perform the speech would be a matter of moving orderly through the rooms and stopping at objects tagged to parts of the speech. The expressions in the first place, in the second place and so on originally refer to this process of moving between information places.

2.2 Reported benefits

Since the inception of the AOM there are many who have written about the benefits of its application.

2.2.1 Recollection

Large volumes of information could often be recalled in flexible ways. The information is organized in navigable environments and this navigability is a key to accessing information in different ways. The user of the AOM can, e.g., navigate through the environment sequentially or randomly or in any other order.

2.2.2 Memory stability

Those who used the AOM constructed memory palaces that could not only hold vast amounts of information, but were also very stable. In fact this feature has also been thought of as a problem. It has been argued that it is difficult to rid the mind of memorized places.

2.3 Memory places and 3D environments

Memory places and 3D exhibitions are both examples of incorporeal environments with strong connotations of place. The memory enabled through the construction of incorporeal place-like environments in the AOM was often contrasted to memory without such environments: natural memory. We believe that the AOM environments share some of the artificial nature of computer generated incorporeal place-like environments, i.e., virtual environments and that it is possible to deploy ideas from the AOM in virtual environments. Moreover, the guidelines for constructing AOM environments can also be applied to 3D exhibitions. We do not want to argue that they always should be applied, but we are interested in what would happen if they did. After all, the principles of the AOM evolved over many centuries for the sake of constructing what we today would term cognitive tools for learning. We are no experts in psychology, but we believe that there are connections between the AOM and cognitive psychology that give some support to the AOM as a learning tool.

3. PSYCHOLOGY AND THE AOM

Some parallels to the AOM can be found in cognitive psychology.

3.1 Key principles

3.1.1 Cognitive mapping

The term cognitive map was introduced by Tolman [5] in order to describe the spatial knowledge acquired by animals and human beings operating in physical environments. Tolman proposed that one result of interacting in a physical environment is the development of an inner representation of that environment: a cognitive map. Since Tolman's research on cognitive maps there has been much debate, about the exact nature of such representations. Should. e.g., cognitive maps be thought of as mental images [6], linguistic constructs [7] or perhaps not as representations at all [8]. Today most researchers seem to agree on that some sort of image of the environment is constructed. If this is true, then the AOM and cognitive mapping both rely crucially on visual representations of environments. We think that apart from the research debate on cognitive mapping and its precise nature, it is useful to consider our everyday memory of environments and places. When we walk into a building for instance, we develop (in varying degrees) some memory of what it was like to be inside the building. It is generally possible to revisit these buildings in memory and to recall some of what we saw. We believe that this fundamental capacity of recalling places (along with content) is of importance in designing information

environments in much the same way as it was important to the users of the AOM.

3.1.2 Level of processing

According to the concept of levels of processing in cognitive psychology, one important factor in learning is how much our brain processes the item that we wish to learn [9]. On this conceptual model, the more deeply and elaborately an item is processed, the greater the probability of subsequent recall. Craig and Lockhart [ibid] stress the importance of presenting information using strong visual imagery and in rich associative ways. This thought of stimulating the memory through the use of visual imagery and associative links is also at the core of the AOM.

4. ADAPTING AOM TO MODERN TECHNOLOGY

One way to think of the AOM is as a methodology for constructing information environments. The user of the AOM builds an internal information environment that through meditative practices becomes stable and more or less permanent. While such information environments have many good features there is one feature that they lack: public access. It was not until museums and their various protoforms were introduced that places were used as systematically designed representational environments. That the end of the AOM era coincides with the birth of museums during the 16th century is perhaps no coincidence. Elian Hooper-Greenhill devotes much of two chapters in her book *Museums and the Shaping of Knowledge* [4] to delineating how the AOM influenced the evolution of the museum through protomuseums such as the cabinet and the memory theatre. The cabinet "a model of universal character made private" [ibid p78] existed in various physical forms (e.g., as cupboards or rooms), but generally sought to represent knowledge by means of orderly presentations of physical artifacts, often along with imagery. The "museums" served the "function of bringing together a number of material things and arranging them in such a way as to represent or recall either an entire or partial world picture." [ibid]. The memory theatre of Guilo Camillo in the middle of the 16th century was a publicly accessible manifestation of the art of memory that no longer resided in imagination but in concrete physical form [ibid p97]. This room-sized theatre was a cognitive tool that enabled two people to observe images and artifacts arranged in a theatre-like structure. The aim of this theatre was to represent the known world in a perspicuous manner. Camillo's theatre is a most striking example of the AOM has influenced the creation of learning environments. We believe that the AOM did not vanish abruptly, without leaving after it some inheritors, but that it has had a ongoing influence on museums as they are seen under the aspect of learning environments. The ancient insight of Simonides that memory can be supported by place-like environments still holds as we go into the museums of today. While beeing no experts on human memory we, like people all over the world, go into museums to learn and to become engaged in place-like information environments. Our research aims to recapture the AOM once again in the world of computers and digital information environments. Digital information environments, and 3D environments in particular, offer several opportunities to realize the art of memory in publicly accessible environments more fully than has ever been done hitherto. Firstly, 3D environments allow for the relatively easy construction of publicly available AOM environments. These environments can be rendered on standard PC computers and made accessible to large numbers of people. Secondly, they can be easily redesigned and customized for various purposes. The rapid advancements in the gaming industry also indicate that 3D environments will continue to evolve in terms of technological possibilities. Thirdly, 3D environments allow for imaginative designs and seem capable of supporting the requirements of the AOM.

5. OUR ART OF MEMORY APPLICATION

The AOM application was constructed with C++ and openGL with the aid of object loading/rendering classes from from Wasa. Wasa is a system of helper classes for rapid prototyping of graphical applications which is under development at our department. Although this approach was work intensive, it enabled us to build the AOM palace with few technical constraints.

5.1 The exhibition

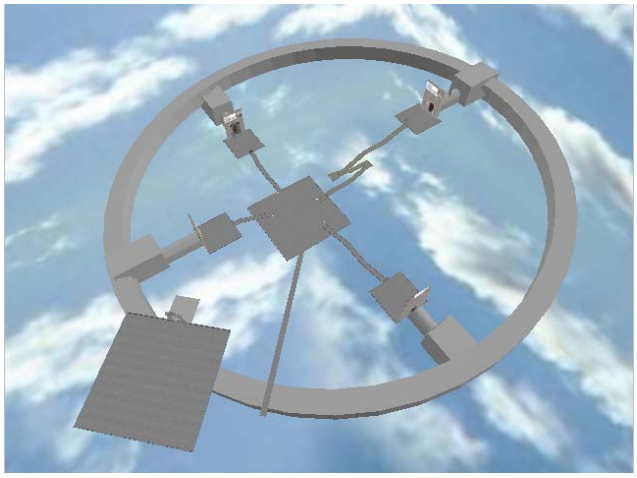

Figure 1. Oveview of the environment. The user starts on the platform shown in the lower left corner of the picture.

Figure 2. A room of one of the philosopher.

Figure 3. An example 3D object. The object illustrates Hume's notion of the mind as a bundle of ideas.

The exhibition was built out of a concern to adhere to the principles of the art of memory. Thus it was built as a 3D environment with a strong sense of place. The overall structure of the environment is architecturally and geometrically varied. Although for practical reasons, the rooms of the environment have the same shape. The environment is dimly lit within the rooms and without distracting elements. The visitor enters the environment from above in order to gain an overview. The environment is also perspicuously designed with rooms arranged in a clear and distinct spatial structure to further enable the visitor to internalize it. Within each room, there are philosophical texts from the philosophers John Locke, George Berkeley, David Hume and Immanuel Kant. Each philosopher has his own room with an epistemological argument. Together these epistemological arguments form a chain that goes from Locke to Berkeley to Hume and lastly to Kant. Thus the exhibition is about the history of epistemology in the western world from Locke to Kant. The philosophical arguments are presented with texts, striking images and 3D objects that serve to illustrate the texts visually. Two hallways were placed adjacent to the each room and here images along with further texts of the corresponding philosophers were placed. This ordering of the main room and the hallways was the same for each philosopher.

5.2 Study setup

The test persons came to a room setup for the study. Ten subjects participated. Five of them were in a AOM condition with the exhibition. The other five were not presented with the AOM exhibition, but only with the texts of the philosophers. The basic scenario was the same for both conditions, i.e., the subjects were to think of themselves as being part of a study group on philosophy. In the AOM condition, the exhibition was on a PC with the AOM exhibition shown using a projector (110 x 90 cm screen size). In this condition the subjects were given a brief introduction on how to use the exhibition and were then asked to explore it and learn the arguments of each philosopher. In the text condition, the subjects were asked to read the texts of the philosophers presented on paper. Thus the same philosophical texts were studied in both conditions, but through different means. In both conditions the subjects were asked to study the philosophers so they could discuss their arguments later in the study group. After the trial the subjects were given a brief questionnaire and were asked to identify philosophical quotations from the philosophers in a matching task.

6. RESULTS

The results of the study are summarized in table 1. No marked differences were found in the subjects' attitudes towards the learning content. Overall, the subjects rated the philosophers just as appealing in both conditions. They found the subject equally engaging in both conditions and there were no marked differences in how difficult they perceived it to be. However, the subjects in the text condition performed markedly better in the label-matching task.

Table 1: Subject ratings (ranking scale from 1 to 10)

	Exhibition	**Text**
Rating of philosophers	5,8	5,6
Ranked difficulty of philosophers	7,2	6
Engagement rating of philosophers	5,6	5,8
Number of correct matches	10	16,4

All subjects but one preferred the 3D condition and all subjects stated that they liked the 3D environment and thought it engaging, visually and aesthetically pleasing, well organised, and easy to navigate. However, the study identified a set of issues that might improve the design of the environment. The large distances between the philosophers' rooms made it difficult for subjects to quickly move between the rooms. We observed that some subjects had some difficulty in positioning themselves and navigating through the environment. Some subjects suggested that more 3D objects, preferably of an interactive nature, should be put into the environment to illustrate the material.

7. DISCUSSION

In this study we assessed the use of AOM principles in the design of a 3D exhibition. In contrast to physical exhibitions such as those of museums our exhibition poses challenges that are related to software usability issues. In the best case scenario our users would not have experienced any difficulties related to the use of the software. Now that we have conducted trials in the environment and gathered user feedback, it is difficult to say just

how well the AOM approach worked in creating an engaging exhibition. In order to make a more truthful evaluation of the AOM as a set of guiding principles, we feel that we need to construct an environment which is less subject to usability issues. There is also the question of whether comparing the 3D environment to a text is a good method of evaluation and if not alternate ways of observing the result of the learning process should be called for. Moreover, we realize that while the exhibition had enough content in terms of texts, these texts could be better illustrated using more images and 3D objects. Overall, the metaphor of place as used in creating the exhibition, e.g., in terms of rooms, pathways, and hallways worked well. The users could readily interact with the exhibition as a game-like environment and required virtually no explanation in getting started. This we believe is one of the strengths of using such place-like environments. It is readily apparent what the fields of possibilities are since we, as humans, are so used to moving around in physical environments and can transpose this knowledge into 3D environments. The problems of using the environment have to do more with the details of interaction. The low level skills required for navigation and positioning were not sufficiently developed in some of the subjects. We would like to go beyond the level of usability attained in most 3D games which can be difficult to use, especially for novices. Our vision is to create an environment which is experienced directly as an exhibition in much the same way that a physical exhibition is.

8. CONCLUSION

We have explored how the principles of the AOM can be adapted for use in a modern computing environment. The limited study indicated the need for usability and environmental richness, but nevertheless showed the potential of engaging users in an educational virtual environment. In this small study we gained a better understanding of how to implement the AOM utilizing a virtual environment. We plan to use this understanding as a starting point for constructing a new improved environment were we aim to tackle the challenges indicated in our study. In sum the main challenges arose with respect to the *graphical richness* of the environment, its *perspicuity* and its ease of *navigation*. Bearing these issues in mind will help us in creating a new AOM environment.

9. FUTURE DIRECTIONS

We have started to develop a new environment as the first iteration in the process of researching the possibilities of applying the AOM for creating engaging computer generated exhibitions.

The new environment will provide a more graphically rich setting with more elaborate objects and illustrations. In this way we hope to engage the users more thoroughly with the learning materials.

Perspicuity

The environment will also be designed in a more perspicuous manner so that it is more easily overviewed. The users should at all times be able to orient themselves and not feel lost.

Navigation

It should be easy to navigate and position oneself in the environment. The users should not have to bump into walls and struggle to position themselves in front of elements within the exhibition, i.e., texts, images and 3D objects.

In this study we started out with a minimalist environment that we could use as a starting point for an iterative process of design. We hope that such an iterative process will yield environments that are successively better implementations of the AOM.

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