Cyberspace as A Memory Container

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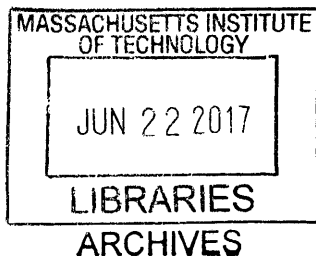
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ABSTRACT

Space is a container for memory. This metaphor is built upon the observation that the human mind can easily acquire spatial information without much deliberation. Moreover, non-spatial information can be better retrieved when associated with a spatial memory.

The mnemonic function of space has been explored since ancient Greek and Roman times. The method of loci uses imaginary space and its spatial continuity to encode information and its sequence. Physical space, such as museum, was also used as cognitive device to enforce knowledge structures and for future information retrieval. The science of spatial cognition demonstrates how human perception is tuned to the features of the environment.

In the digital age, representation of information in visual space shifted from mirroring the real world to triggering experience symbolically. What should virtual space permit and deny in parallel to the real world? Symbolic systems can be capable of eliciting the rich virtual experience from the mind's myriad depths, with even more leverage compared to representing objects in mechanical context.

Given space's mnemonic function and cyberspace's rich potential, this thesis explores the design of virtual space for projecting, retrieving, and composing memory. The project propose different spatial design schemes to experiment with and understand the possible relations between virtual space and memory.

Acknowledgments

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Lastly, I would like to thank Alan, Evan and my family, without whom this would not have been possible.

Cyberspace as a Memory Container
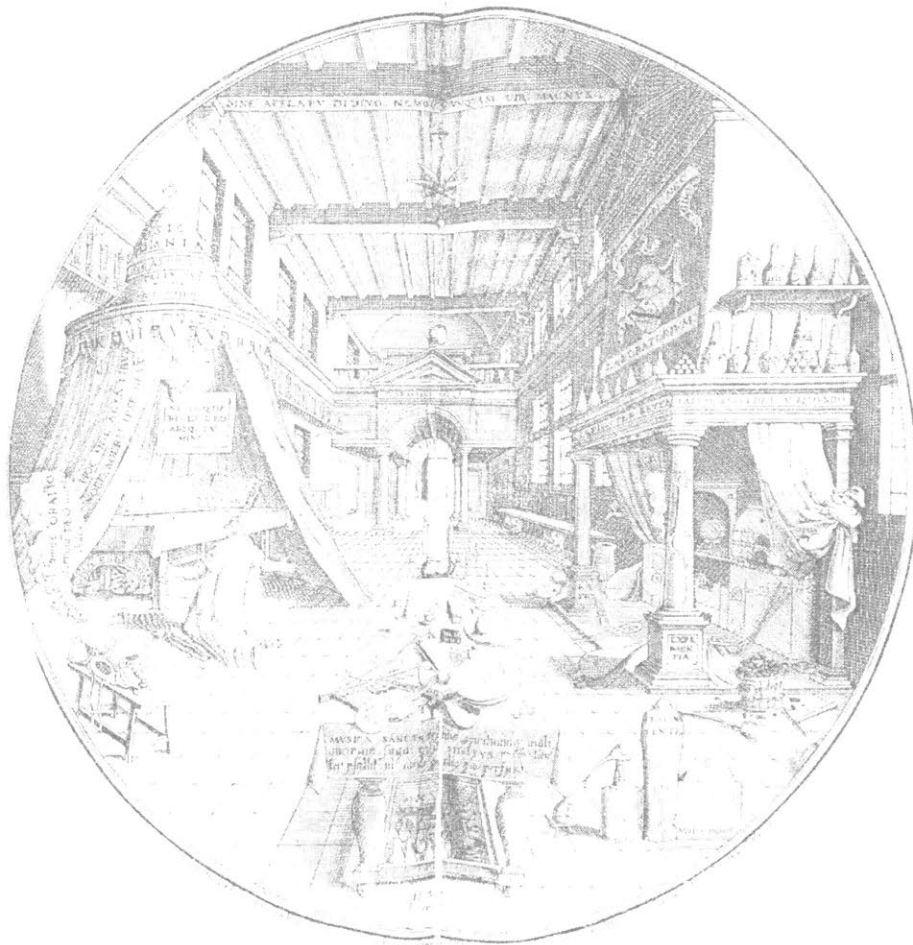
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2016-2017

Introduction

Space is a container for memory. The metaphor is built upon the observation that human mind can easily remembers(encodes) spatial information without intention. Other forms of more abstract information can be attached and related to space for better retention.

The mnemonic function of space has been explored since ancient Greek and Roman time. "Method of Loci" uses imaginary space and its spatial continuity for better retention of information and its order. Physical space, such as building, was also used as mnemonic device to enforce knowledge structure and for future information retrieval.
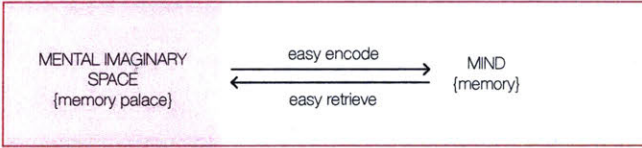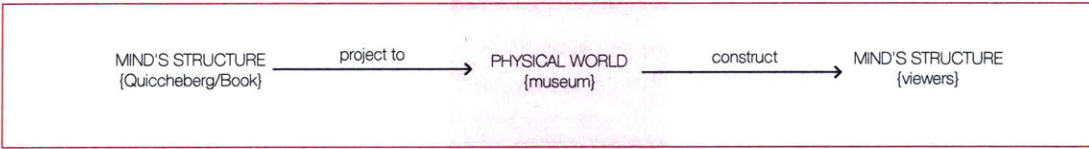
Science of spatial cognition also demonstrated how human perception is tuned to the features of the environment.

In the digital age, representation of information in visual space attempted from mirroring the real world to triggering experience symbolically. This brought up the question of what virtual space should permit and deny in parallel to the real world. Symbolic systems can be capable of eliciting the rich virtual experience from the mind's myriad depths, with even more leverage compared to representing objects in mechanical context. Numerous examples from the early cyber age to present explored a wide range of possible relations between the real and the virtual.

Giving space's mnemonic function and cyberspace's rich potential, my thesis explores the design of virtual space for projecting, retrieving and composing memory. Prototype of virtual memory containers are developed to test the experience of using space to retrieve memory.
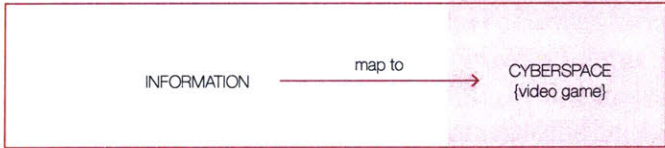
SPACE

**Mind and Spae:
a two-fold relationsihp**

MIND'S STRUCTURE
{Quiccheberg/Book} → project to → PHYSICAL WORLD
{museum} → construct → MIND'S STRUCTURE
{viewers}

MENTAL IMAGINARY
SPACE
{memory palace} —— easy encode ——→
←—— easy retrieve —— MIND
{memory}

**Spatial Mnmonic
Device**

Cyberspace Design

INFORMATION —— map to ——→ CYBERSPACE
{video game}

Mind and Space: a Twofold Relationship

The relationship between human mind and space is twofold. Human mind is tuned to reflect its environment. Roger Shepard wrote in 1990: "We may look into that window on the mind as through a glass darkly, but what we are beginning to discern there looks very much like a reflection for the world". He suggests that the principles of perception are exquisitely tuned to the features of the environment in we which live. In other words, environment structure and spatial arrangement have a deep impact on the how human mind perceives the world.

Environment also reflects how human mind organizes the world. The design decision to arrange the environment is affected by the structure of knowledge that we have for the world. For example, architecture is one way which we intervene with the environment and which we impose our mental organization and categorization into the physical space. Additionally, spacial arrangement elects an order of the world in its visitors. Spacial design can be used to address knowledge organization and assist with learning.

Egon Brunswik emphasized the importance of studying this relation by comparing mind and environment to two married people who have to come to terms with each other by mutual adaption. Human mind and space are closed related in many aspects. For instance, several researches have addressed the spacial foundations for language learning, mathematical learning, topographic representation and verbal recall. This chapter looks into mind and space relationship with an emphasis on spatial features that affect human memory to retrieve information presented in space (memory of specific knowledge rather than an impression of a space). It will investigate how human mind perceives space, and how spatial arrangement is designed to reflect the way human internalizes knowledge in return.

Quiccheberg describes a system for the organization of the spaces in his theatre that is based on mental topoi such as similarities, differences, and opposites. [...] the parallel between the pages of a book and the interior of the theatre prompts us to view the theatre as an extension or projection of the cognitive structure of the mind into the physical world. This relationship, however, could just as well be inverted, with the visitor to the theatre constructing his mental spaces in the form of an amphitheatre, i.e. following the model of a real building.

- The Great Theatre of Creative Thought

Human Mind: A Reflection of the Environment

"We may look into that window on the mind as through a glass darkly, but what we are beginning to discern there looks very much like a reflection for the world."

Roger Shepard, 1990

Shepard's thesis suggests that the principles of perception are exquisitely tuned to the features of the environment in we which live. Shepard argues that perception has been optimized through evolution to make the best possible inference about the world given the perceptual input.

Human perceives differently a specific individual object and a space which contains a number of objects. In his paper, Reflections of the environment in memory, Anderson points out that "the environmental relationships are the same as the memory relationships. Human memory has the form it does because it is adapted to these environmental relationships." What cognitive structure are used to store relations among specific objects? To understand these questions, it is essential to look into models of spatial cognition and spatial memory, and models of how environmental information are processed internally.

Spatial Cognition

Lloyd argues that "with and without conscious effort we continuously encoded information about the environment into our memories". Theoretical model distinguishes two types of cognitive structures that used to store spatial information: object file and mental model. Object files refers to temporary structures for objects in working memory created by perceptual process; mental models are created to encode spaces in long-term memory.

Spatial cognition can be focused on a specific object or a space that contains a number of objects (such as neighborhood or a city). In the latter case, a cognitive structure is developed to store relationships among specific objects, which allow the mind the relate to a set of objects embedded in a common space. Objects are encoded with both locations in space and characteristics (such as shape, color, size) that gives them identities.

Kosslyn et al developed a cognitive model of to subsystems that used in high-level vision to process information from an environment. The spatial organization of the information coming from the eye is thought to be maintained on the surface of the brain in the visual buffer. Attention may be focused more on specific part of the visual buffer with the attention window, and more specific information about the content is obtained through two separate system of what and where system. In this model, different subsystems function collectively to capture various aspects of spatial information.The dorsal system in the brain processes spatial properties, of which part are thought to encode spatial relationships between objects or parts of objects. This type of categorical spatial information as well as coordinate relations is considered can be encoded in long-term associative memory for later use. Object properties as such color, shape etc is processed in another part called ventral system. The spatial and object properties subsystems join their information to associative memory where object can be represented and stored.

Martindale suggests a model of the order and connections among cognitive processes of the environment which starts with input from a physical stimulus and ends with the output of human response. The information acquired from the environment is processed along the way, transformed, and passed on by sensory, perceptual, and conceptual analyzer. The information also interact with previously stored information and may itself be abstracted and stored in some form in long-term memory. In this way the current information becomes part of our knowledge of the environment and can influence future decision making. In Martindele's theory, information is initially received from the environment and processed by a series of sensory, perceptual and conceptual analyzers to be stored in long-term memory. For example object file relate to perceptual processing and mental models relate to conceptual structures in long-term memory.

The theories and models above of spatial cognition offer strategies to understand connections between elements of physical environment and how human processes information.

Spatial Memory

Spatial memory is memory of the locations of objects, places, and environmental features. Human daily activities have heavy reliance on such spatial memories, however it seems so common and effortless to use it. Spatial memories are composed of several types of spatial knowledge depending on the identities and appearances of entities in the environment that constructs the memory. McNamara categorizes them into four major types: knowledge of objects and places, knowledge of routes, knowledge of environmental shape, and knowledge of spatial layout. Each type represents how certain environment entity is reflected in memory.

Object-place knowledge is a term coined by McNamara to capture the notion that whereas some of these environmental entities naturally would be considered objects (eg, coffee table, stop skin), others corresponds to significant location less well-defined boundaries (such small city park, path intersection saddle between two hills). Landmarks are considered to be a special case because they are entities of special significance to spatial memory and navigation. Siegel and White's classical theory believes that landmark knowledge is the building block of other types of spatial knowledge and the first among all types of to be acquired. Based on landmark knowledge, Route knowledge consists of the sequences of landmarks and associated decision and actions to traverse along the entities along the sequences. It is demonstrated that knowledge of routes in all but the simplest of environments almost certainly includes landmarks that functions as associative cues.

The worlds that we live in now is larger carpentered. In such environments, knowledge of environmental shape, from the shapes of rooms, corridors, street capes, to bounded green space, becomes a fundamental type of spatial knowledge and are essential for navigation. There is ample evidence that adults are sensitive to environmental geometry when they learn a new environment.

The most advanced type of spatial knowledge obtained about an environment, according to Siegel and White, is Survey knowledge. It is the knowledge of the overall spatial layout of an environment that includes Euclidean distances and direction defined in a common reference system. Memories of "the spatial relations between locations can be retrieved or inferred even if travel has never occurred between locations". Such spatial knowledge is essential for explaining cognitive map model in later section and for understanding how the mind captures the external environments.

Siegel and White developed an spatial knowledge acquisition theory through how an adult learns a new environment. According to this theory, the identities and appearances of landmarks are learned first, followed by route between them. Survey knowledge is believed to be the most sophisticated form of spatial knowledge and is assumed to be driven from accumulated route knowledge. Later on, Montello's framework emphasizes on the importance of knowledge integration combining separated learned place to a more complex hierarchically organized representation.

Spatial Knowledge Properities

Spatial knowledge have several key properties. In McNamara's paper, four aspects of spatial knowledge were reviewed that have proven to be especially important in understanding human spatial behavior. Distorted and hierarchical structure among the four are closely relevant to understanding spatial memories.

"Distorted" includes spatial relations such as distances, angels, and orientation that often differs from the physical values in systemic and predictable ways. There is a strong evidence that memories of the locations of objects in the environments are organized categorically and hierarchically, such that a region of space may be represented as a whole, containing other regions and locations, and in larger regions. Huteenlocher developed an elegant mathematical hierarchical model of positional uncertainty and bias in memory of the location of single object. According to this model, location is encoded at a fine-grained level and at a categorical level. The relative magnitude of the weights depends on the relative precision of the two sources of information.

Hoden and Newcombe develops a theory about the development of categorical coding. Space is inherently continuous. Spatial categories are any regions that constrains the number of possible locations (in a search task) by using coarse, relational information and by grouping points in continuous space and treating them was equivalent. It is optimal categories without perceptual support: imposing categorical boundaries. Adult spatial cognition often involves non perceptual factors, such as imposing mental boundaries on space or using conceptual information to define spatial categories.

Categorical relations are defined as abstract, general properties of spatial structure such as relations of above/ below or right/ left. In contrast, coordinate relations are more precise metric relationship that can be described in absolute distances.

Cognitive Map

Cognitive map is considered a person's model of objective reality. The cognitive map theory has been an central issue in spatial cognition. The mapping process consists of acquiring, coding, using and storing information from the multitude of environment external to the mind. It can be interpreted as a simple "one-to-one mapping of discrete things that exist in the environment into the mind". Cognitive map stores a set of proportions about the environment. The process receives and code environmental information, store it in an accessible manner, and decode it in such a way to allow spatial behavior to take place. In summary, cognitive mapping process reflects how that human mind captures and internalize the external environment. The processes encode in memory the existence of objects, their characteristics, and known locations in space. A cognitive map encodes structure in the long-term memory of what is where.

Lloyd defines cognitive map as the knowledge we have learned about an environment that is stored in our memory. Cognitive map represent environmental realities since it is acquired through interactions with the external worlds. Based on the process used to encode the information, procedural knowledge and survey knowledge are two types of knowledge to form a cognitive map according to Thorndyke and Hayes-Roth's theory. The procedures used to go from one location to another in the environment is encoded in the memory together with survey knowledge which provides a holistic impression of the environment. One acquires cognitive map by exploring the environment.
Although cognitive map has systematic distortions caused by encoding and storage, and decoding process, its categorization process and spatial hierarchies are formed based on the structure of the environment.

In summary, cognitive map is the mental representation of the environment that captures the spatial relations among things in the world. Such mental process is useful to recognize places, to compute about directions and distance, and navigate in the environment.

Mnemonic Devices:
The mnemonic function of space.
Explore the impact of spatial structure on internalization of information.

The relationship is twofold between space and memory. Research of spacial cognition in cognitive science provides an insight of how mind perceives the world. Studying key properties of the environment shed light on understanding human spatial behaviors. This chapter will examine what environmental information is considered important for human memory. It will also look into different types of mnemonic devices developed in history to explore the mnemonic function of space. Space, especially the order of space and consequence, affects how human mind internalize and memorize the world.

~500 BC
Simonides

Memory of Place

~100 BC
C i c e r o
included story
of Simondies in
his book.

~80 BC
Rhetorica ad
Herennium

~35-100 AD
Quintilian

1529-1567
Quiccheberg
Museum-theatre

1561-1626
Francis Bacon

1794-1824
Sir John
Soane's Museum

"Method of Loci" (Memory Palace)
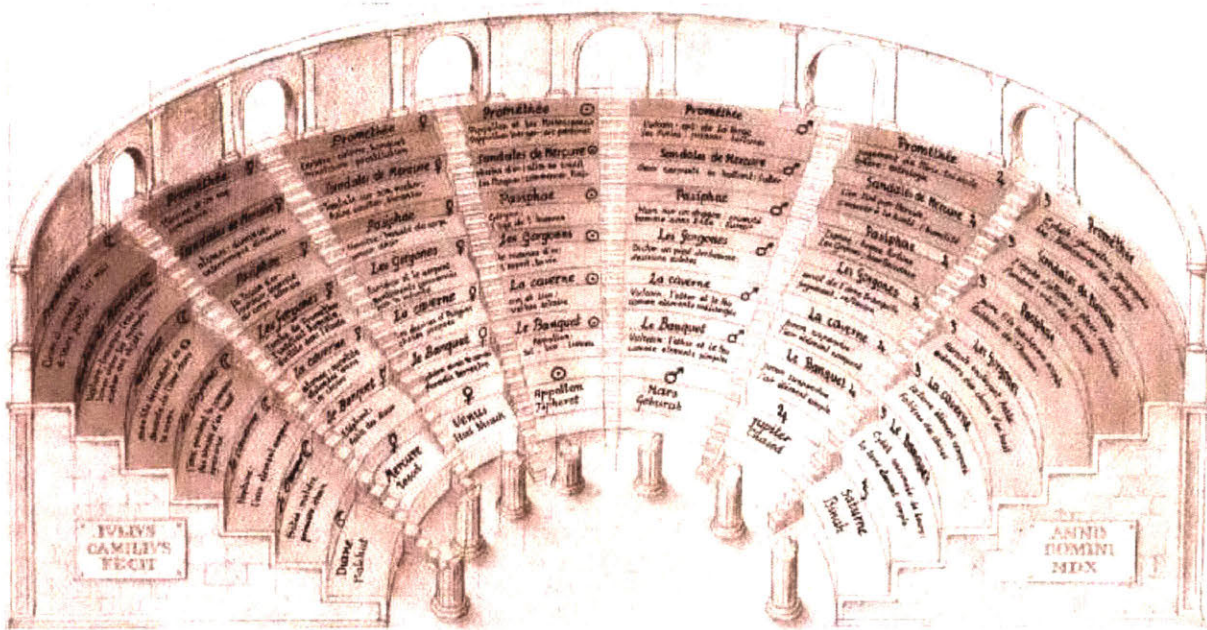
The ancient story of "method of loci" depicts how the poet
Simonides of Ceos was able to recall the name and order of all
guests after banqueting hall crashed. The order of the places
preserve the order of things in Simonides' mind. Simonides
realized that it was through "his memory of the place at which
the guests had been sitting that he had been abel to identify
the bodies". The orderly arrangement is essential for enforcing
memory.

A Roman philosopher and rhetorician, Cicero, further developed and framed the Simonides methods into a mnemonic technique. Cicero included Simonides' story in his De Oratore to introduce the mnemonic of places and images (loci and imagines). He believed that memory is one of the five parts of rhetoric and belongs to the same part of the should as the imagination.

The Rhetorica ad Herennium, a book by Cicero, suggests a theory to categorize two types memories: one is natural and one is artificial. The artificial memory is said to establish from places and images. Cicero suggests locus to be a place easily grasped by the memory, such as a house, an intercolumnar space, a corner, an arch. On the hand, images are forms, marks or simulacra of what we wish to remember.

Cicero emphasizes that Simonides' invention of the art of memory rested not only on his discovery of the importance of order for memory, but also on the discovery that the sense of sight is the strongest of all the sense36. In the ancient world, devoting of printing, without paper for note-taking or typing, the trained memory was of vital importance. Therefore, using space to address memory issue was considered to be an important tactic. Years later, Yantes commented on these classical sources that they seem to be describing inner techniques which depends on visual impressions of almost incredible intensity.

Quintilian

"This achievement of Simonides appears to have given rise to the observation that it is an assistance to the memory if places are stamped upon the mind, which anyone can believe from experiment. For when we return to a place after a considerable absence, we not merely recognize the place itself, but remember things that we did there, and recall the person whom we met and even the unuttered thought which passed through our minds when we were there before."

-Quintilian

Quintilian, a dominating teacher of rhetoric in Rome in the first century A.D., gave clear directions about how we are to go through the rooms of a house, or a public building, or along the streets of a city memorizing our places, helps us understood what "rules for places" were about. He gives an absolutely rational reason as to why the places may help memory because we know from experience that a place does call up associations in memory. An the system which he describe, using signs like an anchor or a weapon for the "things", or calling up one word only by such a sign through which the whole sentences would come into mind, seems quite possible and is within the range of our understanding

Quiccheberg's Museum-Theatre

The second half of the sixteenth century was faced with massive
amount of information produced by the modern civilization
development. A number of cognitive models and frameworks
were designed to impose order on this mass of information
and knowledges. The orderly physical spaces was used to form
the basis for the organization of knowledge. It was realized that
certain architectonic spaces could play a role in the complete
reorganization of knowledge.

Quiccheberg's museum-theatre is designed to incorporate his
mnemonic techniques. The encyclopedic museum in the form
of a well-organized theatre encourages viewers to "acquire
wondrous knowledge in a 'rapid, easy and certain manner' ".
Quiccheberg arranges his books to reflect the primary role of
vision and virtual images. He explains that it is important to give
visual images in the process of learning because their unique
interactivity with memory. These objects, images and words
were organized to manage efficiently the large amounts of
information produced by the theatre's encyclopedic collection.
Quiccheberg's idea reflects the rich relationship between the
classification of knowledge and the spatial structure of the
theatre. His museum-theatre has dual functions: a container to
reflect the mental process and a learning device to inscribe the
order to the viewer's mind.

 The system for organizing the space in his theater is based on the
mental order such as "similarities, differences, and opposites".
The parallel between the pages of a book and the interior of the
theatre allows the theatre to be viewed as a projection of the
cognitive structure of the mind onto the physical environment.
The process of registering object in the theatre resembles the
process of inscribing information into the mind.

Quiccheberg's aim is to educate the animus (mind) of any
average person to gain knowledge in different fields by means
of objects gathered and arranged in a comprehensive manner.
The relationship of theater as an extension of the mind could be
inverted, with the visitor to the theatre constructing mental space
in the form of the real building, in this case, an amphitheatre.
The arrangements of a collection of objects in Quiccheberg's
encyclopedic museum represents the classification of world
he intended to educate the men. Quiccheberg believes that by
"looking at images, studying objects, and using classification
and synoptic table" would make it easy for an average person
to grasp any subject.

Walking around his theater, visitors can view objects with pictures
and classification names arranged in an orderly manner. Thus,
the order of the world will be inscribed into their mind pertaining
the same mode of organization. "The phrases written in various
locations, the classificatory names of the objects on display, and
the synoptic tree diagrams" displayed during one's visit, were
carefully designed to "mediate" between the architectural space
of the museum- theatre and the visitor's mental framework.
Additionally, if inside of the theatre is a reflection of the human
mind, Quiccheberg's choice of a circular form for the exterior
symbolizes the orbicular conception of knowledge. In a sense,
Quiccheberg's museum is a physical container of knowledge
as well as a learning device with an unique interactivity with
visitor's memory.

Quiccheberg's theatre-museum is a good example of mind-
architecture relationship, where cognitive structure of the
mind is extended to the architecture and, vice versa, the mind
is inscribed to the order of objects in the constructed physical
space.

The Keepers, New Museum

Francis Bacon
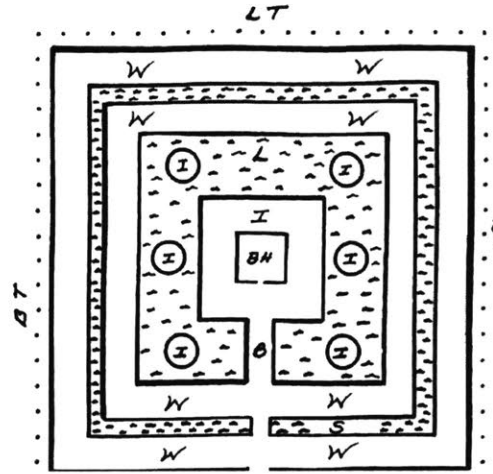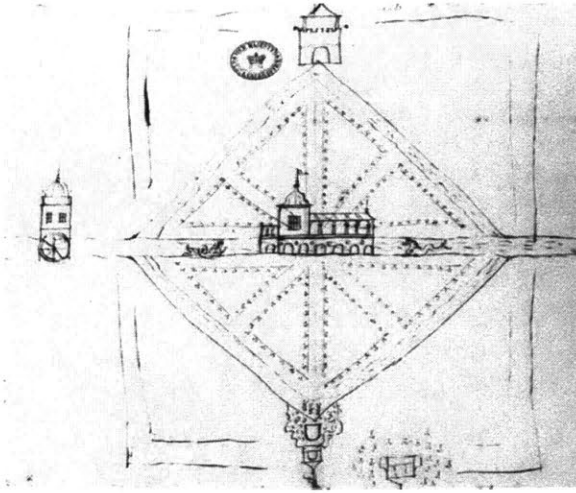
Francis Bacon practiced the art of memory in his architectural design. He designed an actual building for use in his "local memory". In Gorgambury, one of the galleries in Bacon's house, there were paired glasses windows "and every pane with several figures of beast, bird and flower: perhaps his Lodship might use them as to piques for local use"43. Bacon is in support of the ancient view that active image inscribes itself best on memory and intellectual things are best remember through sensible things. He also proposed new uses of space orders for memorizing matters in order in natural history. Science can be advanced by drawing out order out of the chaotic mass of natural history, and by brining judgment more easily to bear up on them
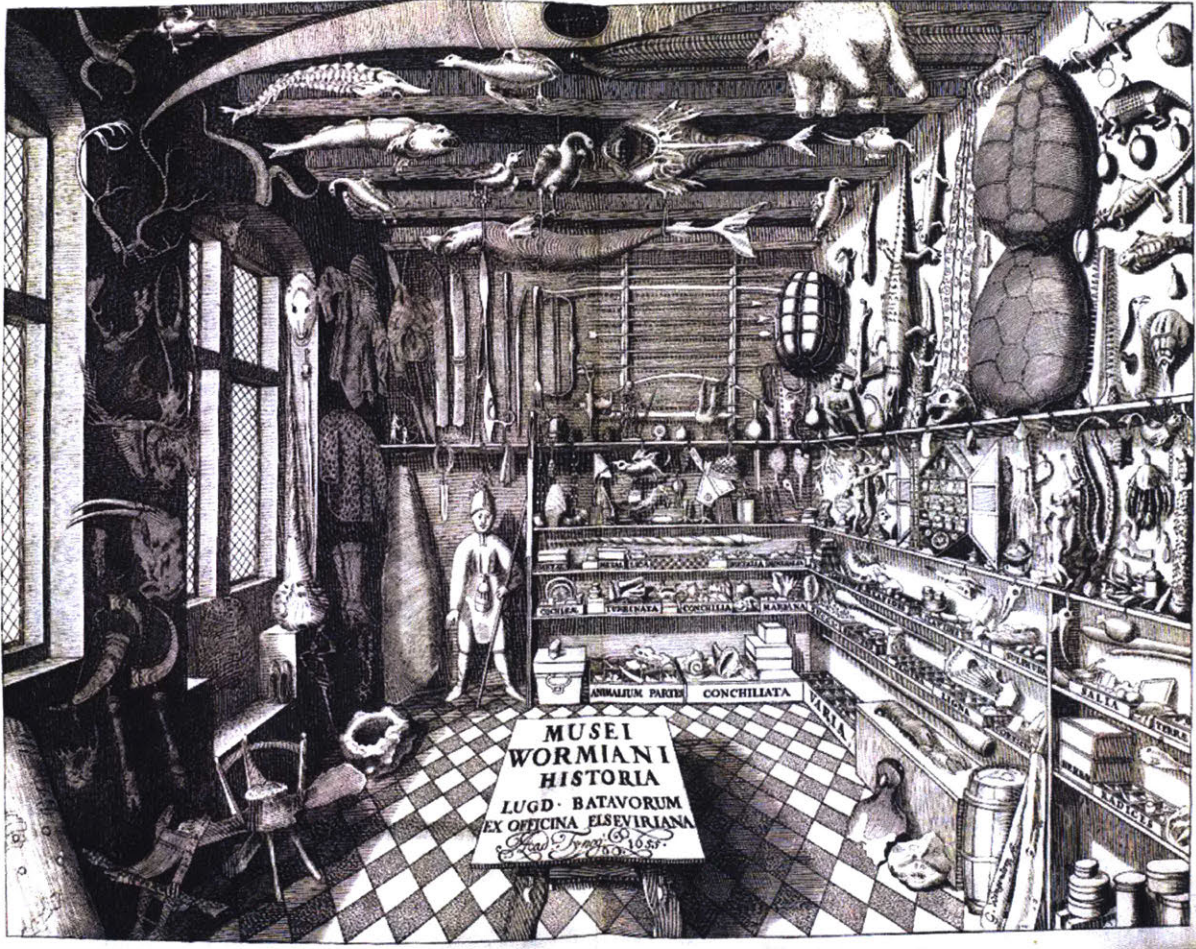
Engraving with an image of Ole Worm's Museum in Copenagh

More Examples
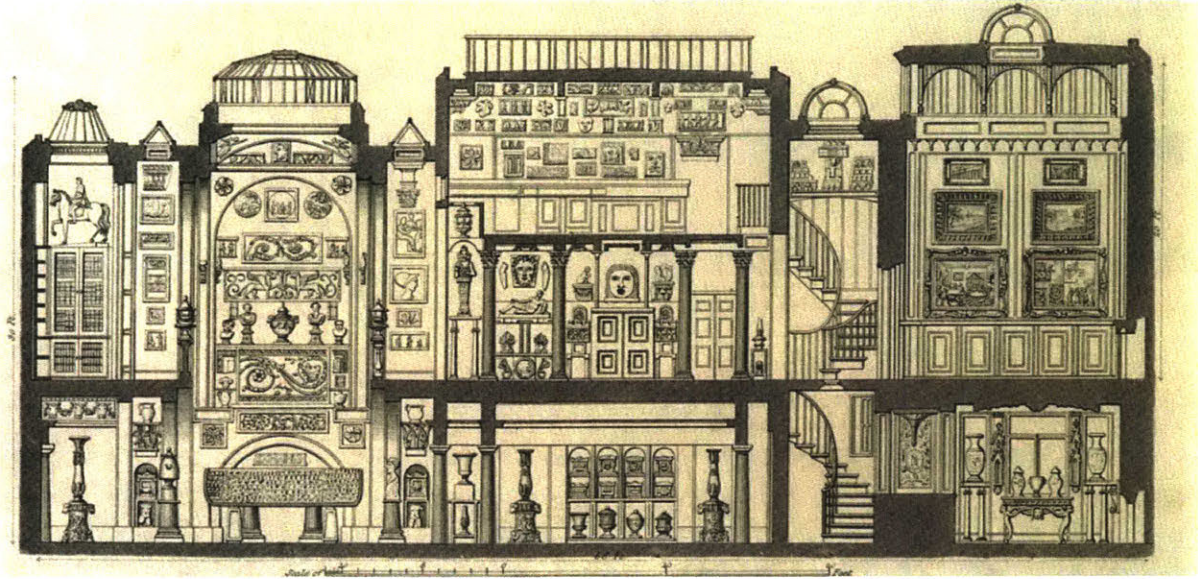
SirJohn Soane's Museum

The natural history collection by Ferrante Imperato (1550-1625)
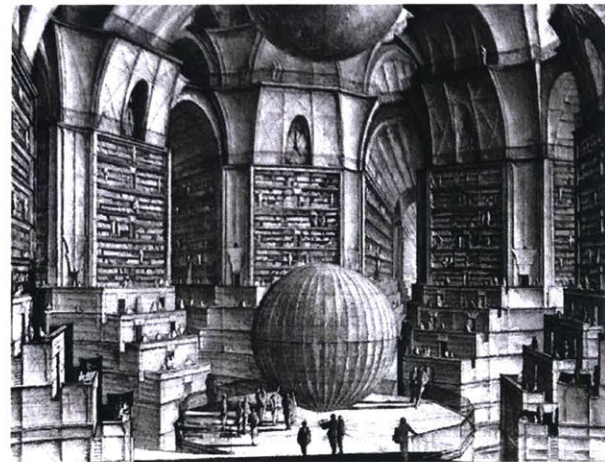
Library of Babel
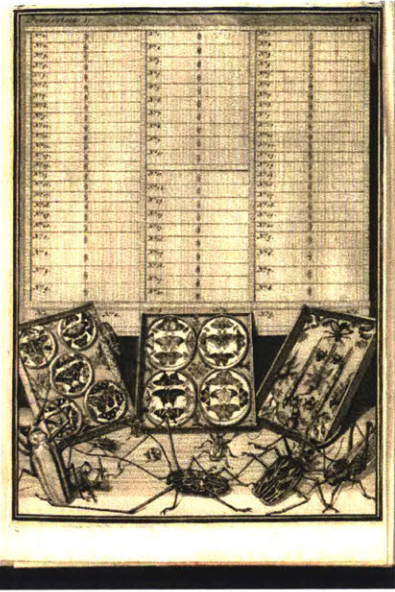
Wunderkammerns

Cyberspace
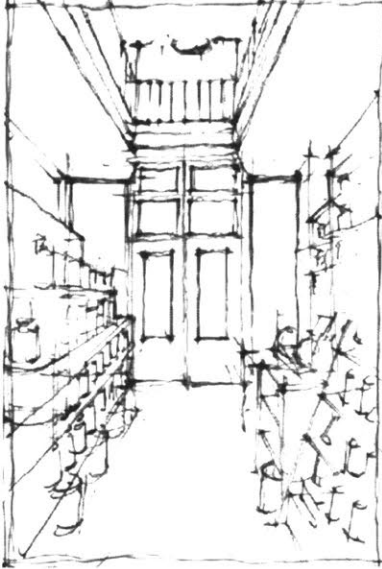
Cyber space is a space in virtual world, a parallel universe to the real world, a re-organized real world.

Cyber space permits us to uncover previously invisible relations simply by modifying the mapping to representation. A separation made possible of data, information and form.

Cyberspace is a habitat for the imagination. Cyberspace places human in information space.

To discover cyberspace, we need to explore which laws and axioms of nature ought to be retained? which laws and axions can be adjusted or jettisoned for the sake of empowerment? What are the opportunities and constraints of real space?

REAL SPACE

Physical space/existance

Constitutes of materials

Dimensionality: 3

VIRTUAL SPACE

No mateiral objects

No physical dynamics

Experienceable (actul) but non-physical (unreal) space

A mental space of internal spatiotemporal logic, representation, and the free imagination

Dimensionality: unlimited

1984

Apple
Macintosh
Desktop

1988

Daniel Wise
Visual database
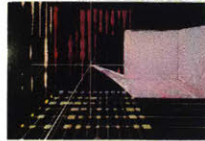
1988

Jim Rojas
Cyberspace
design

1989

Stan George
Matrix (Urban
landscape)
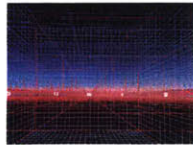
1990

Clyde Logue
Sales in
cyberspace

1990

Daniel Kornberg
Video store

1990

Gong Szeto
Data cell
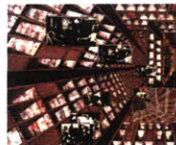
1990

Danielle
Sergent
Cyberspace
auction house

1998

Microsoft
Data Mountain

2000

MIT Media Lab
City of News
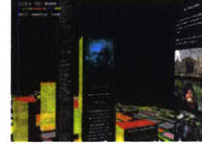
2002

CHI
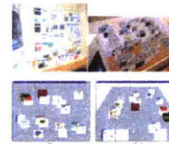
2003

Second Life
Online game

2016

Pokemon Go

Cyberspace Design Review
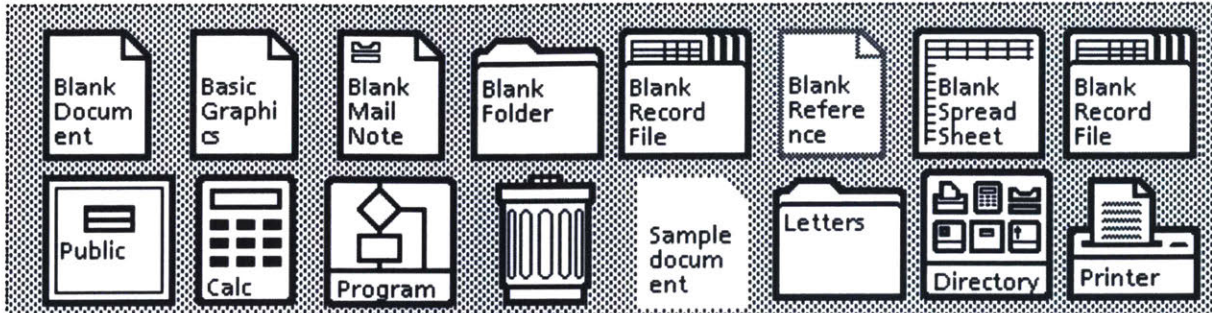
1973, Xerox Alto

The Xerox Alto was the world's first Graphical
User Interface based computing system. It was
designed around an metaphor of "office". The icon
of Calculator, Document, Folder and Trash haven't
changed in almost 30 years.

1984. Apple Macintosh Desktop 1.0

Apple adopted the office metaphor to make
navigation easier for new users. It also borrowed
the concepts of the "Desk Accessories"
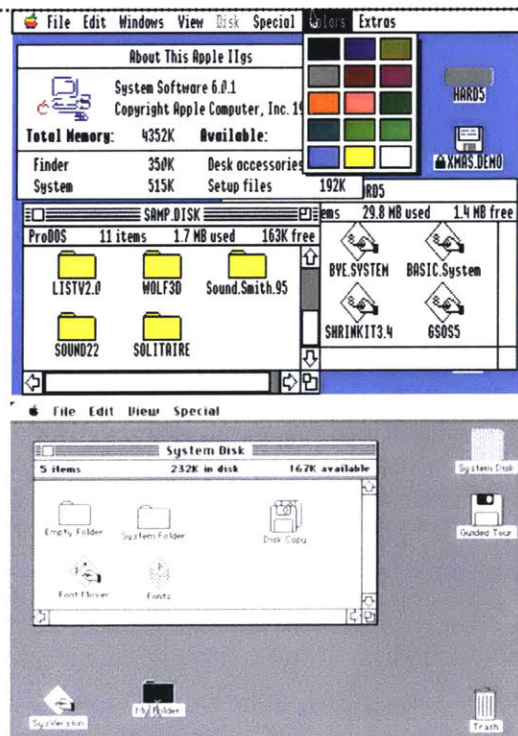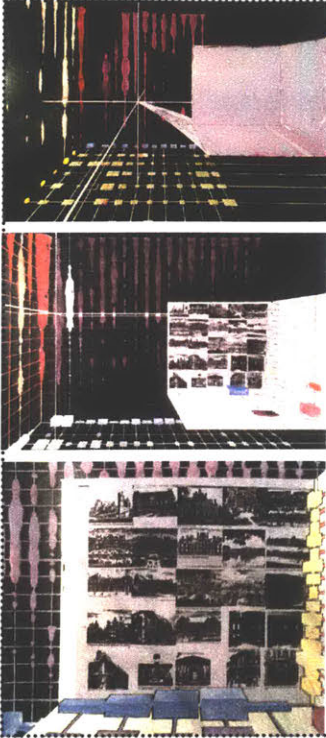
1988, Daniel Wise Visual database

One vest datacell providing access to a visual database. Data available at the intersection of the three "crosshairs" opens into a subspace of three further dimensions.

Two surfaces of the subspace continues to display navigation data while the third surface beginning to show destination data (the sought image)

Users can move in to inspect images more closely.

1988 Jim Rojas Cyberspace

A spiraling helical construct maping architectural history with ascending time.

Within the spiral, user can look down and see other users on distant ramps and search the database. Users are rendered by the construct according to color and motion-style indicating perosnal characteristics.

Cyberspace Design Review (cont'd)
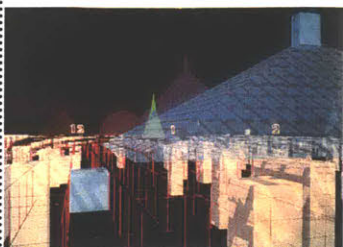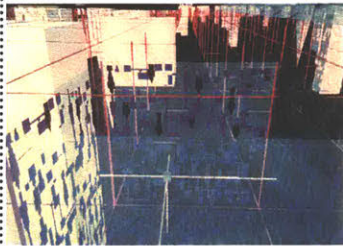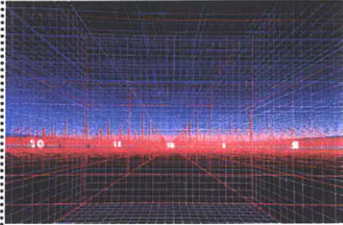
1989 Stan George Matrix (Urban landscape)

George tried to visualize the underlying structure of the matrix, seen from within a cell and above a cell. A possible "urban landscape" of the matrix. ownership and identity groups of data cell are indicated by the transparent superstructures. It mimics the idea of "plot" in real world. Horizontally, clock-number indicates the orientation systmem.

1990, Clyde Logue , A Sale Convention

Logue attempted to visualize a sales convention center in cyberspace emerging from a flock of panels.

Differential resolution, a visual cocktail pary, participants in discussion overheard.

Tee user is addressed about a product while the whole panel construct is seen to float uncertainly above a coursing terrain in the background.
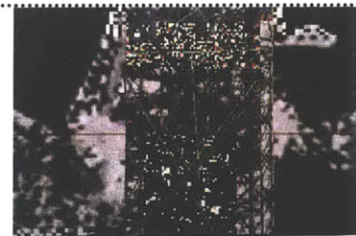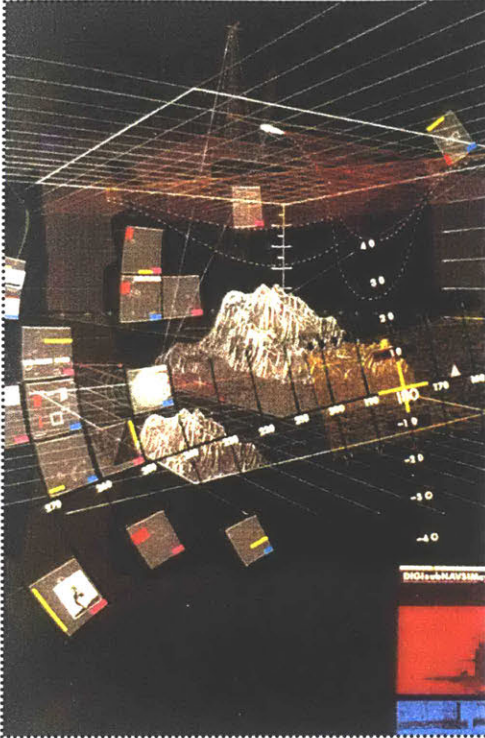
1990, Daniel Kornberg, Video store

Kornberg designed a an infinite video and movie store. The user plucks scenes and fragments, searching and creating new experiences. There are windows to other parts of the construct.

The visualization shows the interior of a hexagonal structure along whose surfaces displays the videos. The idea is user would be able to find and preview movies before dwonlaoding them.
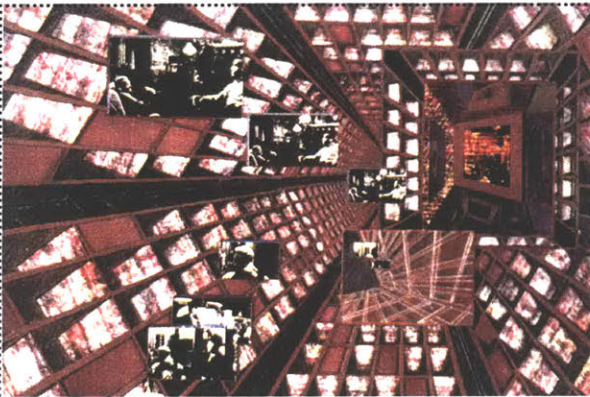
1990, Gong Szeto, Data cell

A data cell with an active surface approached "subaqueously". A spherical scrim of windows, analytical tools, support data, and navigational displays rotates over the scenes.
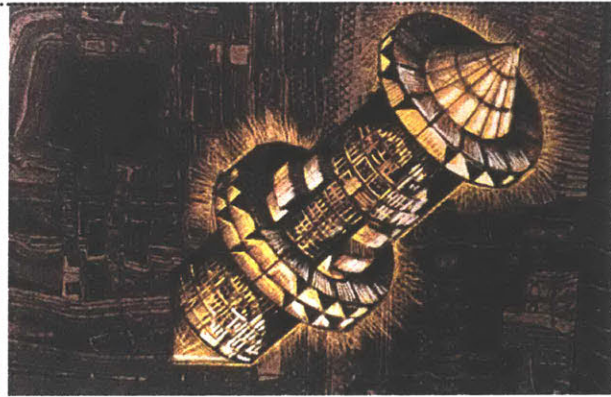
1990, Danielle Sergent, Cyberspace Auction House

An auction house somewhere in cyberspace. A circular museum with displays viewable from within and without. Its shape changes with the contents of the auction underway.

Cyberspace Design Review (cont'd)

2000, MIT Media Lab, City of News

How do we explore the digital box of fragments that pastes together disjunctive arrays of images and sets of data into a seemingly continuous display?
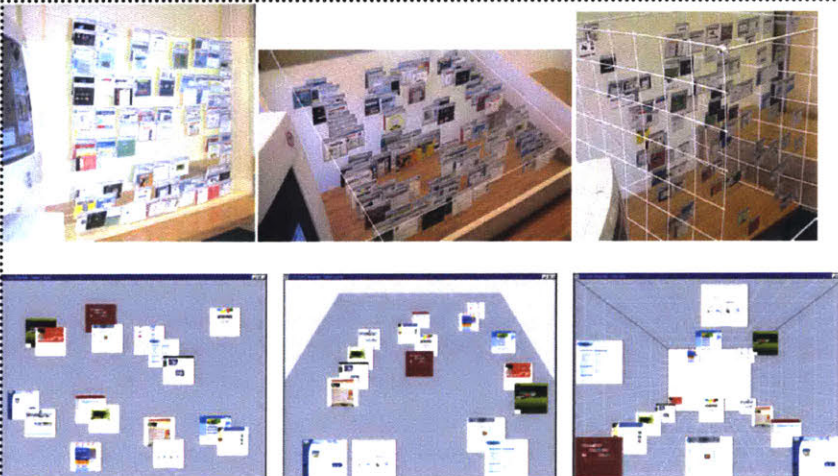
2002 CHI - Evaluating the effectiveness of spatial memory in 2D and 3D physical and virtual environments

Improving task performance by exploiting the powerful human capabilities for spatial cognition.
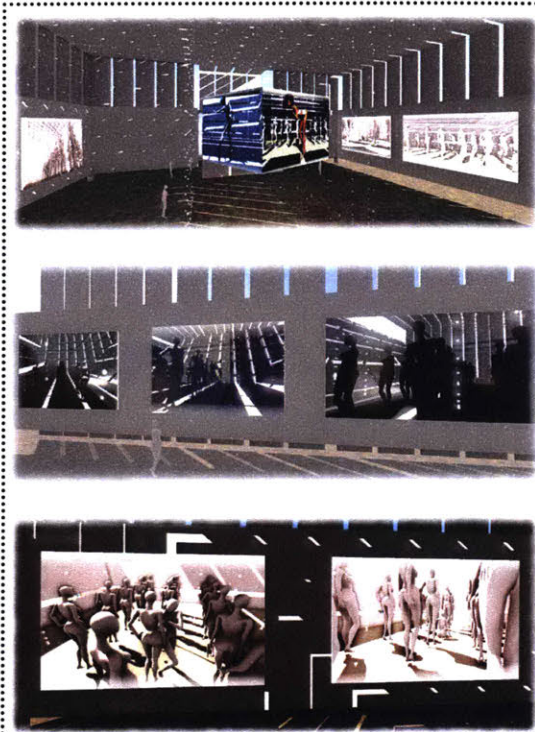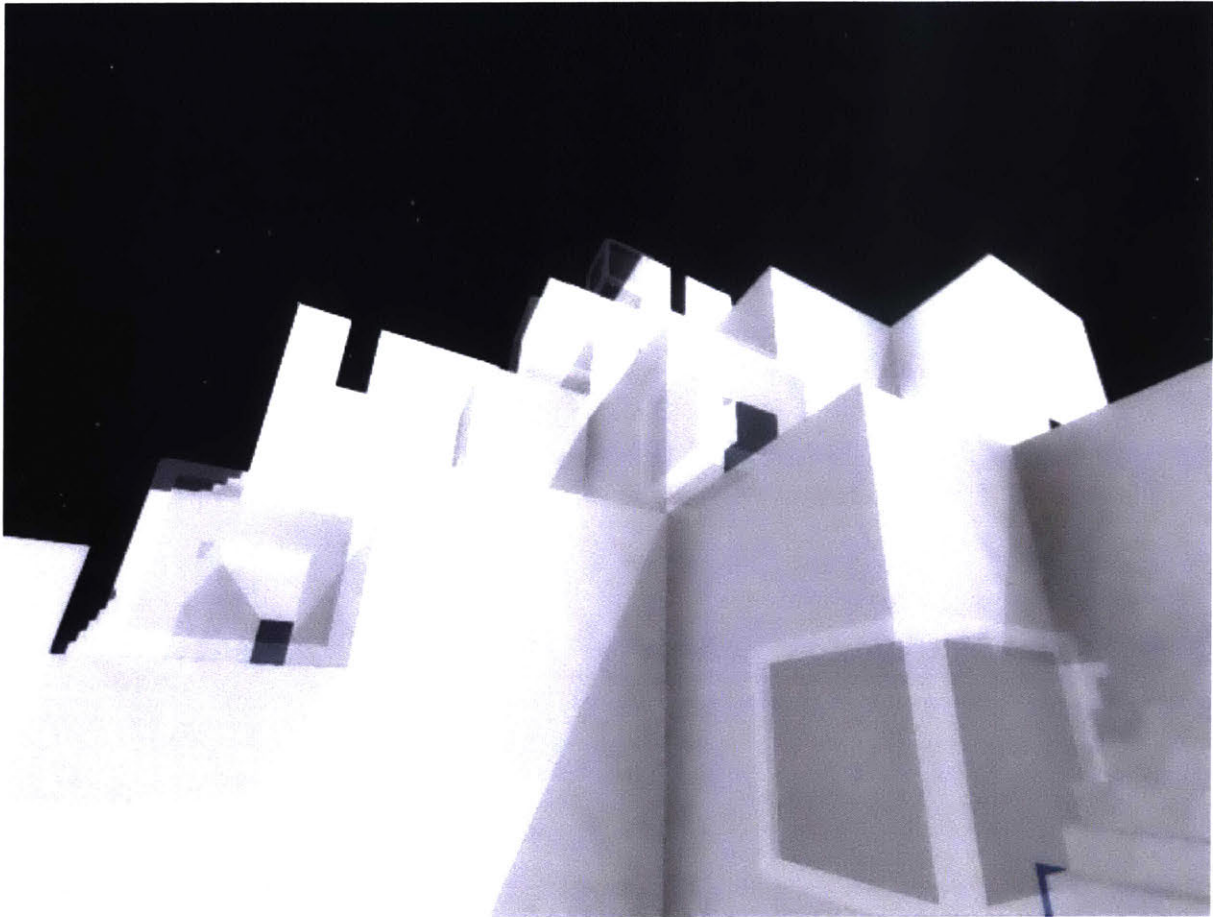
2003, The Good Days, Second Life

An exhibition in online game exploring the duality of being an insular individual in a world of contexts, interests, opinions, rules

2016 Pokemon Go

An location-based augmented reality game that let players physically travel to explore the game's map and visit PokéStops and gyms.

Design of Cyberspace as a Memory Container

The previous chapters showed the rich potentials of cyberspace
and the mnemonic function of physical and imagery space. Can
similar mnemonic function be applied to cyberspace? What are
the potentials for cyberspace to serve as a memory container and
how would it be occupied? Considering memory as a program for
cyberspace, this chapter proposes a solution that involves a series
of experiments and design schemes to explore space-memory
relation.

Four Schemes

A1

WORD LIST 1

B1
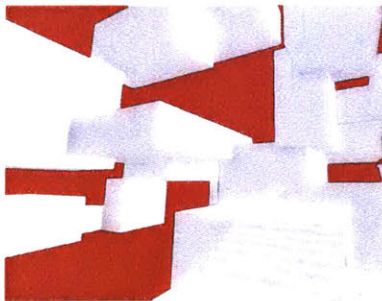
WORD LIST 2

B2

WORD LIST 3

B3
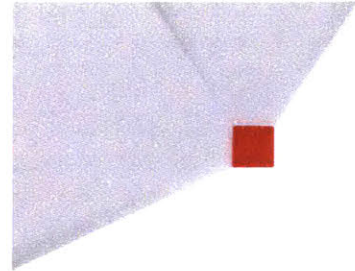
WORD LIST 4

One initial test scheme is chosen and three virtual schemes with different spatial variables are proposed to explore the relationship between cyberspace and memory. An interactive game-like experiment is designed to measure the mnemonic effectiveness of different spatial qualities and their interventions on memory. How cyberspace affects memory and how users occupy each space. Combined with interviews, the experiment is also a prompt to help understand what the cognitive process and strategies the users use to occupy the space.

EXPERIMENT SETUP
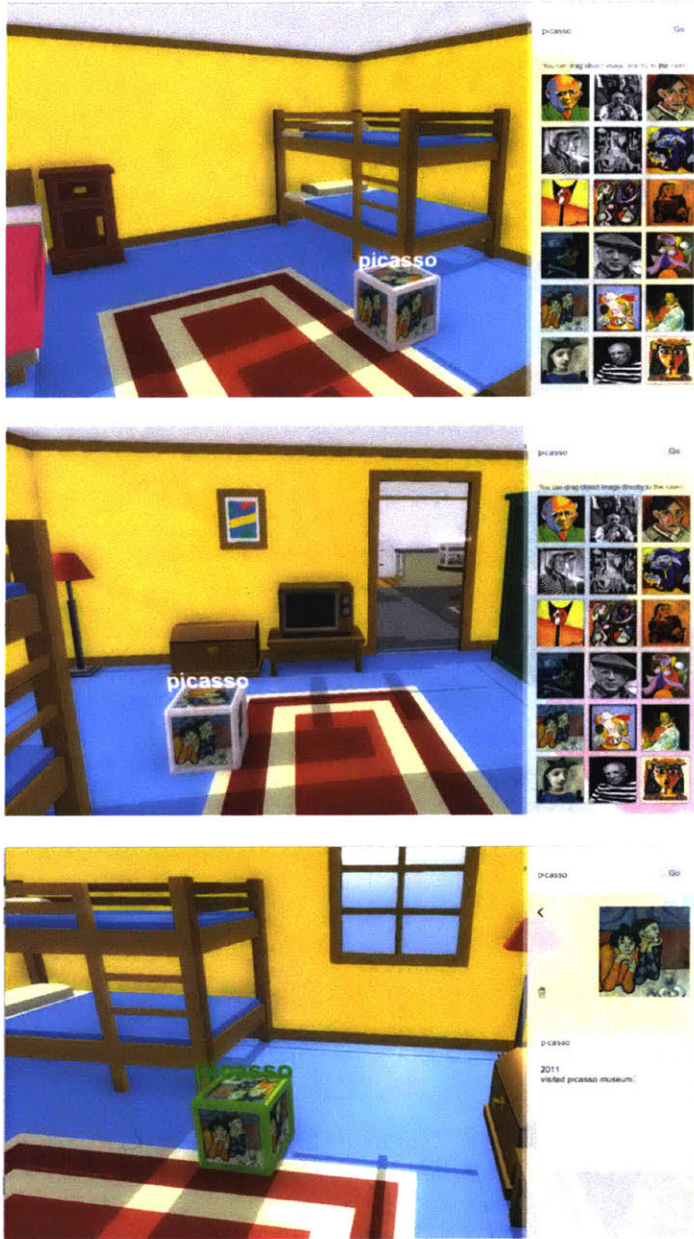
Setup

An interactive virtual 3D environment is created and allows user to search and place object into the space. Object name can be be modified in order for user to choose object that best serves as a personal memory cue but does not necessarily match the given word.

User is given a list of 16 words to be placed in each virtual space. They are asked to recall the list of words after the experiment, as well as after a certain period of time.

Words in the list consists of both concrete and abstract. They are chosen randomly without any obvious connections.

List 1
MILK
MASK
BLOCK
PINK
CONE
FRAME
KEYWORD
NECKLACE
TRIP
SPRING
BOOKMARK
SCORE
NOTE
MAILBOX
BALCONY
FESTIVAL

List 2
BOWL
WINTER
SCHOOL
SMILE
RUBBER
CHAIR
HEADPHONE
LAMP
WIRE
BUILDING
MIRROR
LAW
RACKET
KEYWORD
ELEPHANT
RUG

List 3
VASE
TIGER
HAT
SPADE
TEAPOT
CAMERA
CUSHION
ICE CREAM
PIANO
BOOK
HOUSE
ORANGE
FIVE
MEMROY
DREAM
LIGHT

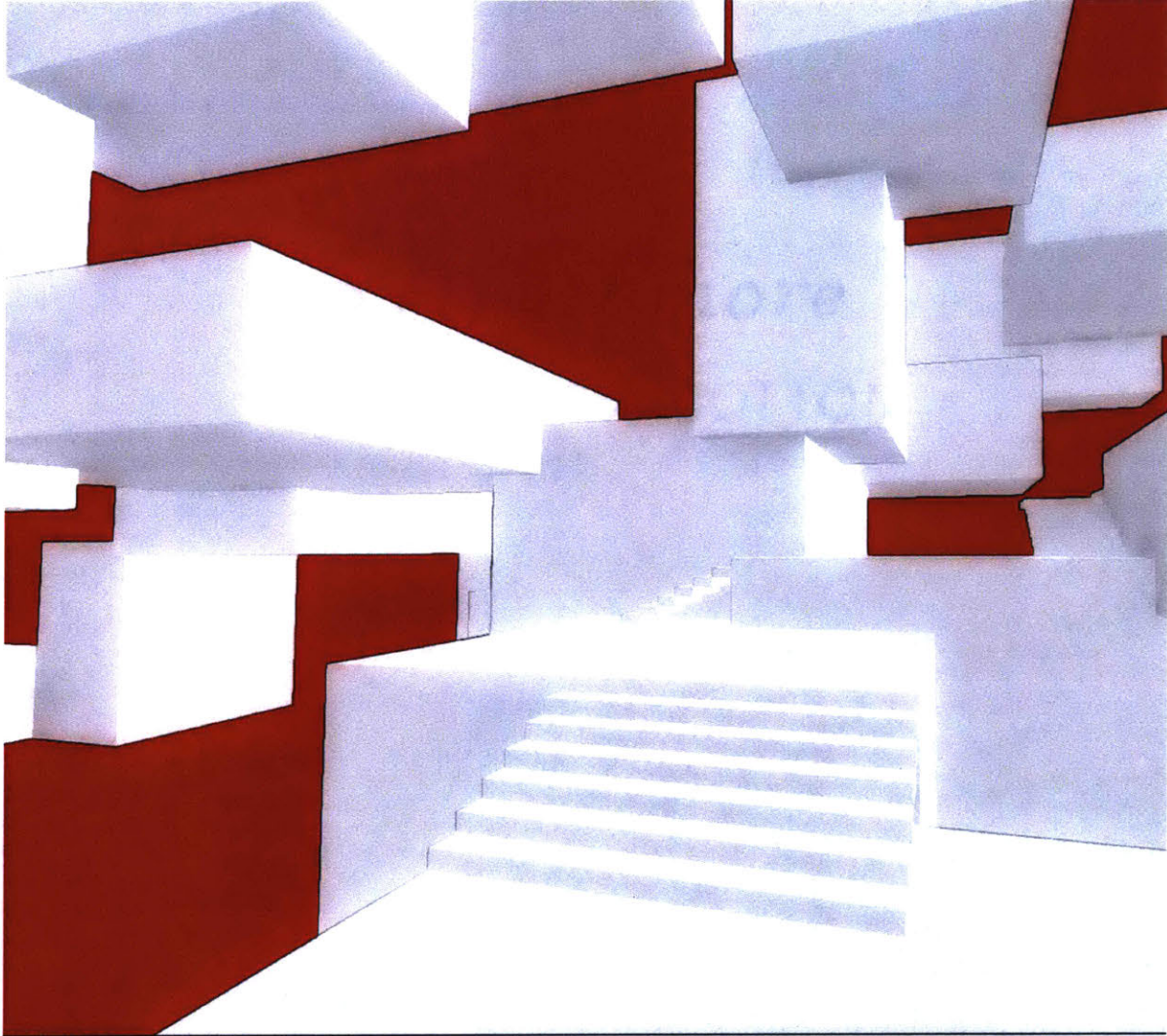| List 4 |
| --- |
| NINE |
| SWAP |
| CELL |
| RING |
| LOVE |
| PLUGS |
| LAMP |
| SWAY |
| ARMY |
| BANK |
| FIRE |
| HOLD |
| WORM |
| CLOCK |
| COLOR |
| BABY |

SCHEMES A

SCHEME_A1
IMMERSIVE: +++
SPATIAL COMPLEXITY: +
FLEXIBILITY: ++

Scheme A1 is a generic apartment. It is chosen as an initial environment to test whether space alters memory for a list of word compared to control group (no space).
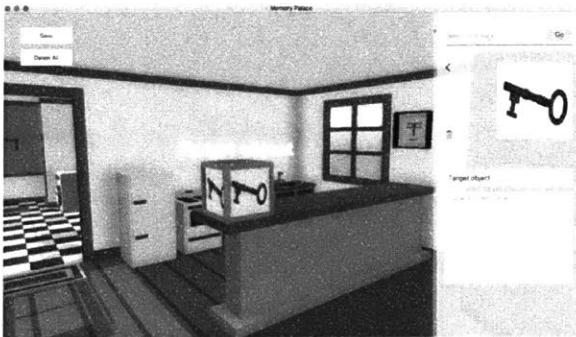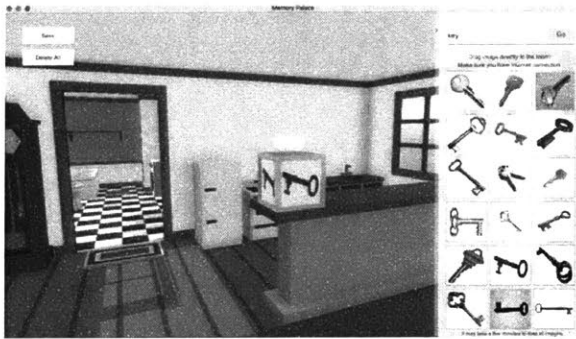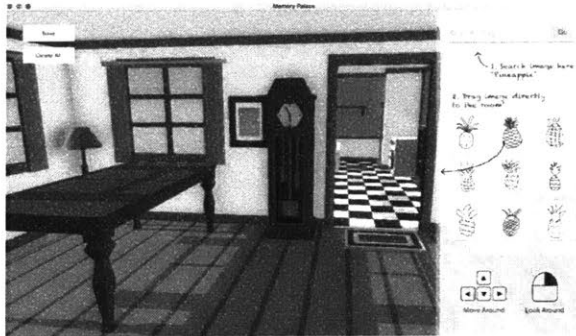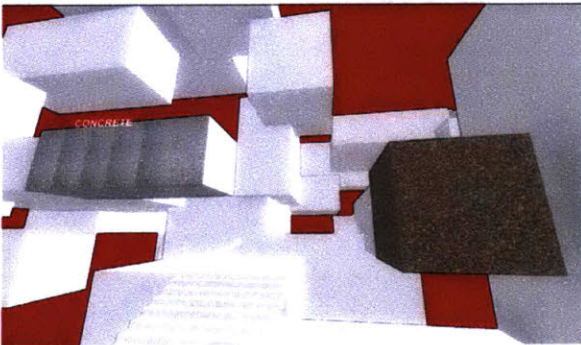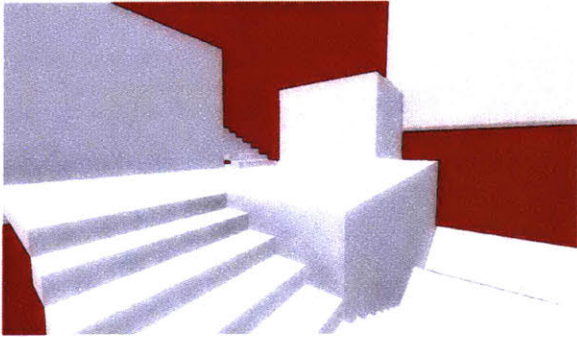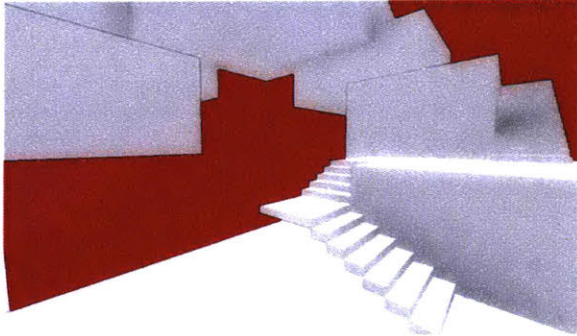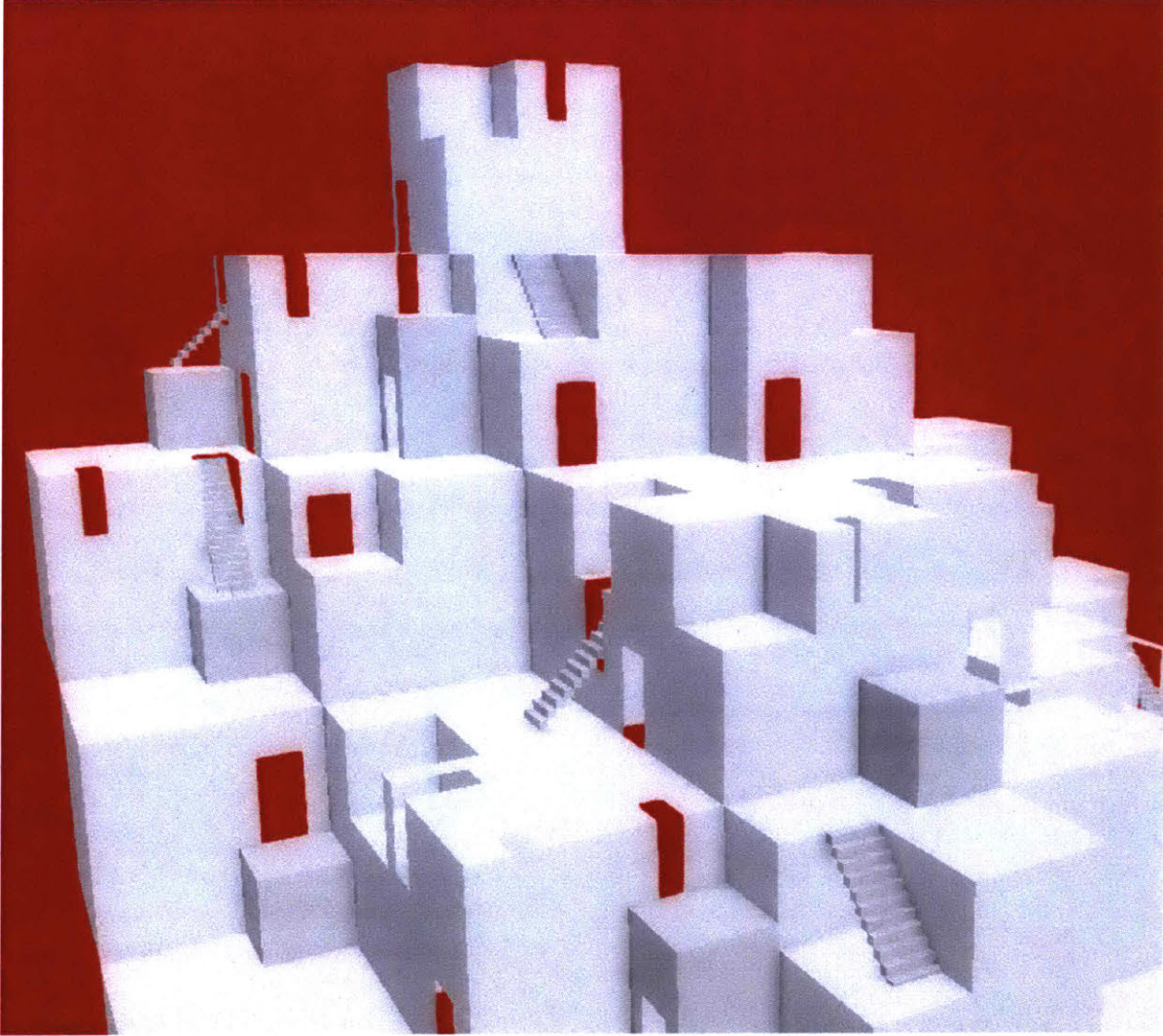
SCHEME B1

SCHEME_B1
IMMERSIVE: +++
SPATIAL COMPLEXITY: +++
FLEXIBILITY: +

Scheme B1-B3 eliminate variables of different textures, colors and other contextual information such as furnitures and building components. The goal is break the cognitive connections that a user would naturally develop upon looking at a scene given their prior knowledge.

Scheme B1 places user in an immersive environment. User has freedom to view to all directions and traverse the space. The space itself is highly complicated and does not propose an strong hierarchy. User could, but does not have strong incentive to change the structure of the space given it's complexity.
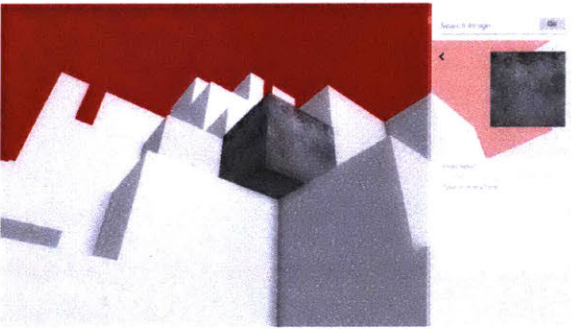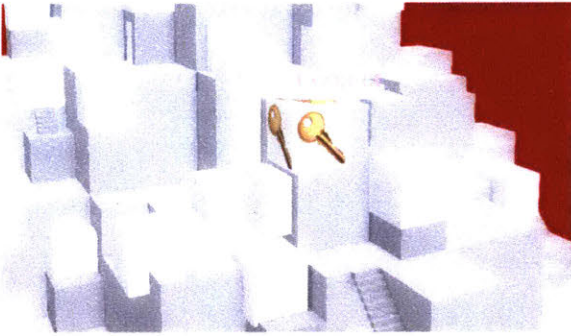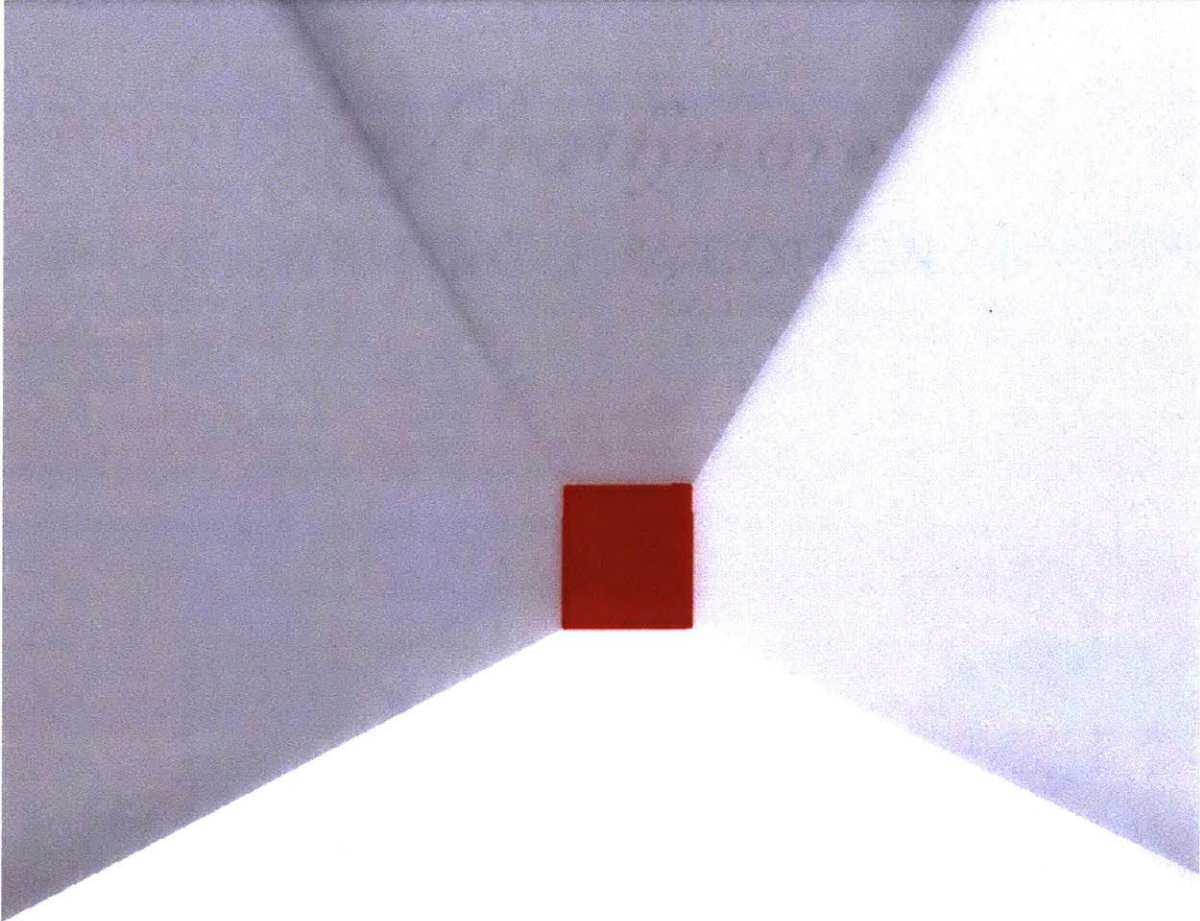
SCHEME B2

SCHEME_B2
IMMERSIVE: +
SPATIAL COMPLEXITY: ++
FLEXIBILITY: ++

Scheme B2 places user outside the occupiable space in an aerial view. The spatial structure is simpler compared to B1. It also suggests a strong hierarchy.
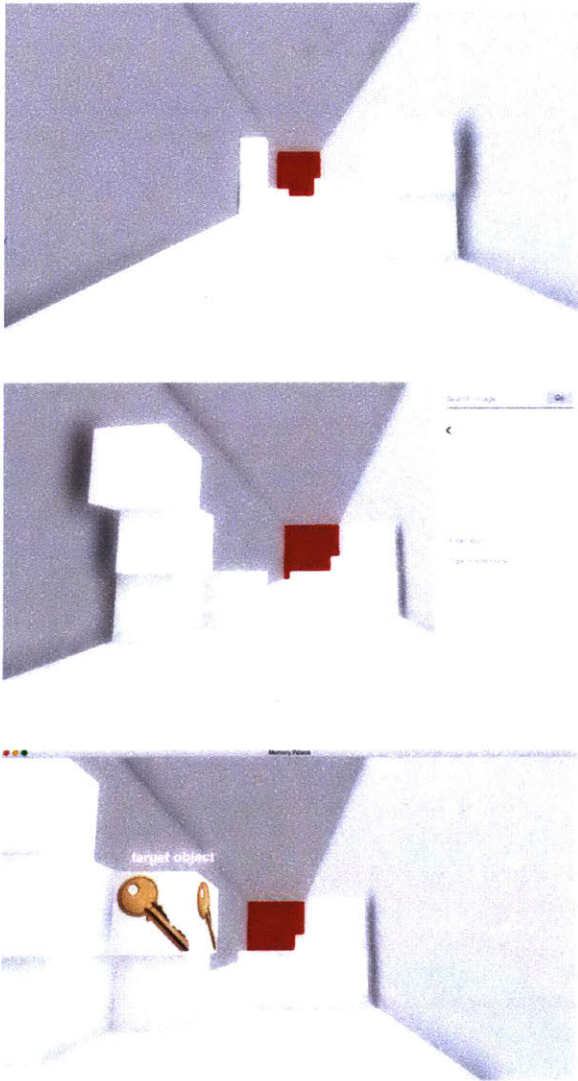
SCHEME B2

SCHEME B3

SCHEME_B3
IMMERSIVE: ++
SPATIAL COMPLEXITY: +
FLEXIBILITY: +++

Scheme B3 suggests an essential empty space. The intention is to give the user the authority to structure and occupy the sapce based on how they understand the it and the word context.

User Test Setup

20 users are invited to participate in Scheme A1,B1,B2,B3 and control scheme. Upon finishing each experiment, they are asked to think aloud and recall the list of word corresponding to that scheme. Users are also asked to describe the strategies they use to place objects and structure the space in follow-up interviews.

The following page shows an example of one user in the series of experiments.

The space did helped.
...It was a combination of
space and the order which
I placed the thing in.
But I think this space is too
overwhelming for me.

The fact that it was
complicated helped me
form a story. A lot of layers
and levles.. but I can see
them all in one view, so
I can remember it quite
easily.

I put them in groups..
I was walking in this
space more.
This space is simple,
but it's actually harder
because it was more
random.

A1

B1

B2

B3
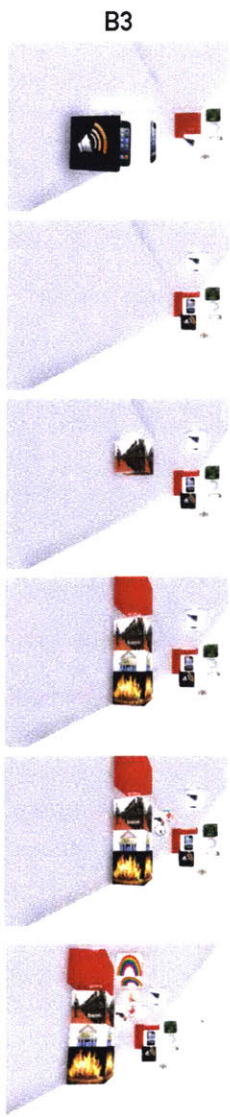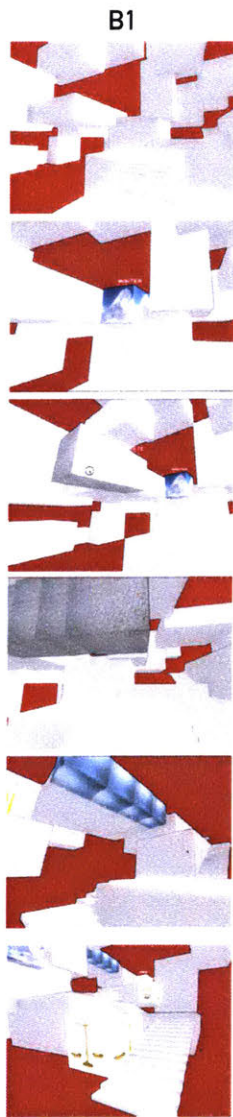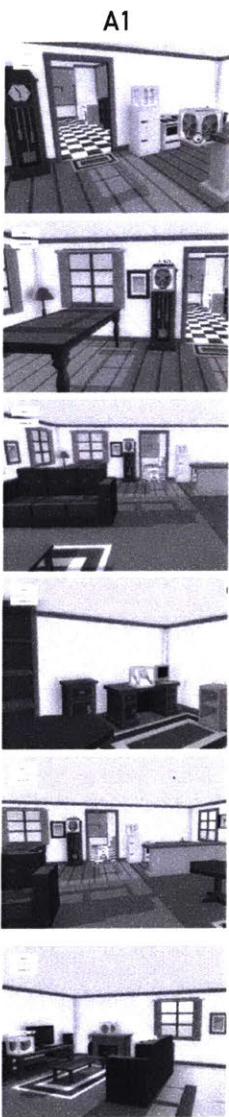
RESULTS:

| 15/16 | 9/16 | 15/16 | 14/16 | Control group: 10/16 |

Final Spatial Configurations

B2 populated after game by different users

B3 populated after game by different users
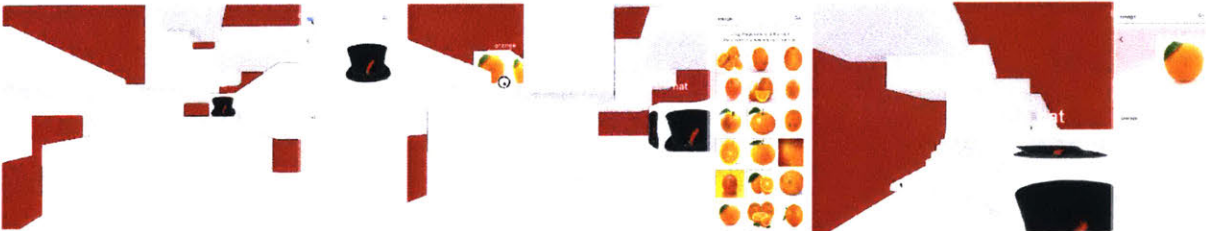
Spatial Strategies

Inherited spatial hierarchies

No hierarchies I form of groupings

### Movements in space I spatial sequence

Conclusion

The combination of the experiments and the follow-up interviews probes into how virtual space affects projecting, retrieving and composing memory. The discoveries are based on a set of 20 subjects.

The result shows that grouping or categorization is a primary spatial strategy that most users adopt to start occupying a space. When the given spatial structure suggests strong hierarchies, users tend to take advantage of that hierarchy and fit into their task context. When no spatial structure is given, users tend to create structures that can aid them in categorizing objects into different visual clusters. There is also an observation of the different navigation strategies in space. Some users traverse the volumetric virtual space and switch views that are directional to a first-person perspective. Some users never change views and treat the interface as a flat representation of the space, using directions from a third-person perspective.

The experiments and design schemes are not intended to replace a scientific experiment. The emphasis is on the process of different people's approaches to projecting, retrieving and composing memory in relation to space. Design schemes in this project are examples created to investigate into this process. Designers can potentially use the interactive approach towards future designs that intend to alter memory in one way or another.

Video

All user interivews are video-taped and all screen interactions in each experiments are captured. Comparing both in a synchronized manner offers insights of how user occupies, structures and modifies the space.
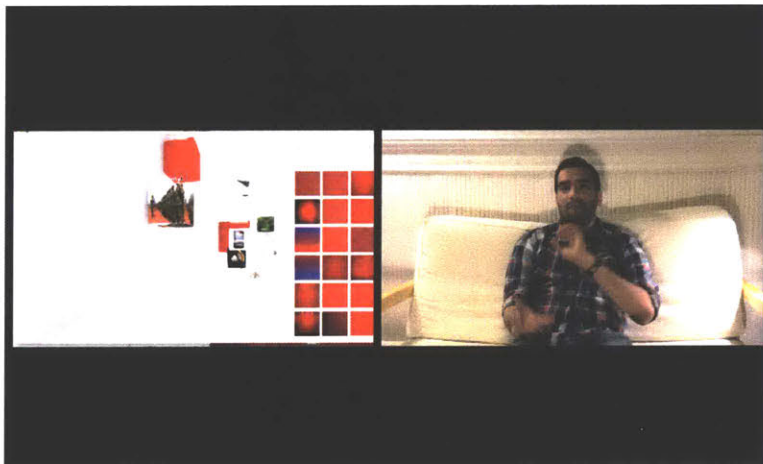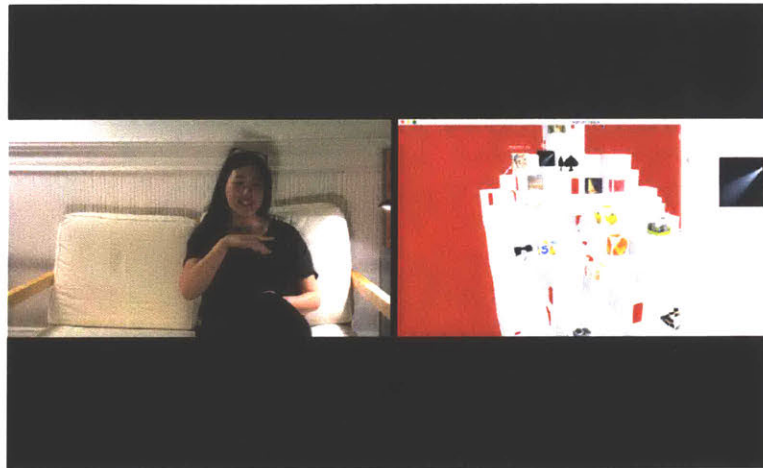
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