Spatial Navigation of Digital Information on the WWW.

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[section 1] _Introduction

ABSTRACT

The world wide web allows user access to a wealth of information that originates from around the world and from millions of sources. A search for any topic yields thousands of results over the wide expanse of the web. The act of jumping from one page to another, one link to another, leaves users disoriented and without knowledge of why and how they arrived at these specific pages. How do users determine that the information they have found is related to previous information?

The human mind recognizes and prompts action based upon position, distance, and relationships in time and space. In navigating cities, architect and theorist Kevin Lynch found that users perceive specific components and relationships among them, regardless of the specific city: districts, paths, edges, nodes and landmarks. It makes sense, therefore, to apply the same typology to the navigation of virtual / informational space in the world wide web.

In a spatial analogy, one based on landmark, node, district and path, users of information may understand the parallel nature of relationships among data. The hope is that users make choices about path based on spatial affinities, not on arbitrary linguistic codes or structures. Users also gain a visual understanding of what it is to traverse web-based information when they are within a system, what it is to step outside of and re-enter that system, and the experience of moving between separate systems that contain related information.

In short, the goal of this project is to better understand how to navigate through and how to reach desired information found on the world wide web.

PROBLEM STATEMENT

How can components of the built world, such as landmark, node, and path, as they have been defined by Kevin Lynch (*Image of the City*), serve as a metaphor for navigation through complex digital information?

SUB-PROBLEMS

What are the defining characteristics of a digital landmark? How can direct experience add to the identification and definition of a landmark?

Within a range of new media environments, how can a digital landmark transform itself into a node or hub of activity?

How can a path through complex digital information be visualized?

JUSTIFICATION

In experiencing information on the web, users may feel as though they jump from page to page, with no ability to distinguish the path taken between pages and no understanding of the relationships that exist from one page to the next. Each new page of information is presented in a similar manner through the browser window, never establishing a sense of hierarchy or the structure of content from varying positions within the system.

How then can users determine what information is most relevant to their specific needs? The design community must establish ways of providing navigational systems that reflect the spatial organization of the web and its content. The 'page' metaphor currently in use refers to a 2-dimensional, linear model from print media. In the web, however, each unit of content is simultaneously interrelated to hundreds and thousands of others, which, contrary to the 'click to the next page' actions of current browsers and web pages, creates multiple non-linear relationships. Currently there is no visualization of the virtual space in which these relationships exist. Users may be provided with visual representation of how far a link moves the browser away from an original position as a signal for determining the interrelatedness of the content, but this representation does not accurately depict the alternative relationships of the current unit of content to its predecessor or to other, not yet accessed units of information. The visual transition between these states should be deliberate in reflecting the transition of meaning found in the content.

Many metaphors for the spatial world already exist in the digital realm. All users 'enter' a web page, and use 'forward' and 'back' buttons to move through a web browser. Hyperlinks allow users to 'go to' a specific unit of information. The desktop metaphor itself is a representation of space found in the physical world. While these examples use the names and vernacular of the spatial world as metaphor, they fail to apply any of the functionality of the real world. They do not consider what it is to physically exit one space and enter another. If the structure and navigation of a virtual information environment was organized in a manner similar to the physical realm, users could orient themselves and interact with the data, in a way parallel to their daily tasks in the real world.

ASSUMPTIONS / LIMITATIONS

In defining the components of the built world for this study, references will be made to Kevin Lynch's language of form, as described in *Image of the City*. This study will be based upon his descriptions of how people interpret physical space. Although, Lynch's definitions arise from the physical world, they do not directly apply to either an information or digital environment. Therefore, all analyses must be critical in the use of Lynch's explanations of these components and their application to new hypermedia based environments. Although there are many parallels that exist between the physical and virtual worlds, there are also many exceptions and implications that must be defined and considered during this investigation.

This study includes an examination of large systems of information as found in a web environment. It does not create original content, but uses an existing body of information as content. This existing content must include the following characteristics:

- complex information
- nested systems
- multiple entry points
- allow for iconic and / or metaphorical representation
- ability to be placed into different structures that are:
    - system based
    - focused on relationships between multiple characters
    - temporal / strategy based

The projects examined are a series of small studies investigating the elements of spatial systems in both physical and virtual worlds. These are followed by a complete digital system that is designed on the basis of the theories and elements discussed in this document.

[section 2] _Background

ENTER KEVIN LYNCH...

In 1960, Kevin Lynch published a seminal study on the structure of three cities, Boston, Los Angeles and Jersey City, entitled *The Image of the City*. During the investigation, Lynch interviewed the inhabitants of each of these environments to determine a common language for interpreting the way people envision their own surroundings. The study went on to provide explanation of how the inhabitants of these environments interact with the structure of the physical world around them. Lynch created this language of form based on architectural components common to all three cities, describing the physical world in relation to the parts of an urban community or city. These components are referred to as a set of patterns which can be applied (loosely) to any spatial setting of similar scale and complexity.

Based on Lynch's investigation, all "cities" are comprised of **districts**, the largest sections of the whole containing like elements with a set of common characteristics. Within the district exist thousands of **nodes**, each being a separate point of activity or information [action /response]. Nodes are arranged along paths, as well as at their intersections. A **path** is the manner in which an individual travels between nodes within a single district, as well as between districts. At the border between two districts there exists a recognizable **edge** which distinguishes the boundary at which two districts meet. Lynch went on to define the method by which people in these cities are able to distinguish one district from another, understand their orientation from inside a district, and determine direction between a location and a destination. This methodology carries over to allow the separation of nodes in one district from those of another (Lynch. 46 - 89).

The identification of one district from another is accomplished through the recognition of **landmarks**. Landmarks act as signifiers for the districts in which they are located. The landmark not only aids in the identification of a district, but also the nodes and paths which occur within its boundaries. The characteristics of a landmark, in Lynch's definition, set it apart from its surroundings through unique features and shape. It is in bold contrast to, but maintains a pattern with its immediate environment. It is a fixed point upon which one can base direction, and use as a beacon for orientation and navigation. In the built world, however, Lynch's study states that a landmark is an object that cannot be entered; that the only interaction in which one can participate is entirely external to the landmark. This is a limitation of a landmark in relation to the built world. If the Washington Monument in Washington,

PATH_
channels along which observer / user customarily, occasionally, or potentially moves; allows for recognition of the experience between two points.

LANDMARK_
point of reference, orientation, direction; not entered into, external; identifiable, simply defined; unique characteristics; set apart from its surroundings; approachable from all sides.

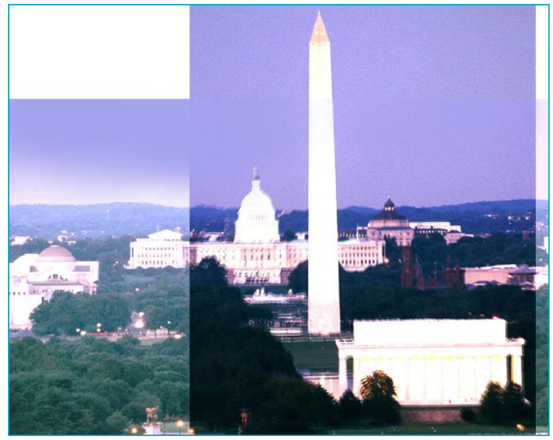
DISTRICT_
medium to large sections of the whole (city); observer is either 'inside' or 'outside'; unifying characteristic(s) found throughout all components within.

NODE_
points of entry or exit; used for travel; junctions, crossing or convergence of paths; a hub of activity.

EDGE_
linear breaks in continuity; not considered to be paths by observer; walls; boundaries.

(Lynch. 46 - 89)

[*figure 1_ Its towering, monolithic shape sets the Washington Monument apart from its environment.*]



[*figure 2_ Washington Monument, Washington D.C.*]

D.C. is considered a landmark, based on Lynch's theory, it is the shape and visual dominance over the surrounding landscape that actually serve as landmark characteristics [*fig. 1 - 2*]. The architectural structure itself is merely a node that any patron may enter (Lynch. 78 - 85).

It is through the mental map of Kevin Lynch's system that an individual manages to navigates the complex labyrinths in the built world. It is this system that explains how millions of people accomplish countless tasks, maneuver between hundreds of thousands of points of interaction [nodes] on a daily basis.

It seems logical that Lynch's language of built form could be applied to the digital information environment with parallel success. However, for this to hold true, one must first consider how the digital environment functions, exists, and responds to its primary inhabitants… the user.

The first examination must focus on the method of communication employed between user and machine. Here, the computer displays information on a flat monitor or screen, while the user responds through a number of specialized input devices (keyboard, mouse, touch-screen) all of which manipulate the cursor appearing on that flat screen. This balance of stimulus and response between human and computer is known as direct manipulation.

In order to apply a spatial theory such as Lynch's to the digital realm, one must first define the attributes of that environment, and examine, just as Lynch did in *The Image of the City*, how the inhabitants interact with their surroundings. That is to say, create a taxonomy of user behaviors that already exist within the digital. How do structural elements differ between the two, and how parallel do they function? Finally, what is the basis for user stimulus and response in the digital environment? The answers to these questions lie in the manner by which an interactive system must be constructed, as well as its necessary components.

OF MOUSE AND MAN...

Direct manipulation is an expression first used by a software designer named Ben Schneiderman in 1983 to describe the use of a mouse in pointing at information on the computer screen; the user moves the mouse which moves a cursor on screen. The user clicks the mouse and the cursor selects an object on screen. It is this simple relationship that has been learned by users and is now a convention for navigation that gives the individual a physical position within the digital environment. Schneiderman goes on to explain the nature of direct manipulation as being the combination of [1] continuous visibility of the object of interest; [2] rapid, incremental, reversible, physical actions on the object; and [3] immediately visible results (McCullough. 5). The principle components of direct manipulation throughout, stress the importance of action in the digital environment.

In *Computers as Theatre*, designer Brenda Laurel emphasizes the importance of how a person relates to an object in the real [built] world. This relationship is carried over into the digital world and the manner in which a user encounters complex information. Laurel goes on to explain the expansion of this idea by Donald Norman and his associates (Hutchins, Holland and Norman, 1986) with an additional concept they title **direct engagement**, defining the moment that a user experiences a direct interaction with objects in an environment.

> "It seems likely that direct manipulation and direct engagement are head and tail of the same coin (or two handfuls of the same elephant) — one focusing on the qualities of action and the other focusing on subjective response. The basic issue is what is required to produce the feeling of taking action within a representational world, stripped of the "metacontext" of the interface as a discrete context."
>
> (Laurel. 8-9)

If the combination of direct manipulation and direct engagement explain the ability of the users to act / react to digital objects as they would in the built world, then what causes those relationships to exist in the built world? Here lies the task of identifying spatial intelligence in human cognition and the ability to navigate the built world.

Rooted in the theory of multiple intelligences, **spatial intelligence** refers to the ability of the human mind to accurately perceive the physical world. Largely dependent on the sense of sight, this mode of cognition allows an individual to re-create the characteristics of a real world experience and then be able to manipulate those characteristics within the mind, whether imagining the appearance of a different side of an object, the object from multiple distances and vantage points, or even a redefinition of the shape of that object. This mode of intelligence also allows an individual to recognize instances of a single element and mutations of that element and to accurately interpret graphic depictions of the element, as seen in the use of maps, diagrammatic forms, and even photographic representations. Spatial intelligence is the function of the mind which creates a representation of the world a person exists within, as well as all the elements which comprise that world. The human brain makes sense of its surroundings through this mental representation.

So, if spatial intelligence interprets the physical world, what are the cues of that world that enable an individual to navigate through the environment, establish and complete tasks and goals, and use the environment to his advantage in completing goals? Such question refers to **navigation** and **wayfinding**. Navigation through space requires the action of several cognitive processes, the first being decision-making. It is through decision-making that an individual determines a set of needs and goals, assessment of abilities, and engages in critical judgement of his surroundings. During a critical assessment, the individual is able to comprehend his own immediate position as part of a larger system, thus expanding his "field of interest" (Passini. 53-54). It is at this moment in the cognitive realization that the individual defines their own orientation in respect to elements of the surrounding system. Through a series of observations, a general position is identified, as well as a primary sense of direction relative to nearby elements, which builds a cognitive image of the space.

[example] I am standing…
I am standing on a sidewalk…
a sidewalk in a city…
a sidewalk near a tall building…
between a tall building and a river.

These observations create a sense of **direction**. Once direction has been established, the observer understands his orientation within the space, but is now free from dependency on elements within that space. In *Wayfinding in Architecture*, Romedi Passini defines orientation as the ability to maintain a direction while moving, or pointing out a specific direction independent of one's location in space and without relying on the cues that may originate within that environment. After establishing one's orientation, the individual sees the complexity of the space and identifies choices (Passini. 10 - 23). It is at this point that the development and application of needs and goals becomes important. Passini addresses the importance of complexity within a spatial environment, stating:

> **Spatial complexity and the unknown awaken curiosity and the desire to explore. The factors of surprise, of discovery, all contribute to a full spatial experience.**
>
> (Passini. 22)

ORIENTATION_
to ascertain the bearings of: a usually general or lasting direction of thought, inclination, interest, or location: awareness of one's position or location.

(http://m-w.com/)

NAVIGATION_
the method of determining position, course, and distance traveled; the science of getting from place to place

DIRECTION_
the line or course on which something is moving or is aimed to move or along which something is pointing or facing.

ENVIRONMENT_
the circumstances, objects, or conditions by which one is surrounded.

IN THE GARDEN OF THE FORKING PATHS...

With the establishment of orientation, individuals revisit their needs and goals, and assign purpose to their movement in order to fulfill them. During any given day, a person must reach a great number of destinations to complete an even greater number of goals. The number of destinations increases under detailed examination of the whole environment. It is at this micro- view that individual sections of the whole cosmology appear. The complexity of the system becomes evident, with many new and very specific choices determining movement. This level of complexity acts as a maze or labyrinth and creates a sense of disorientation. In purposeful movement, as well as more open-ended exploration, the individual needs to maintain a balance of both orientation and disorientation. Disorientation reveals the unknown, questions the familiar, and causes the traveler [user] to cognitively map out their location based on what he knows, what he doesn't yet know, where he has been, and where they intend to go. It is this mapping that develops an individual's **path**. The path becomes the manner in which users travel through the space time after time, allowing new branches of exploration off of that constant. The sense of orientation is now based on the familiarity of that path.

> **The antithesis of a maze is a situation in which you can see your goal and the path to get there, one that preserves your sense of location while under way, making it equally easy to get back.**
>
> (Raskin. 152-153)

Having recognized the complexity of an environment, the next step is identifying and understanding the parts of the whole. How does the mind make sense of all the elements within an environment? The answer, in its most basic form, is pattern recognition. In *A Pattern Language*, architect Christopher Alexander investigates the underlying patterns that describe architectural environments; that is, cities, towns and communities. At the highest level, Alexander describes the elements of an environment that, due to a common characteristic(s), form a region(Alexander. 11- 15). A region is constituted in the same manner as a district in Lynch's terms: medium to large sections of the whole (city). Within a single region can exist individual towns, communities, and sub-cultures. These sub-cultures are a human version of Lynch's nodes, and are where specific information and response reside.

If all of the elements that fall within the bounds of this region are distinguishable from those of neighboring regions and share a common pattern with those inside this specific region, how does an individual recognize that pattern? What is the method of distinction among regions? And how can travel be established between multiple, separate regions? Through the recognition of a landmark within a region or near the inner elements of that region (nodes), an individual is able to differentiate one area from another.

In both physical and virtual worlds, individuals move toward another region, they encounter the edge or border between the current and neighboring district.These edges are identifiable by the dramatic shift between characteristics of both neighboring districts. Edges share these characteristics of both sides, thus signifying the change between regional environments. In order to establish a path across this edge, the traveler must find a gateway which allows for passage from one space to the next. Gateways are nodes that exist in between two separate regions. Any node can be considered a gateway in its ability to lead

GATEWAY_
an opening or device for controlling passage; a means of entrance or exit; an area for departure or arrival

REGION_
an indefinite area of the world or universe; a broad geographical area distinguished by similar features

(http://m-w.com/)

users to new information. However, the gateway nodes existing on the edges between districts differ from internal nodes in the sense that they are portals between large categories. These gateways represent a massive shift in both the organization and content of information. Gateway nodes also allow users to move back and forth between these large regions of information, and therefore, to the edges on which exist share a characteristic of districts which they connect.

Transitioning between two regions or districts can be represented by modern web travel. The action of moving between two districts in the physical world serves as a direct metaphor of moving from one web page to another. Based on that metaphor, current web travel has few cues to enlighten users as to destination; previous locations; or even the state of having changed location. In order to create a spatial means of navigation through **virtual** information, the design must [1] incorporate a clear representation of the user's path, [2] provide the users with insight as to their direction of travel through recognizable landmarks, and [3] establish a sense of transition at the moment users encounter and move through the edge between two districts.

The necessity for users to understand their own paths relates to architectural wayfinding in the physical world. As a user engages with a complex spatial environment, he explores the unfamiliar aspects of that space. This exploration sets users on an unfamiliar path, in which landmarks have not yet been determined. Therein lies the need for users to not only understand their paths, but to build a cognitive map of them and retrace the space, through which to predict and retrace steps.

This unfamiliarity can be defined as the metaphorical **labyrinth** of digital information. As in an ancient Greek labyrinth or Chinese maze, these virtual information spaces can confuse and instill placelessness. The ability to visualize the paths through virtual data could orient users to information and its use. The stronger the sense of orientation, the better understanding of content. Users more accurately predict what lies ahead, projecting a cognitive map for information they have not yet encountered.

The ability to project estimated locations prior to encounters with information demands definition of key content or transactions along paths. These definitions constitute the landmarks, often user specific, through which orientation is established and upon which new directions are based. In identifying certain content as landmarks, users are able to

LABYRINTH_
something extremely complex or tortuous in structure, arrangement, or character: a maze formed by intricate paths.

VIRTUAL_
of or pertaining to an artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer; relating to the digital.

(http://m-w.com/)

branch their explorations into larger information spaces or move deeper into unknown areas of the environment. Such experiences create a parallel understanding of the relationships existing in both large scale sections of the whole, and smaller content nodes. Both in representation of path and the cognitive map of the whole environment, users must be able to manipulate the scale of their investigation in order to distinguish the events and locations of landmarks and nodes in order to navigate the environment with purpose.

An example of users' ability to project estimated locations can be found in the interaction with amazon.com [*fig 3*]. As users enter the system, they encounter a collection of primary landmarks which identify a separate section or district within the system's cosmology. These initial landmarks denote districts such as *Books*, *Electronics*, *Apparel*, etc. which exist beyond users present position. These districts are specialized categories of information which can be entered into from the primary stage (*Welcome* page). Users estimate district contains the specific information node they seek based on the initial landmarks they encounter.

Amazon.com is a unique online system in that it allows users to visualize their paths. Although it is not designed as a spatial environment, the importance of place and orientation carries over into amazon's interface. Users are not only allowed to access the objects they recently viewed, but branch off of their previous paths in order to reach new nodes of information.

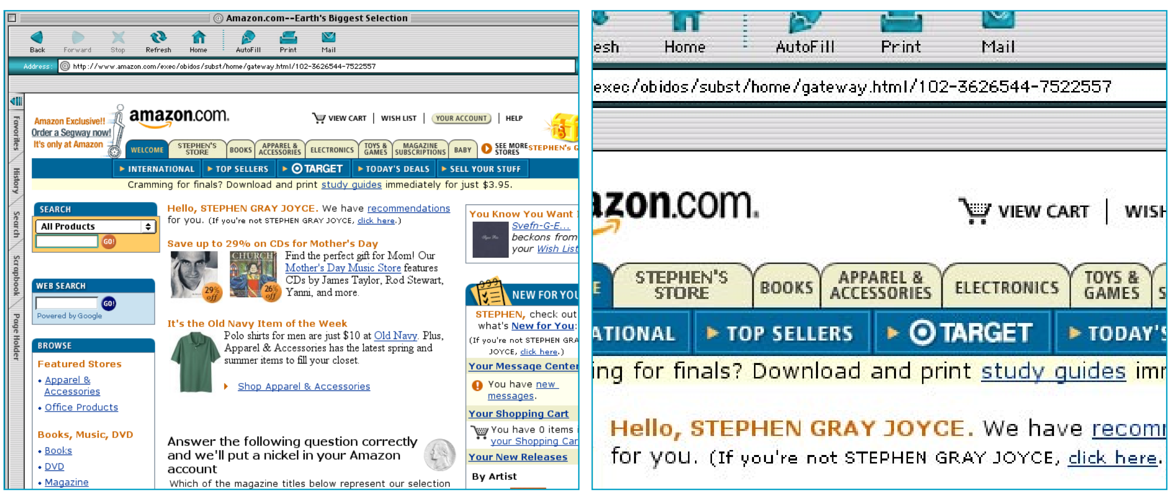
MACROCOSM_
a complex that is a large-scale reproduction of one of its constituents: the great world or universe.

MICROCOSM_
a community or other unity that is an epitome of a larger unity: a little world.

(http://m-w.com/)

DURATION_
continuance in time: the time during which something exists or lasts

FREQUENCY_
the number of repetitions of a periodic process in a unit of time

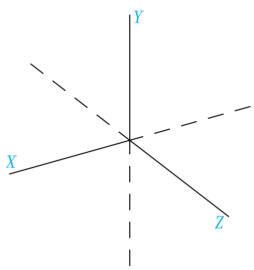


[*figure 3_ amazon.com. Welcome page*]

[section 3] _Study of the Elements

UNDERSTANDING THE COMPONENTS

In order to create a digital catalog of information in which the primary mode of navigation is based on spatial elements [such as those defined by Kevin Lynch], the designer must first have an understanding of how each of the components functions in the digital realm. What are the affordances of each of these components for navigating virtual information? And how does the hypermedia environment redefine the nature of each of these elements?

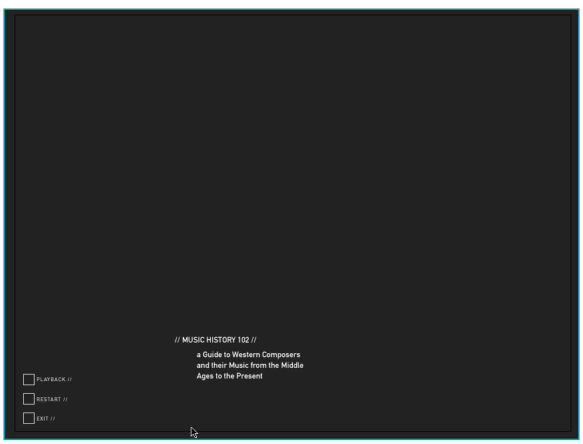


Each of the following studies investigates a single component of the Lynch language and how its functionality changes when used as a component of virtual information space as opposed to the physical world.

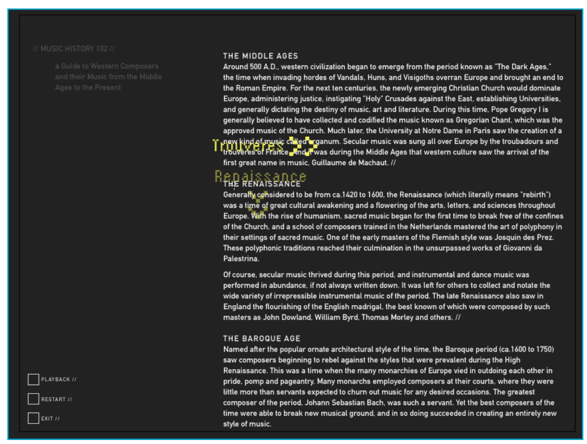
BEHAVIOR OF AN ENCOUNTER

This first project, entitled *[3D] MUSIC HISTORY* [*fig. 4 - 17*], landmark can be redefined in the digital environment. In this purely typographic environment landmarks serve as signals that more information can be reached beyond the currently visible level. Separate levels of data are located on vertical planes which intersect one another at points within the content. The primary level serves as an introduction, with districts containing more detailed and specialized information branching off on perpendicular planes.

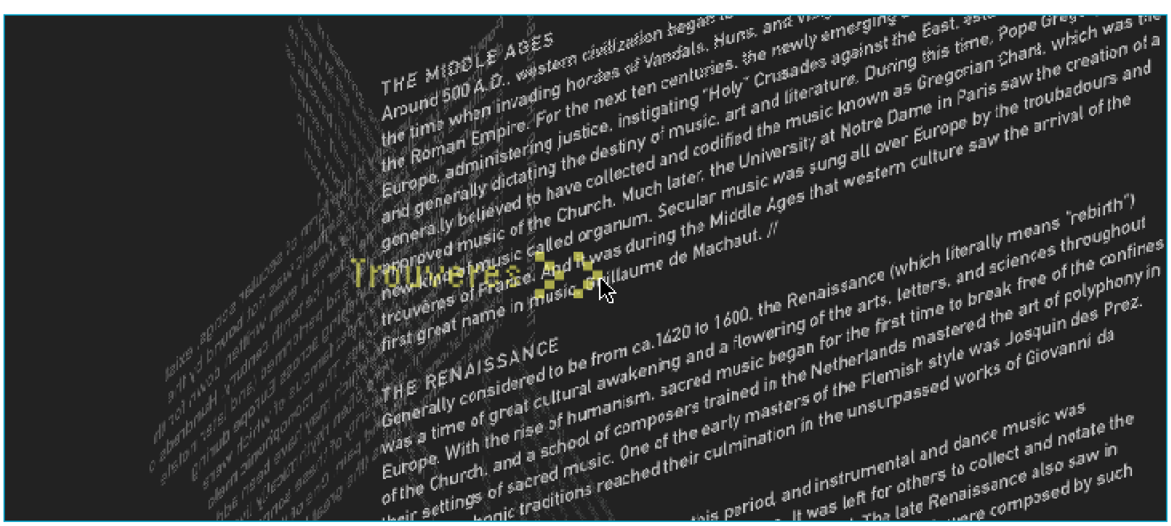
The format of the environment is based on the functionality of a landmark in the virtual world; pivoting the data planes around a point is the same as turning a street corner in the built world. The new street contains buildings, businesses, neighborhoods, etc., but



[*figure 4_ [3D] MUSIC HISTORY study*]

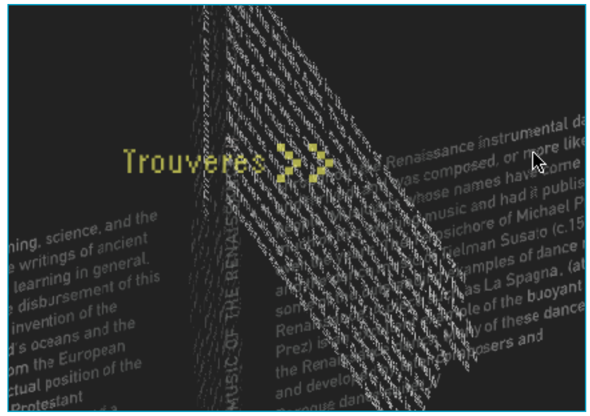


[*figure 5_ [3D] MUSIC HISTORY study*]

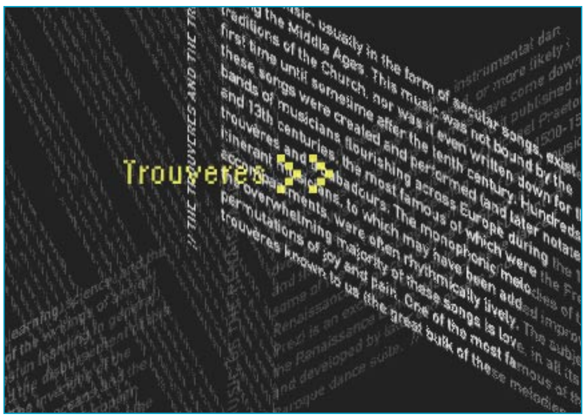


[*figure 6_ [3D] MUSIC HISTORY study*]

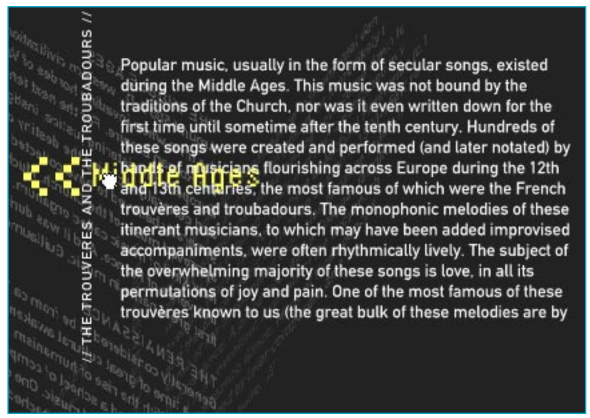
[*figure 7_ [3D] MUSIC HISTORY study*]



[*figure 8_ [3D] MUSIC HISTORY study*]



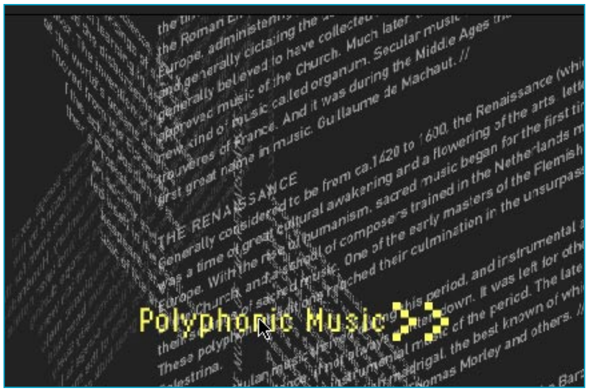
[*figure 9_ [3D] MUSIC HISTORY study*]



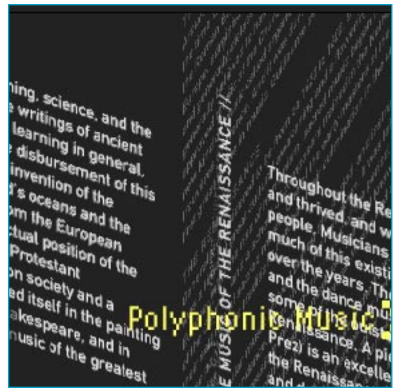
[*figure 10_ [3D] MUSIC HISTORY study*]

maintains a fixed relationship to the original street. The relationship between streets is identified by the landmark at which the turn was made. The landmarks found in the typographic space are separated from the supporting text by color and choice of font. These landmarks are relatively simple in their visualization and text identification. The landmark is signified by its separation from the main content of the plane.

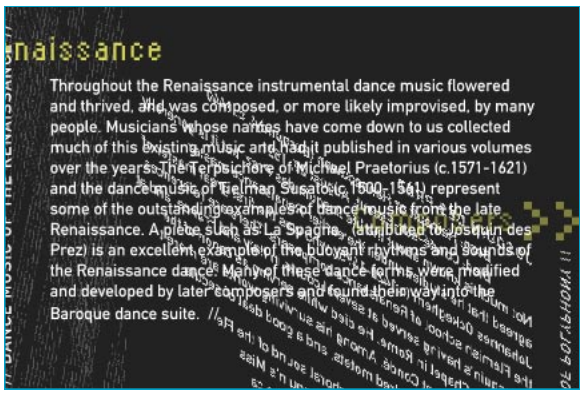
The manner in which the user moves between the individual data planes in this study also centers on landmarks. Upon rolling over a landmark the cursor changes to an open hand icon, prompting the user to click the mouse. Upon click-and-hold, the cursor shifts to a closed hand, prompting the user to continue to hold the mouse in the down position, or maintain the grab-like function. Once grabbed, the entire environment can be rotated along the *X* axis and is controlled by the user's input. This combination of actions creates a reactionary function equivalent to the user physically rounding a corner of a 3-Dimensional object in the physical world. The rotation occurs on a fixed *Y* axis where the landmark is located, therefore, the landmark is a fixed point through which the user can orient himself within the information. Because the landmark has been used to signify the turning function, the nature of the landmark has been transformed into a node at which an action takes place; the landmark is now able to serve as a hub of activity.



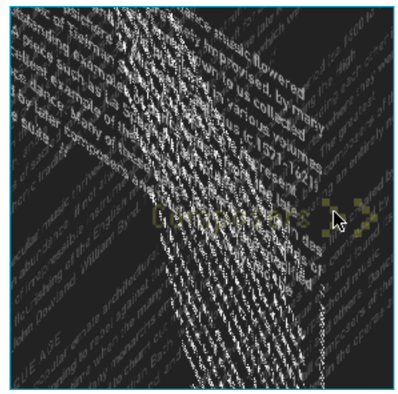
[*figure 11_ [3D] MUSIC HISTORY study*]



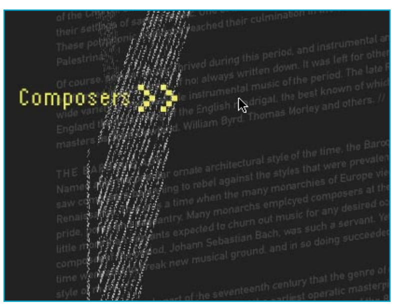
[*figure 12_ [3D] MUSIC HISTORY study*]



[*figure 13_ [3D] MUSIC HISTORY study*]

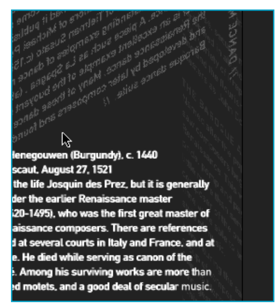


[*figure 14_ [3D] MUSIC HISTORY study*]



[*figure 15_ [3D] MUSIC HISTORY study*]

[*figure 16_ [3D] MUSIC HISTORY study*]



[*figure 17_ [3D] MUSIC HISTORY study*]

The investigation *[3D] MUSIC HISTORY* illustrates the manner in which users encounter and interact with directional landmarks in the physical world. The act of changing direction based on recognition of a single event or object in one's environment is represented in this investigation through the physical act of users rotating the digital environment before them, in order to access the information existing beyond their current position…

…Like making a left turn at a traffic light or street sign.

DIRECT EXPERIENCE + PATH

Kevin Lynch defines path as encompassing the entire sensory experience between origin and destination (Lynch, 49 - 62). In order to chart or trace the path visually, there must be representation of these sensory experiences. This includes the encounter of landmarks and nodes of activity along the way. How can experience be depicted on the computer screen?

The concept of direct experience allows a user to interact with the computer in ways similar to encounters in the real world. Direct experience, as applied to digital media, is the ability of a system to respond visually, aurally, and kinetically to the user's actions, thus immersing users in the physicality of information being presented.

A direct experience in a spatial environment is one that requires users to identify their point of view or perspective within surroundings. This enables users to identify changes in direction and orientation, establishing wayfinding abilities. Users must recognize key events in the environment by which to orient themselves and manipulate directions of path. This is the ability to distinguish landmarks from the blur of moving through and environment, thus identifying the path experiences that exist between landmarks.

In the virtual world, this mode of digital experience requires both exploration and commitment on behalf of the user in order for all the information to be revealed. Without these, the user may overlook an important event, or miss a section of data altogether.

As an investigation of visualizing the direct experience of a path, a simple, everyday task was selected and documented; going to the grocery store in preparation of a dinner party. A path never exists without first establishing a goal at the end of a journey. This requires the iden-

[*figure 18_ Destination book, front cover*]

[*figure 19_ Destination study, point of origin*]

[*figure 20_ Destination study, path: initial stage*]

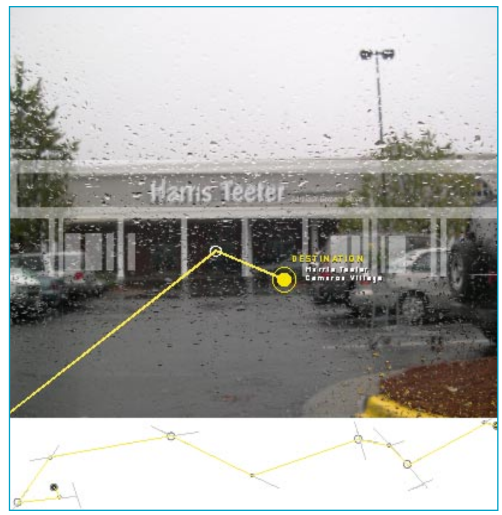
tification of both origin and destination nodes, though the destination can be nonspecific, as long as it exist in a general location other than that of the origin. In the study *Destination* [*fig. 18 - 24*], the point of departure was a townhouse, and the point of origin was a neighborhood grocery store. A means of movement must be identified [in this case: an automobile], as well as a set of familiar landmarks by which to navigate the space existing between origin and destination. These familiar points are fixed in location and are notably distinct from one another. They act as the landmarks by which the travelers orient and update their current position. These landmarks also serve as beacons for determining directions shifts when the travelers encounter a node at an intersection of multiple choices.

The travelers, in this case, identify approaching landmarks prior to coming in contact with them through a process of searching for forms that match the known landmarks along that path. This familiarity comes from prior experience on that path. The more times a single path is traversed, the fewer new decisions must be made upon returning to it. In the case of this study, the landmarks are architectural structures, each with distinct characteristics that set it apart from its surroundings. Because of their permanence in this environment, each landmark allows users to base the next step of the journey on the relationship existing

[*figure 21_ Destination study, landmark encounter series 2*]

[*figure 22_ Destination study, landmark encounter series 2*]

[*figure 23_ Destination study, landmark encounter series 2*]



[*figure 24_ Destination study, final destination*]

between two sequential landmarks. However, it is the common experiences of encountering those landmarks that creates the sense of familiarity in the user/traveler. Users know what the next stage is because of their previous experiences with a permanent landmark.

The representation of these permanent, physical landmarks is primarily centered around the architectural aesthetic of each individually. This is accomplished by isolating and exploiting a single structural attribute of each landmark that sets it apart form the immediate surroundings. This is in direct correlation to the nature of a natural landmark as defined by Kevin Lynch, where an object is isolated from its environment based on a distinct physical characteristic. The landmarks in this study were characterized in the same fashion: the marble facade of Brooks Hall; the muraled side of Mission Valley Theatre; the monolithic shape of the NC State Belltower [*fig. 21 - 23*].

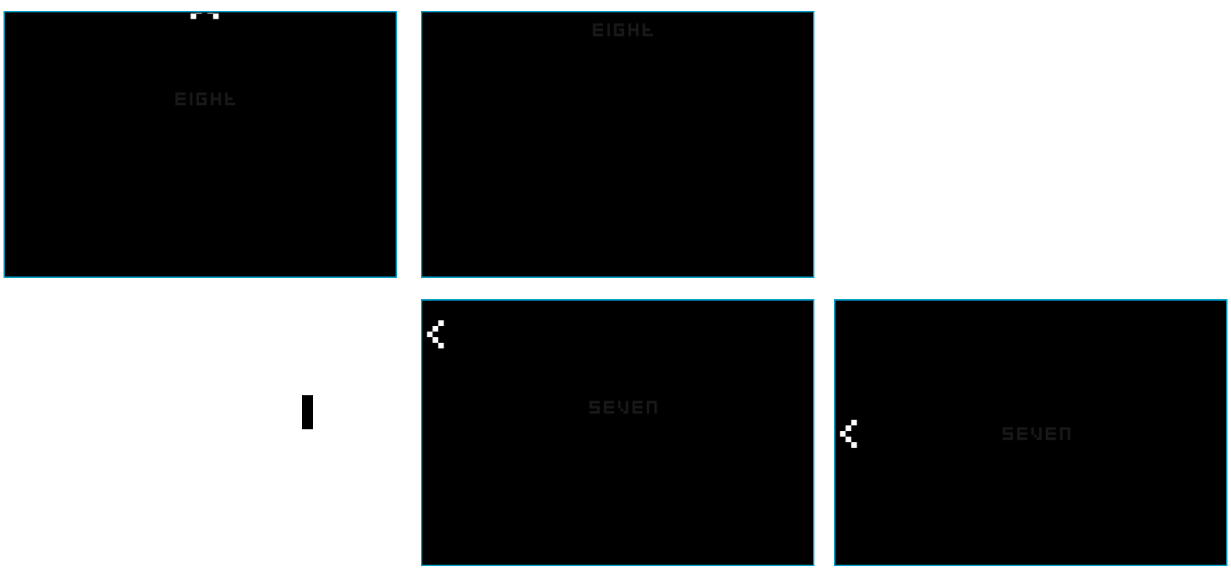
TIME + SIMULATED SPACE

If there is a temporal quality to the direct experience of a physical space, then a virtual space must also incorporate the passage of time as part of the interactive space. However, the digital world gives the ability to both user and designer to modulate time within that virtual space. It is possible to create the impression of space based almost entirely on the manipulation of time as an element of multimedia design. In the study entitled *Temporal Space* [*fig. 25-27*] space is described by the durations of time in which the screen is left black and nothing appears to happen. This is followed by a rapid move of a typographic countdown onto the viewable frame. At each step in which text signifying a number appears, movement is halted, until the user clicks on an arrow, pointing in a seemingly new direction. Upon clicking this arrow, the user experiences another expanse of blank screen followed by the next sequential number moving rapidly from the direction defined by the previous arrow. This process of quick movements on screen, balanced with long moments of no action and no response work together to simulate a sense of a large space. The longer the break between each stage, and the faster the movement of the following character upon appearance, the greater the distance the user feels has been traversed. This simple interaction of user with computer and the deliberate use of time simulate a temporal/spatial experience. Even without representation of typical spatial cues, through the temporal shifts from one action/response to the next, the user understands the experience as a spatial relationship. He maps direction, basing orientation on the sequence of encounters and the duration between those points.

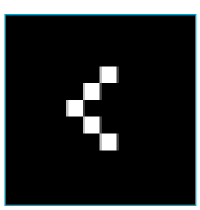
[*figure 25_ Temporal Space, countdown sequence*]

In the cognitive mapping of such a space, one devoid of any spatial cues representing the physical world, the user's mind changes direction to correlate with the appearance of the numbers.

The users' curiosity gives light to their desire to explore the environment in order to answer the question: "What is at the end of the road?" The minimal response from the interface, paired with the appearance that the user is moving great distances through a nebulous universe, feeds the exploration, though never entirely giving a clear answer. The lack of spatial clarity in this interface causes the users to build their own understanding of the environment, which defaults to a spatial understanding applied to the real world, in which the users understand the concept of time as it relates to motion and distance.



[*figure 26_ Temporal Space, countdown sequence*]



[*figure 27_ Temporal Space, directional / spatial cue*]

SIMULATION OF THE PHYSICAL

When placed in the city metaphor, as in Kevin Lynch's work, the acts of searching and browsing retain the characteristics of their digital counterparts. The act of searching within the setting of a physical city, requires a prior knowledge of at least a single node of information, or the knowledge that a particular landmark does exist within a specific district. Both in the virtual and physical worlds, searching requires the specific input of users in response to their familiarity to the current environment. Contrary to this, browsing in a city can be maintained with little understanding of the city's structure as a whole, and with little or no prior knowledge of the components therein. However, the act of browsing allows users to interact and experience far more of the city than the act of searching. Where searching is detailed and deliberate, browsing maintains its curious and explorative nature, leading users into the unfamiliar nodes and districts of the inner city.

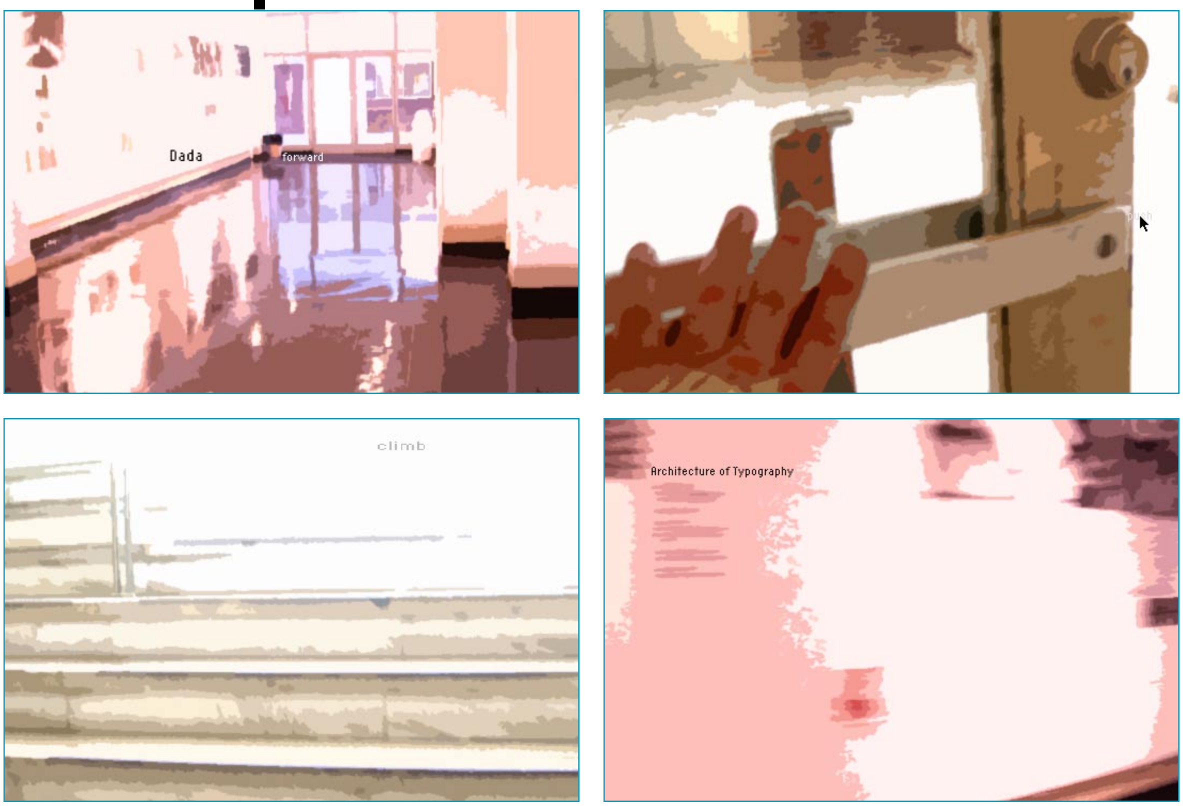
Martin Dodge, in his essay, *Mapping the World Wide Web* (***Preferred Placement: Knowledge + Politics on the WWW.*** **Rogers 2000**), distinguishes between these actions of browsing and searching in web use. Dodge defines two classifications of information existing online as being [1] Communication based, animated data: chat environments, email, Usernet, message boards, and virtual world communities; [2] Inanimate information resources, primarily accessible through web browsers: web pages, achieves, images, and databases (**Dodge. 81-95**).

Browsing is defined as an explorative activity, usually with no planning or specific goals, which rarely yield useful results except by chance. This activity is currently supported by two forms of web interaction: (hyper)links and directories, both of which can be confusing and unproductive. (Hyper)links may lead to information that is barely relevant to the previous page, while directories are primarily organized by human judgment. Both of these result in difficulty in navigation, as well as a lack of understanding how one body of information relates to another.

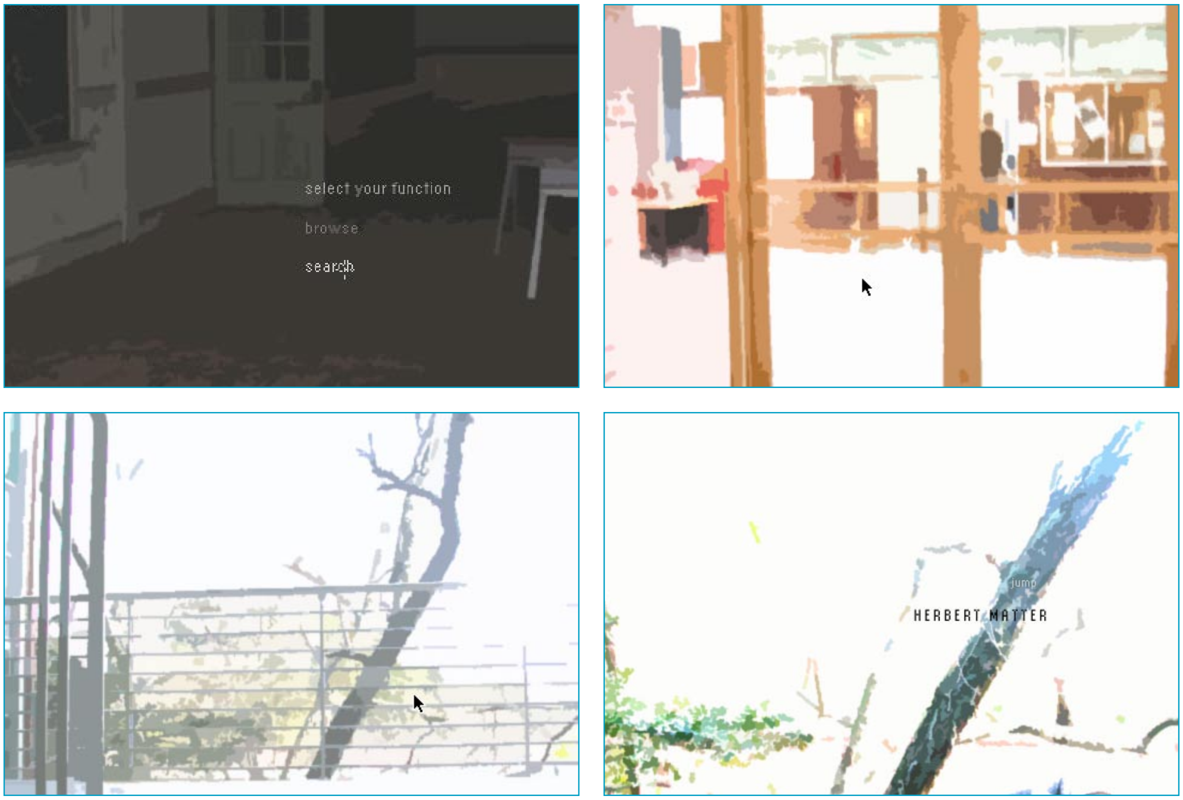
[*figure 28_ Search vs Browse, intro*]

Searching is an action performed with a specific intent and/or direction. Users generally come to new information with some prior knowledge of what they are looking for and how they might access it. However, new information is accessed through the same routes as data found through browsing.

At the start of the study entitled *Search vs. Browse*, users are confronted by a decision in the first room and must choose **Search** or **Browse** in order to continue on [*fig. 28*]. If users select browse, they are able to move slowly through all of the remaining rooms at their leisure, accessing a variety of information through each new space. The users may even exit the space and re-enter as they see fit.



[*figure 29_ Search vs Browse, browse function*]



[*figure 30_ Search vs Browse,search function*]

If the original selection is of the **Search** option, users are prompted to choose a single topic from the list of the whole, then are rapidly transported to that specific space, bypassing all rooms (and information) along the way.

In the **Browse** function, there is an endless amount of time for users to move freely through the space, exploring and encountering as much or as little of the space as they choose. Time is parallel to experiences in the physical world, similar to that of walking through a real world gallery or museum. The action of walking in this virtual space is a 1:1 metaphor of walking in a physical space. The use of a mouse to navigate reflects navigation in the physical world.

By selecting the **Search** function to locate a single topic, users are shuttled through the remainder of the space without the ability to halt time, stop or explore. Time has not changed, but the task itself has been abbreviated. **Browsing** allows for exploration with little determination of a destination, whereas **Searching** determines a finite destination and limits the amount of information the users confront. The search creates a limited, deliberate path to specific content, minimizing the experience of the elements along the way. Users move quickly from one landmark to the next, never stepping off the predetermined path, never allowing for new paths to be formed. Browsing encourages the users to explore new paths and step into the labyrinth, providing a much more complete and meaningful experience, whereas a search limits users to a brief encounter of small sections of the labyrinth. Because of the more detailed nature of searching, then, users are unable to define their location within the macrocosm, having only experienced the smaller internal nodes within a district.

As a literal interpretation of movement through space in the physical world, the study *Search vs Browse* [*fig. 28 - 30*] examines the application of function and information to virtual space. In a virtual representation of a physical room, complete with doorways leading to connecting halls and other rooms, the environment is immediately familiar, and the user knows how to interact and move through the space. The user instinctively looks to the door as a means of exiting the current space, expecting another new room. Likewise, he expects to find new content on the other side of that door.

These are examples of landmark encounters in a 1 : 1 relationship in which the digital environment is a replication of the physical world in most ways. If a system is designed as a 1:1 correlation with the physical world, using literal images of physical spaces as a basis for the digital environment, there can be misconceptions on the part of the user, arising from prior experiences in the real world. In order to design a 1:1 system, the environment must agree with the content and information found within it. That is, a system such as this must match content with the physical space represented.

> [example]
>
> In the case of Search vs Browse, if the environment was a clear representation of an art gallery or museum, users could gain faster understanding as to what type of content they might encounter in that space.

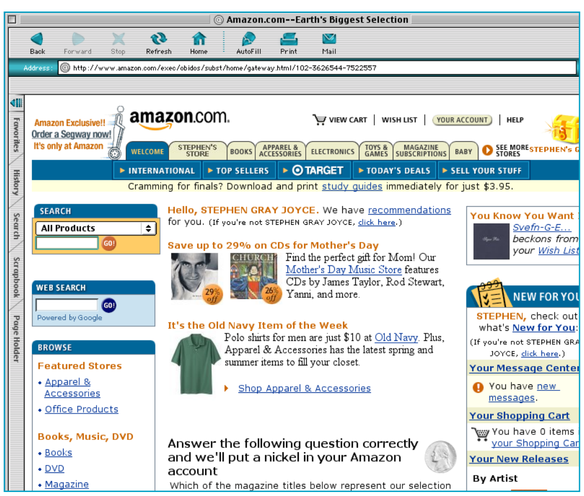
Though, the *Search vs Browse* study does not accomplish much in the way of creating a new spatial system within the digital world, it does examine how space can provide meaning and functionality to that experience.

MAPPING RELATIONS

In designing any system or digital catalog of information, it is imperative that users understand the structure of information in the digital environment. Therefore, when designing for the world wide web, one must consider how information lives on the web. Obvious districts and landmarks can be identified, as well as secondary levels of information and points of interaction. The nature of the web and current web use frequently moves users across the edges of those districts, jumping from one web page to another, one server to another, and at the same time making large cognitive leaps between subjects by way of a hyperlink, with little or no explanation of why the move is made. There are few references as to how these millions of bits of data relate to one another, aside from a highlighted common word used as a link.

In a spatial metaphor, these connections must be made clear through the construction of and user interaction with the system. Relationships between all levels of digital information must be investigated. Amazon.com serves as a familiar example of a complex online system, capable of moving users through multiple districts of data, as well as linking to outside systems. By mapping the components of amazon.com, relationships can be traced as they reconfigure at every level and provide multiple points of entry and categorization [*fig. 34 - 35*].

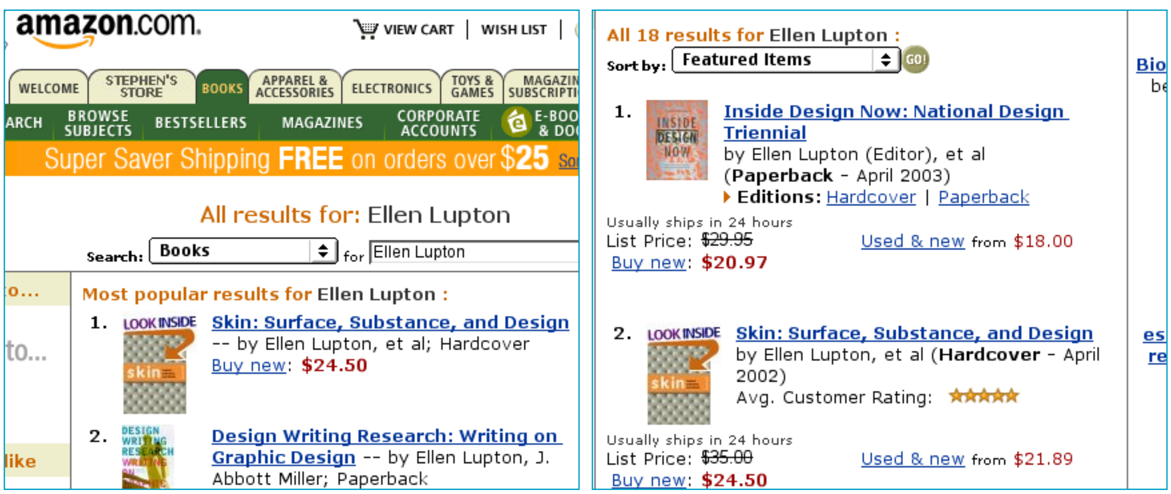
As users move through the amazon.com system from the welcome page, searching for a specific author in the 'Books' section, they encounter a number of landmarks. These include the tabs at the top of the page leading to specialized departments in the system, the categorized search function, and personalized purchasing information [shopping cart + wishlist]. Engaging any of these primary level landmarks moves the user into a specialized district. By searching for author 'Ellen Lupton' under the 'Books,' the system responds with a new dis-



[*figure 31_ amazon.com, welcome page*]

[*figure 32_ amazon.com, 'books' search*] trict comprised of individual nodes representing books written by, or having to do with that author. Each of these nodes can be entered, launching even more specific information concerning an individual book. At all of these information levels, users may reorient themselves by re-engaging the primary landmarks found on the welcome page. Though user positions have shifted in relation to the system, the repetition of these landmarks creates a sense of place, allowing users to track and retrace their path. At the same time, the site constantly updates landmarks to encourage exploration within the system. These new landmarks allow a single user to access information left behind by previous users, leave information of his own, or move outside of the amazon.com system to partnering systems, such as borders.com and target.com.

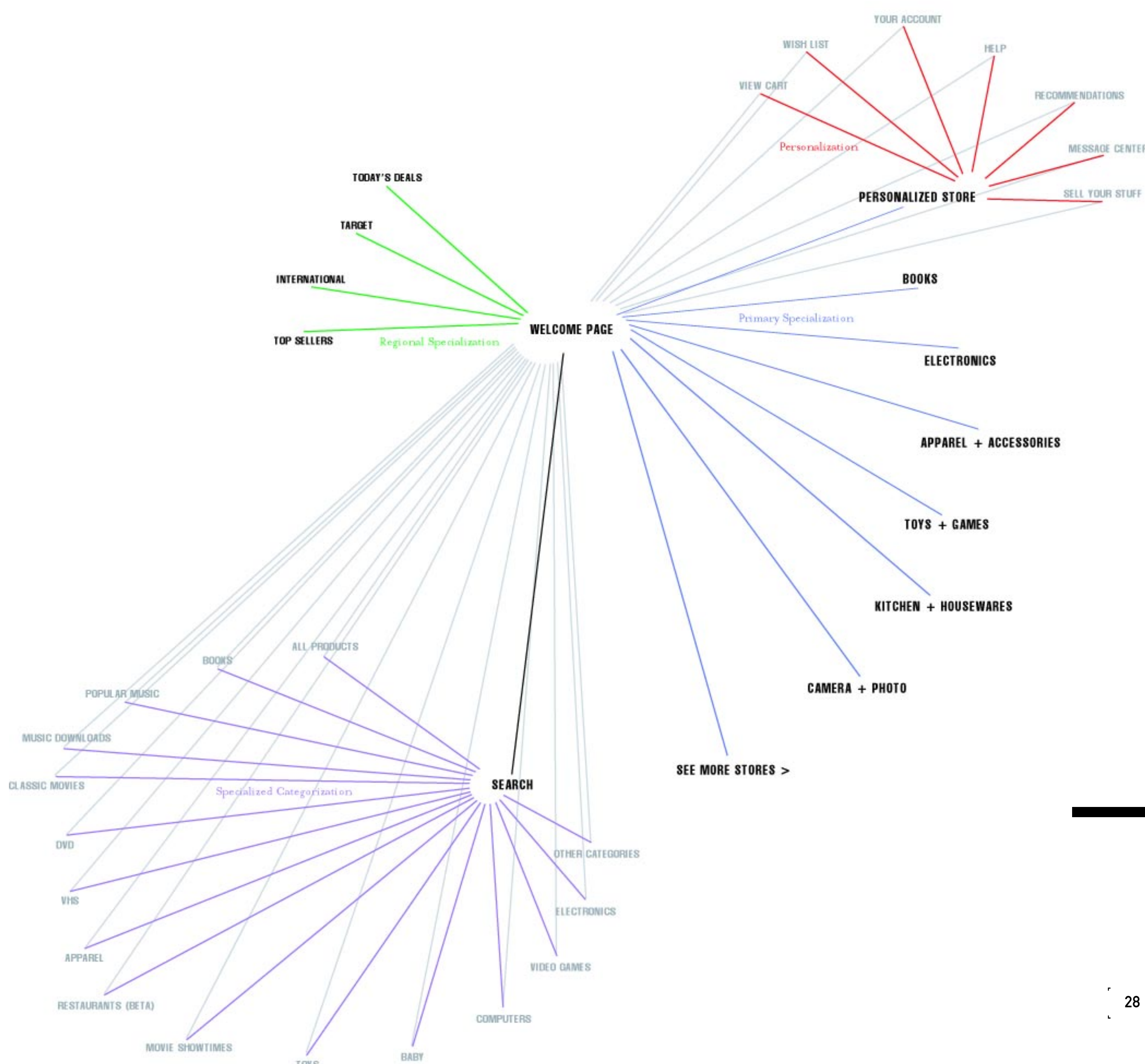
Amazon.com is not a spatial system, but is based on sections and subsections; an intricate set of categorical rules applied to a large body of information that is constantly in a state of flux. However, conceptually speaking, Lynch's terminology does serve as an applicable metaphor for organizing the same content and information. One primary shortcoming of the existing amazon.com structure, in spatial terms, is the inability to leave the system and re-enter from that same exit point. The current structure forces the users to enter the system form the same point with every returning experience.



[*figure 33_ amazon.com, 'Ellen Lupton' search results*]

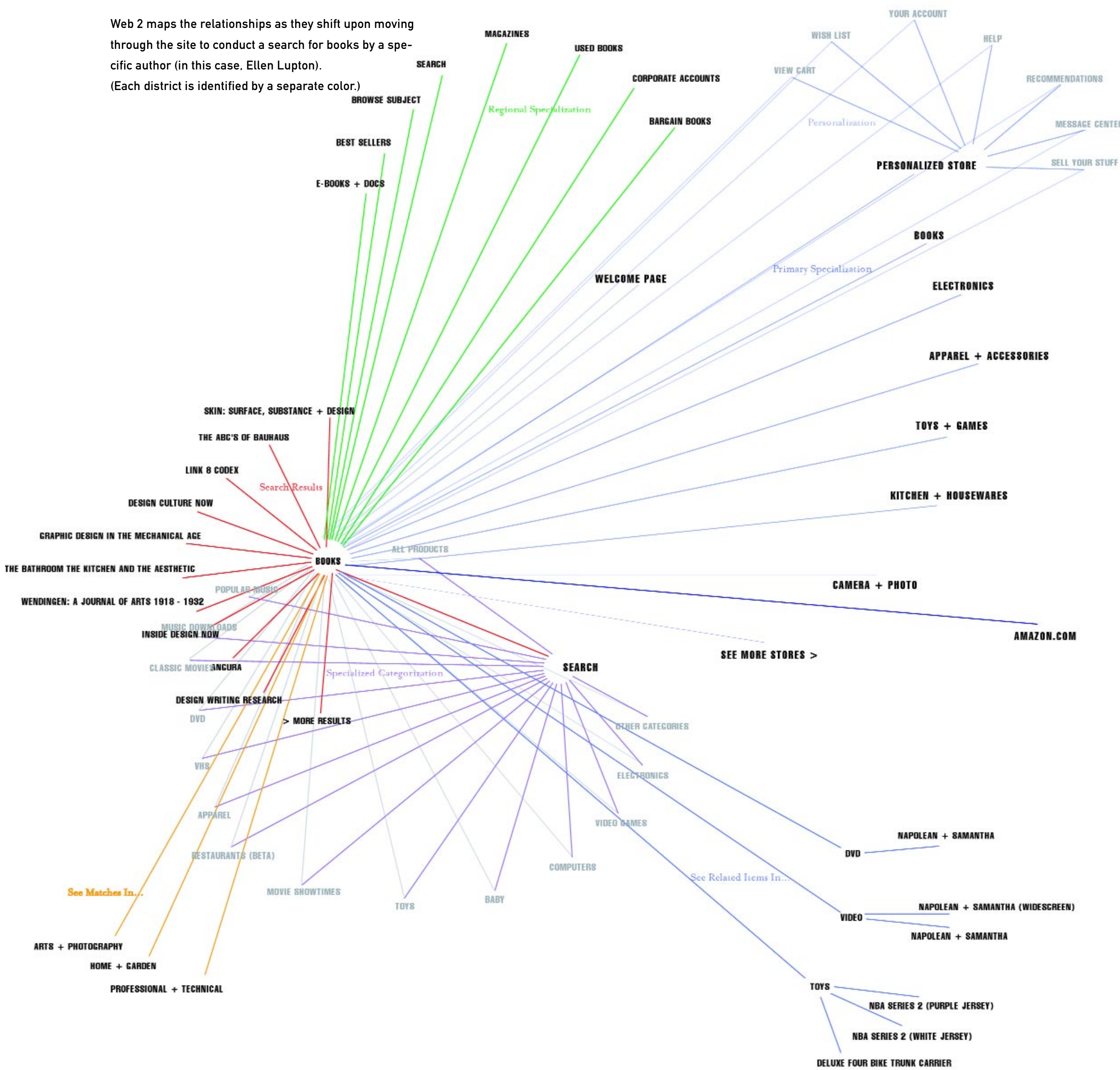
[*figure 34_ system mapping: amazon.com*]

This web maps the relationships between the primary districts within amazon.com as they are accessible upon entering the welcome page.
(Each district is identified by a separate color.)



[*figure 35_ system mapping: amazon.com*]

Web 2 maps the relationships as they shift upon moving through the site to conduct a search for books by a specific author (in this case, Ellen Lupton).
(Each district is identified by a separate color.)

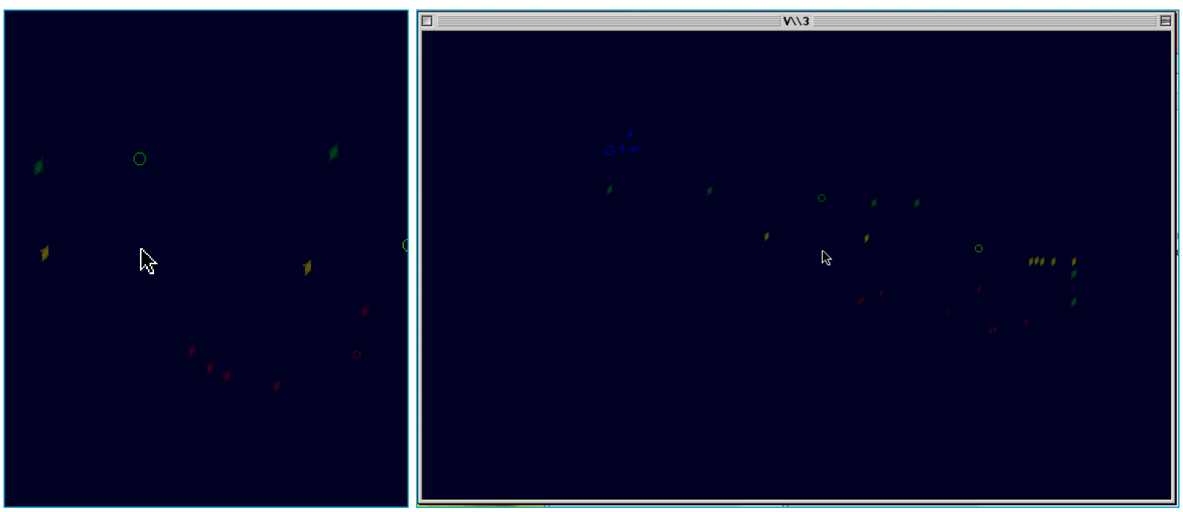


ORBITAL SYSTEMS

After examining how Lynch's concepts can be applied to an existing, non-spatial system, the task is to create a new system based on these principles.

In an effort to design a spatial system from the ground up, a catalog of information was selected that allowed for many of the same relationships to exist as were found in the dissection of amazon.com. This catalog of data comes from Ellen Lupton's History of Graphic Design timeline found in *Graphic Design in America* (Friedman and Heller, __ - __). This body of information allows for many separate relationships to be drawn, as well as multiple points of entry to and from other sources of information.

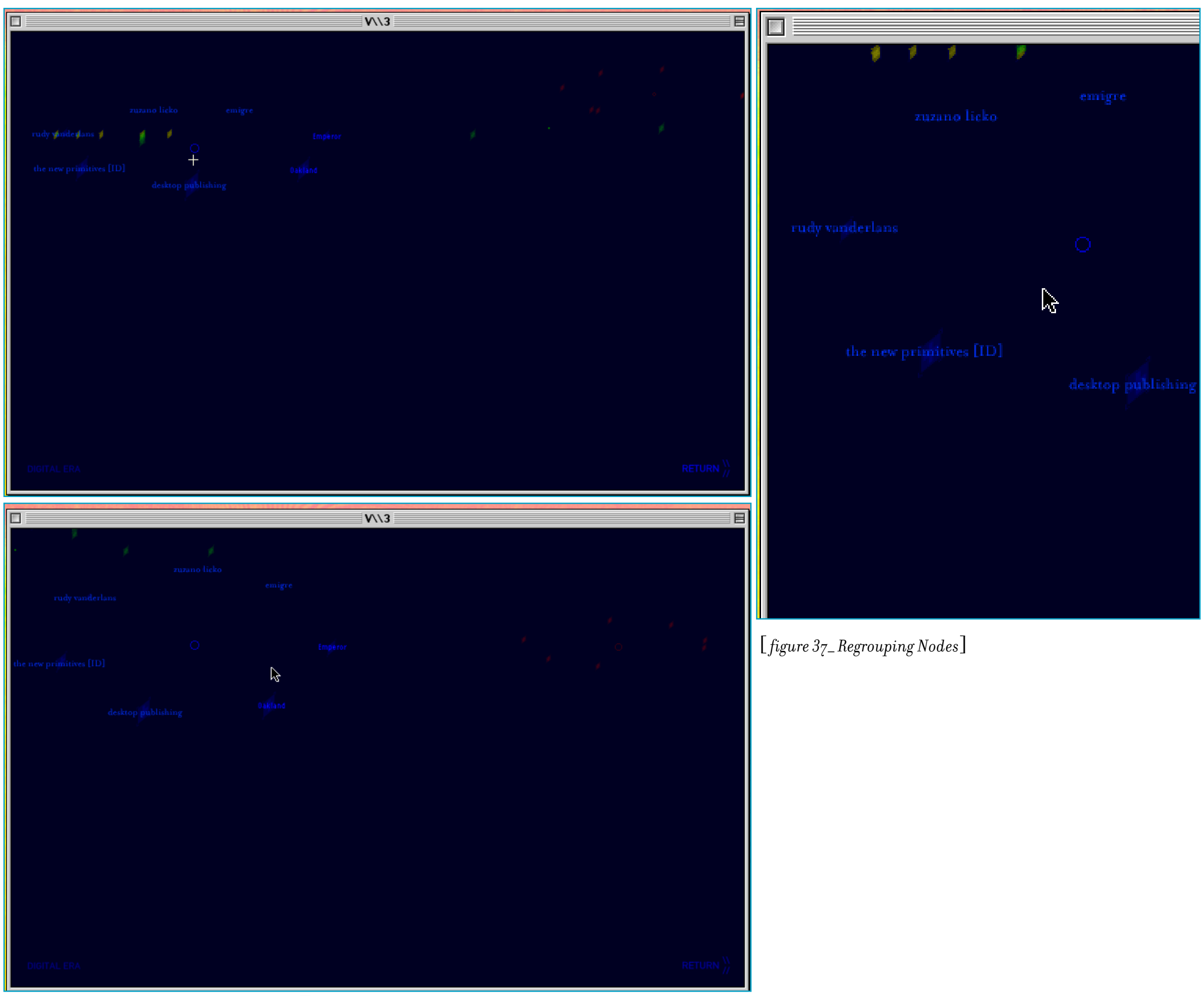
In order to reconfigure the historical data from the structure of a chronology, it is necessary to create a new purposes for its use. If multiple modes of organization are available, such as temporal, qualitative, and quantitative, then an intermediate stage is also required in which the users choose and enter specific structures. Visualizing this structures as orbitals seems appropriate. Multiple objects orbiting together in nebulous space appear linked because of their common movement and constructed arc or orbit. Individual orbitals can exhibit differing speeds to separate themselves from each other and at the same time a sense of unity through the shape. Likewise, closely related objects move at similar rates and in clusters.



[*figure 36_ orbital nodes*]

The ability of these orbitals to function as districts and simultaneously as nodes within the whole, enables the system to reconfigure itself. These new configurations are based on the user's point of entry via a set of primary landmarks: Design Theories & Movements; Individual Designers; MassMedia & Publication; and the Chronology (of events and design practitioners).

Once a mode of primary organization is chosen, individual nodes regroup based on their respective content (re- their definition of district). These new groups cluster in response to the landmark through which the users entered the secondary level. At this level the orbitals are frozen in place until activated by interaction with a new landmark, or an individual node. When a single node is encountered, the remaining nodes activate and modulate in orbit and position in response to the now central node, transforming that node into a landmark re-orienting all other information. These regrouping nodes allow users the ability to constantly re-distribute the data throughout the space, forming new relationships within a fixed set of objects. This state of flux increases users' understanding of each components in the system and its varying relationships with every other component.



[*figure 37_ Regrouping Nodes*]

[section 4] _Spatial Design

CONTENT + AESTHETICS

In designing a spatial system, many of the required relationships must respond to the structure of the content. However, the meaning of content itself must remain fairly arbitrary to the design of the system. It must provide a hierarchy, one with distinguishable categories (districts), sub-categories (landmarks), and specific information (nodes) residing in these sub-categories. It is then the responsibility of the system design to visualize relationships among these components (path). For the final project *Design History* [*fig. 38 - 45*], content is carried over from an earlier study (Ellen Lupton's History of Graphic Design timeline from *Graphic Design in America*).

The visual quality of this spatial system must serve as a clear reflection of its content and structure, but allow for connections to be information outside the system. If on the web, the design must allow for users to enter and leave from new sources of information while understanding their position in relation to all systems, internal and external. However as seen in the *Search vs Browse* study [*fig. 28 - 30*], if an environment is designed in a 1:1 representation of the physical world, the understanding of information is limited by the content of that environment; that is to say, the content cannot be placed in an arbitrary or unrelated space. In a system designed to be navigated through a series of landmarks, districts, edges and paths, the characteristics of those elements must reflect the information within them.

This relationship, both visual and conceptual, must maintain a strong enough tie to the content structure so that users are able to move outside of the system and re-enter with ample understanding of both their exit location and their new point of re-entry. Therefore, the visualization of large ideas must be designed in a manner that is reflective of the inner workings of the same system, as well as decipherable when the user leaves the system for the expansive context of the web.

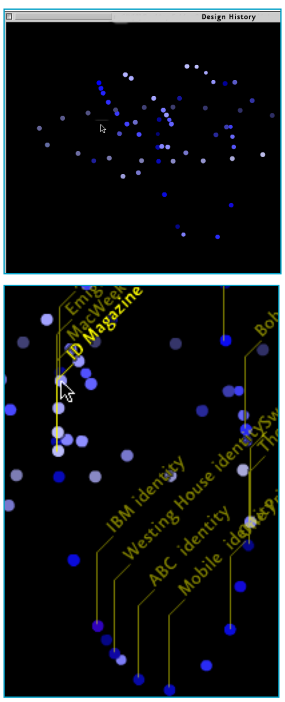
[example]

[-] linking of [E. Lupton Timeline] Spatial System to amazon.com results page for Ellen Lupton search

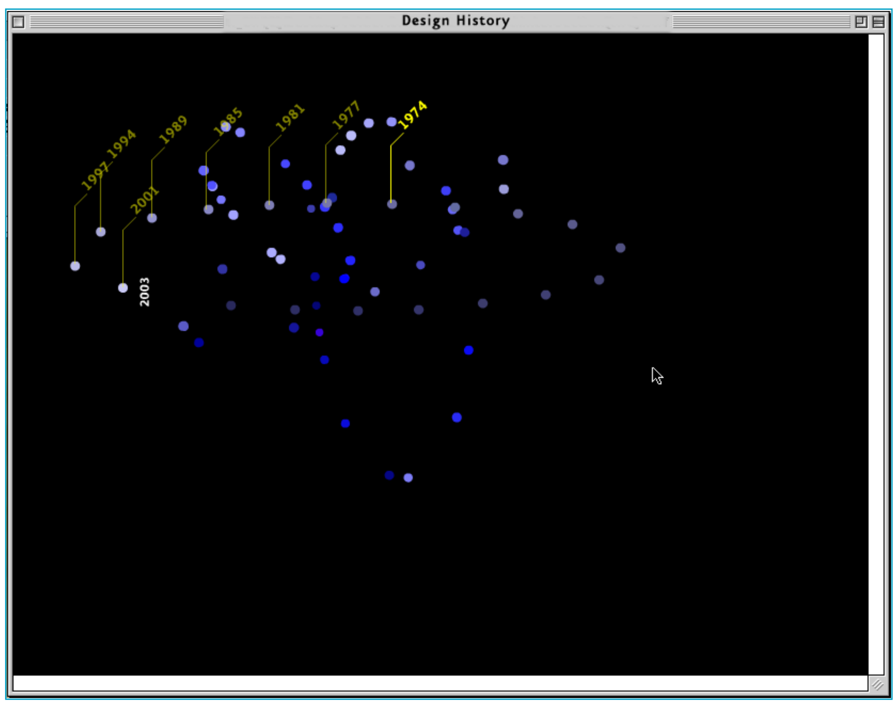
[-] linking of Zuzano Licko, Rudy Vanderlans, Emigre info pages to emigre.com

STRUCTURE + FUNCTION

The structure of this information system is rooted in concepts explored in earlier orbital studies. As users enter virtual space in *Design History*, they confront a multitude of orbiting dots, in a nebulous void. The quantity of dots in these orbits represent the amount of information nested within the system. Each orbit intersects, the other orbits at a common point. At this introductory level, orbits are seemingly indistinguishable to one another in content, but upon cursor rollover, the orbit pauses and nodes are identified as specific information. The shape and speed of each orbit distinguishes it from the others. Each orbit functions as an individual district of information, and is located on its own plane in space. The speed, shape, and planer location of each district serves to identify each one as an event or landmark with which users can navigate the sea of information nodes. These four landmarks represent the initial districts into which the information can be organized: *Designer*, *Movement / Theory*, *Chronology*, and *MassMedia / Publication* [*fig. 38*]. As users engage a single node (single click) within a district, nodes in the three remaining orbits rotate around to the point of intersection based on their relationship to the engaged node's content. This reflects the direct experience of encountering a landmark in the physical world, where the temporal nature of the experience is responsive to users. This draws relationships among the individual nodes, based on their proximity to one another, as well as by the distance of their position from a chosen node in the district.



[*figure 38_ Design History, MassMedia/Publication district*]



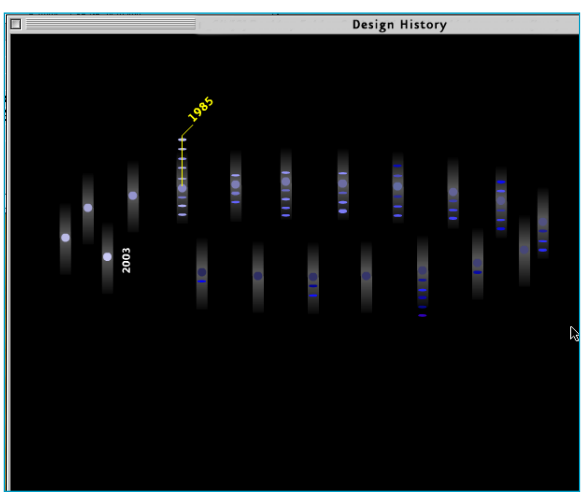
[*figure 39_ Design History, Chronology District*]

As users encounter the *Chronology* district at the primary level, for example, the other nodes re-locate themselves, which rotates correlating nodes around to the point where all four districts intersect [*fig. 40*]. Upon entering into the *Chronology* district, the three remaining districts collapse into the *Chronology* orbit, and are organized on vertical planes which intersect each original *Chronology* node. As users move through dates, the nodes track to new positions as they correspond in time. Users are able to view an exploded view of the nodes along the vertical plane, allowing access to detailed information. It is within the exploded view that users encounter nodes of information that spawn gateways to outside systems.

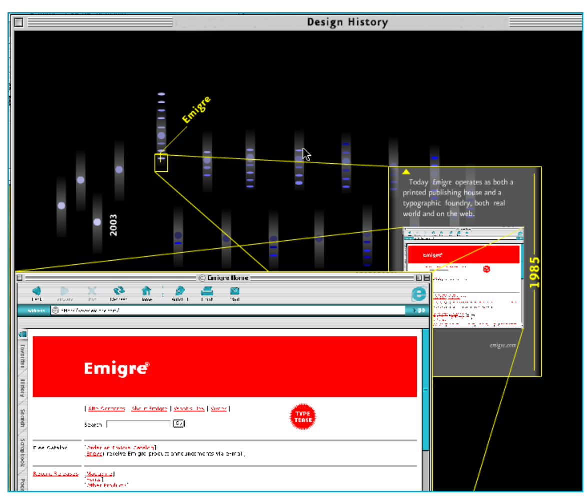
Upon stepping back out to the primary level and moving the cursor within the *MassMedia / Publication* or the *Designer* orbits, users' clicking within that district edge causes a reaction in all the nodes, which culminates in the nodes of outside districts re-aligning around a those inside the district. The re-organization of nodes within the *MassMedia / Publication* or the *Designer* districts is a vertical orientation in chronological order, and positioned in respect to the chronology of each designer. The remaining nodes, consisting of artifacts, clients, technological innovations, and ideological movements, are disbursed over the new vertical plane based on their place in the history of each designer. The stacking of nodes in this manner allows for certain information nodes to be present over several designers' groupings, such as nodes where information regarding design movements and theories as well as dates.

[example]

In order to draw a connection from designer Lou Dorfman to Herb Lubalin, a user must establish a path traveling through nodes for the New York Times, for which both designed ads, as well as through the Black Markets node, as both designers' ads were in support of commercial advertising geared toward black markets.



[*figure 40_ Chronology district, nodes regroup into linear progressions based on content chronology.*]



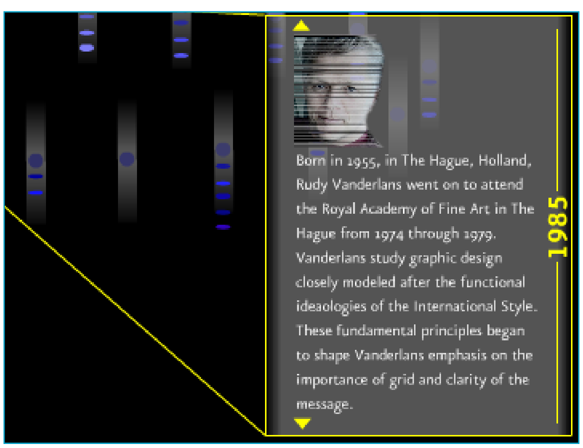
[*figure 41_ Chronology district, exploded view: Emigre with gateway to emigre.com.*]

The structure of *Design History* forces users to navigate information by way of landmarks and districts presented at the primary level. From the start,the system bombards users with information, an overload of choices. If a single node is entered at this initial level, users are only able to access that specific information, bypassing the relationships of that data with the remainder of the system. This is representative of a search function on the web, requiring users to come to the system with some prior knowledge and a specific destination already in mind. By engaging the landmarks, users move into secondary levels of information where nodes are reconfigured and given meaning through a new relative position.

As users progress through each subsequent level of information, each getting more specific as users travel deeper, new locations of high activity become apparent within each district. These re-grouped nodes appear in accordance to sub-level landmarks. In the *Chronology* district, the sub-level landmarks are formed from the specific years cited by Ellen Lupton as increments of time in the original timeline found in *Graphic Design in America* [*fig. 41*].

Upon entering a node located in any district, users are provided with detailed information pertaining to a single subject. While nodes are the smallest spatial elements in Lynch 's typology of form, in the virtual world a node may have multiple smaller nodes nested within it. A node located in one district may reappear inside another node in an entirely separate district. Here again, the affordances of the digital environment allow for elements to modulate in position as well as function, contrary to its counterpart in the physical world.

Once inside a single node, users encounter additional nodes and completely separate information environments existing beyond the edges of the *Design History* system. This enables users to move in and out of the system as a whole through gateway nodes, which in turn serve as perimeter landmarks for the entire environment. Within the *Rudy Vanderlans* node, users are able to move outside of the system to *emigre.com*, an independent system linked only by common subject matter (emigre.com is the online identity of Vanderlans' Emigre Magazine).



[*figure 42_ Design History; Rudy Vanderlans Information Node*]

[*figure 43_ emigre.com*]

[section 5] _Analysis / Reflection

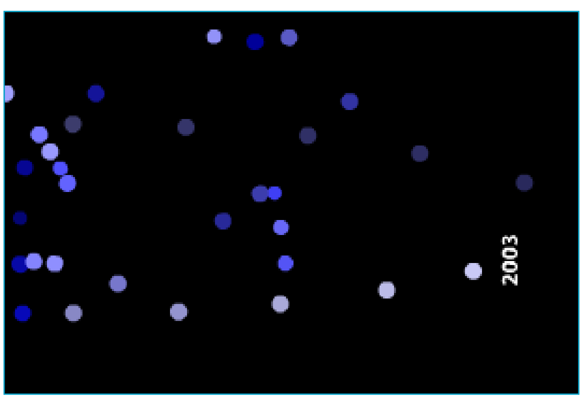
APPLIED THEORY

For a virtual information environment to reflect navigation principles found in the physical world, a system must incorporate a balance of user familiarity with a sense of placelessness and the unknown. It is within this balance that users in physical spaces establish the need for orientation and identity within their environment. The same concept carries over to virtual spaces, where, amidst complex bodies of digital information, users seek out key elements and move through that data. The physical counterparts of these key elements are defined by Kevin Lynch as districts, paths, edges, nodes, and landmarks.

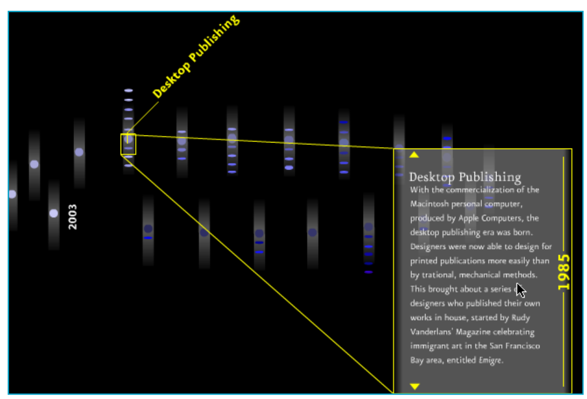
As seen in the analysis of amazon.com, users gravitate toward recognizable points in any interactive system. It is very easy to apply Kevin Lynch's terminology to such navigation of complex web environments. However, the fact that amazon.com maintains the accessibility of all of its primary landmarks throughout the site, breaks down the spatial metaphor users never feel that they have stepped beyond the surface level, and only swap initial information with new data.

It is clear that there must be a sense of moving closer to and away from primary level landmarks if a spatial metaphor is to be successful. Amazon.com does succeed in defining edges and districts within their virtual space. The separation of like items into categories helps to create an information district, which is set apart subtly from the others by updating information present in each sequential stage. The edges of these districts are loosely defined by a type of introductory page for each individual district, which provides users with generalized nodes relative to only that district.

This terminology, when applied to the design of a catalog of virtual information, allows users to establish patterns of data use parallel to those found in the physical world. The defining quality of a group of information serves as a landmark by which all members of the group can be categorized, and oriented. By establishing direction and orientation, digital



[*figure 44_ Design History, 2003 serves as a familiar landmark and point of entry for users into the timeline*]



[*figure 45_ Design History*]

landmarks act in the same manner as their physical counterparts. However, the digital landmark is able to take on a new life that is not possible in Lynch's physical world. This is the ability of the landmark to transform into a node of activity and information. A landmark can be used as a means of entering a district of information and simultaneously reorganizing that data based having been chosen by the user.

[example]

By engaging the Designer landmark in *Design History*, users move into a district where all content is organized based on its relationship to individual designers. Nodes representing specific projects, design movements, as well as clients and cultural events, are repositioned across a Cartesian grid, where their proximity to a landmark(s) determines the nature of its relationship to that designer.

In this same example, a reverse effect is apparent in the ability of digital elements as individual nodes representing designers begin to serve as landmarks which identify the relationships of all other nodes in a district.

SUCCESSES

In the system designed under this investigation, there are cues that promote the activation of spatial intelligences. These cues cause users to search out identifiable landmarks in order to define directions and gain a sense of orientation. The mutability of digital elements allows users to define the manner in which they encounter complex information, each with the ability to determine where paths begin, and through which landmarks they move. These transformations of landmarks to nodes and nodes into landmarks gives users a sense of control over how information is categorized, allowing a recognizable path through unfamiliar information to be formed by each user.

FAILURES

The largest hurdle in applying Lynch's language of form to the design and navigation of digital environments, comes down to the simple problem of mis-interpretation of visual representations. Without some additional clarification, it is difficult to determine the exact content of the experience depicted by a landmark. This boils down to a thorough investigation of semiotics, in both literal and cultural interpretation.

In order to reduce misinterpretations by users, the design must carefully consider the nature of the content, as well as its potential meanings. Any misrepresentation or mistaken identity made in navigational elements negates the purpose of a spatial system as a means for clarifying complex data and causes confusion and overwhelming disorientation in users.

The transition from inside the *Design History* system to an external, independent system such as *emigre.com*, is problematic in the visualization of user path. While the representation can be controlled as users move out of the spatial system, it is lost upon entering the emigre site. Users are then unable to retrace their paths in order to re-enter the *Design History* system. There is little ability to overcome this problem, short of embedding the external systems within the overarching structure of the spatial system.

[section 6] _Conclusions

CRITICAL MASS

Of primary importance in applying a spatial metaphor to navigation in any digital system is to activate on the spatial intelligence of all users. This is accomplished by providing users with stimuli that are recognizable and seemingly familiar and that create curiosity of the unknown. The establishment of clear path enables users to move through multiple levels of information in a sequence reflective of the content itself. Transitions at edges between districts inform users of shifts in content, organizational structures, and the dissemination of data existing within those districts. A clear representation of landmark ideas and concepts enables users to distinguish one district from another, as well as the content found within, thus maximizing users' ability to engage meaningful experiences within a system.

A complete spatial experience, whether in the physical or digital world, must encapsulate recognizable points of entry and exit, understood paths for users to travel, and multiple destinations from which to choose. The environment must be complex enough to create a sense of curiosity and engage the user. Areas that are initially unfamiliar and familiar alike must be accessible to users without confusion or disorientation. Finally, this environment must have fixed points of reference by which users can determine direction and establish their own orientations to existing elements within.

"At every instant, there is more than the eye can see, more than the ear can hear, a setting or a view waiting to be explored."

(Lynch, 1)

[section 7] _Projections

The next stage in the development of a spatial system based on Kevin Lynch's terminology, is to create a series of individual systems which can function independently on the web. These systems, similar to the one presented in the study entitled *Design History*, will be linked by a set of common characteristics acting as landmarks, as well as gateways. These macro– level gateways would convey the relationship of one system to the others, and act as highways between the many virtual cities of information.

This is an effort to take Lynch's study to the next level. While Lynch focused on the use of the city as a whole, the next goal in this application of his theory will be to examine how the city functions in a group of cities; to determine the relationship between multiple cities within a common countryside. In this expansion, other elements of the physical world will be considered beyond the study conducted by Lynch, including larger scale elements which serve as natural edges in the physical world, i.e. mountain chains and oceans. How might these "naturally occurring" elements coincide with designed elements in the larger scale of the landscape and how do these relationships translate as a metaphor in the virtual informationscape?

In these larger scale relationships, users gain the understanding of the world as the macrocosm, not just the environment existing within the walls of the city. It is the same understanding that can be gained by users of the world wide web as a whole, without limiting the metaphor to a single system or subject. It would be the hope of this expanded study to maximize the potential of the web as a medium for communication, allowing a better understanding of both web structure and its contents to users.

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