Information/Knowledge Design in Contextual Hypermedia Systems

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Abstract

"Our responses to the environment ... are determined not so much by
the direct effect of external stimuli on our biological system but rather
by our past experience, our expectations, our purposes, and the individual
symbolic interpretation of our perceptual experience."
[Capra, 1982, The Turning Point, p. 295]

As we begin to comprehend the ways we interact with the data/information/knowledge structures which construct our individual perception of reality, we see a shift from the dyadic Cartesian method of reading our environment, to a triadic, or Systems View, which accounts for individual perceptual readings and individual realities. This shift in thinking relates that we are dynamic, self-organizing, complex systems which form an individual perception of our environment based on the relationships we identify between ourselves and the interrelated systems of data/information around us.

Recognizing this shift, the research project associated with this thesis, utilizes interactive digital multimedia, or hypermedia, in the design of a set of tools with which to identify and illustrate these interrelated systems. It is the author's belief that once identified, these dynamic relationships will provide an ideal source of user-defined navigation of the group of interrelated objects.

The dynamic qualities of hypermedia, which provide the author different modes of linking information of many different data types to one another, making it an ideal venue for the illustration and navigation of systemic relationships. Employing two and three dimensional methods of visual and spatial representation, integrated within various combinations of graphic organizational models, the product of this thesis will provide the user an information-rich environment in which to identify and navigate the associative relationships found amongst a group of physical objects, in this case furniture of modern design.

The thesis also looks ahead to speculate on the impact of emerging technologies such as Augmented Reality, Virtual Reality, and Tangible User Interfaces, on the design of information/knowledge "spaces". The author will propose a future implementation of these technologies in relation to the current subject of illustration.

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This thesis focuses on a digital interactive media, or hypermedia, as a tool utilized in the design and development of information /knowledge structures. It notes the shift in thinking within the Cartesian paradigm to an integrated Systems View, as a vehicle for the development of hypermedia structures which contexualize the user within the information space.

The research project associated with this thesis explores these issues through the implementation of a systemic structure of the navigation of information. This structure looks to utilize the contextual relationships identified between objects as a method of illustrating the richness of the individual object and navigating a the group it belongs to.

As a basis for this exploration, this thesis will examine various origins of interactive technology, illustrating this shift in thinking from a static linear structure to a more systemic associative, non-sequential mode of information/knowledge navigation. Through these source examinations and views into emerging technologies, it will be possible to offer conjecture as to new directions in which these digital technologies could be utilized in relation to the research project.

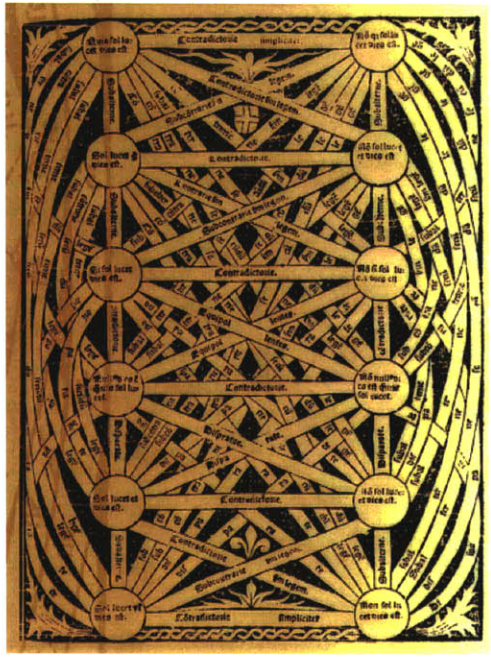

fig. 1.a systemic diagram illustrating a complex web of interconnections.

-Thanks to William Mitchell for his keen yet subtly guiding hand in the shaping of this thesis, his ability to cut to the quick and see through the haze.

-Thanks to Jim Goodlett for his guidance, support, lashings, and friendship, access to his physical and virtual collections of data, information, and knowledge. Let's try and watch the speedometer, shall we?

-Thanks to William Porter for his perspective during the formation of this thesis, and as the placemaker of my first year here at MIT.

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augmented reality technology -Display system using transparent glasses or heads-up displays on which information can be layered onto the user's visual environment. This allows the user to view data such as maps and alphanumerics as images superimposed upon his "real world" view. Applications of such systems include engineering, security, navigation, and medicine.

collage -The act of relating different elements of different media and meaning, which when viewed as a whole, constructs an illustration which is both representative of the sum of the individual elements, and a new idea as well. Collage can refer to many methods of execution including two and three-dimensional representations of homogeneous and mixed visually based media, sequential arrangements of unrelated film clips (called montage), architectural styles (many gothic cathedrals are considered collages of different styles and ideas, built up over the time of their construction), or even narrative text.

dataglove/datasuit -Developed by Thomas Zimmerman and Jaron Lanier of Visual Programming Languages, the dataglove and datasuit are wearable interface devices which incorporate highly sensitive tracking systems to translate body movements into digital input, used to navigate digital information systems.

dyadic experience - A component of the Cartesian paradigm in which the user reads an event only in relation to a universal truth, rather than and individual perception of reality based on individual experience. THIS means THIS. Saw decline in relation to the Systems paradigm's concept of a triadic, or perception-based experience.

happening -Art form emerging worldwide in the 1960's which was purely dependent on the interactive participation of the attending audience. Completely improvisational, artist who "organized" happenings saw the spontaneity of the viewer as a medium to be explored.

hypertext/hypermedia -Describes a digital technology which allows the user to shift their focus associatively through the activation of visual or sensorial cues, called hyperlinks, a hypertext system refers to a text based system of interrelated data, whereas a hypermedia system is composed of multiple media types used to illustrate themes, ideas, or relationships between information structures, at different levels of meaning and scales within the system.

immersive VR -Describes virtual reality systems using head-mounted displays and position tracking sensors linked to the user's body, to create the illusion of being sensorially immersed in a computer generated space.

information/knowledge design -The process of organizing and presenting elements of data into informational structures at different scales of complexity, with the purpose of conveying knowledge. Information/knowledge design involves the identification, analysis, classification, assembly, editing, and presentation of these structures in a form that is most efficient and illustrative to the proposed group or individual recipient. Also referred to as *content design.*

installation -Rising to prominence in the 1970's, an art form featuring the creation of total, "environmental" works of art installed in entire rooms or other interior spaces. Such installation works can involve a wide range or mixture of media.

interface -A object or entity which forms the boundary between to distinct things. A device that bridges different systems, devices, technologies, ideas, etc. The connection made between two or more elements which are part of the same system. The interface between humans and computers has rapidly progressed from direct wiring of computer hardware, to batch processing using notched punch-cards, to a command line technology as seen in the MS-DOS or UNIX environments, to current Graphic User Interfaces (GUI) that designed as digital representations of physical "desktop" environments such as Windows and Macintosh systems first developed by Xerox PARC in the early 1970's. New interface developments include Augmented and Virtual Reality technologies(AR and VR), and Tangible User Interfaces(TUI) which look to simulated and physical environments as tools in digital manipulation.

interactivity -Generally the term refers to a reaction based on every action, activity "inter" or between two sources of action. A digital interactive system could be defined as an information structure which is user driven, and therefore non-linear, allowing the user to navigate the data presented through associative connections. This method of navigation allows the user the utmost freedom in their exploration and understanding of the information presented.

realtime -In terms of both analog and digital technology, the condition provided in which there is no discernible delay between user input and technical output. Realtime animation or simulation is necessary for the illusion of telepresence found in virtual reality systems.

system -An interrelated complex arrangement of parts, dynamically shifting, relating simultaneously with other elements at different and non-local scales.

tangible bits technology -Developed by MIT researcher Hiroshi Ilshi, refers to the integration of digital technology within physical objects and spaces, providing the inaccessible bits (digital representation of binary signals of zeroes and ones representing off and on positions, built up to construct complex systems of data) as tangible representation.

telepresence -The phenomena which occurs when a VR system succeeds in creating the interactive feedback loop between our perceptions and the real environment. Haptic stimulations and feedback are key to the illusion of telepresence. There are two divisions of telepresence, teleoperational telepresence and artificial telepresence. Teleoperational refers to a system which simulates an existing reality in realtime, allowing the user to "be" in the other location and manipulating tools within the distant space. Artificial telepresence simulates a completely virtual environment which does not exist in physical reality and therefore does not adhere to traditional rules of nature, but rather is a representation of the information it contains.

triadic experience -A component of the Systems View of our environment in which the user considers their own collective experiences in relation to the reading of an event. THIS means THIS to ME. Saw rise in acceptance with the decline of the Cartesian paradigm and its concept of the dyadic experience

virtual reality technology - The simulation of reality through realtime 3D modeling, position-tracking, and stereo-audio/video techniques. VR systems break away from the convention of the user/screen interface, and surround the user with a "realistic" computer generated environment. This "information environment" provides new opportunities in the storage, display, and manipulation of information. see immersive VR.

Introduction

In order to understand the different ideas and technologies associated with the design and execution of this thesis' research project, it is helpful to look at the formative foundations within the arts and sciences from which they evolved. Just as important as the scientific developments which allow computers to do amazing new things, it is important to understand the conceptual and sociological ideas which have changed the way we think about ourselves and our relationship with our environment. There is no one without the other, meaning that this shift in view is in part responsible for the development of new technology. While at the same time, the development of these technologies provide us the tools with which we may further develop these same ideas, in turn providing opportunities for advances in digital technology, etc.

Shifting Paradigms: Toward A Systems View

> The whole thing gears together like one big symphony, with everything unconsciously structuring everything else... Everything arises in mutual relation to everything else... -written by Joseph Cambell.
> [Briggs, Peat, 1990, p.12]

As our culture and society continue to evolve the ways in which we comprehend our turbulent environment, designers must apply these expanding ideas to the methods we use to convey information in the pursuit of knowledge. The author would like to familiarize the reader with characteristics of the major paradigms, and the changes in perception which lead to the shift from one mode of thinking to another, incurring new methods to be used in the expression of data/information/knowledge.
In 1970, Thomas Kuhn scientifically defined the term paradigm as an archetypal experiment or "problem-solution" which in regard to a current perception, tells scientist how to view the world. [Kuhn, 1970] Theories and concepts create dominant views which establish the identification and acceptance of a culture's dominant paradigm. Over time this mode of thinking declines based on a shift in popular perception.

The organic paradigm was one of the first identified paradigms. With its foundations in a religious theology, people believed that all observed phenomena could be attributed to the actions of an all-powerful God. As science emerged and began to explain such observed phenomena, the Organic paradigm reached its intellectual limits. It's decline has lead us into the Cartesian paradigm.

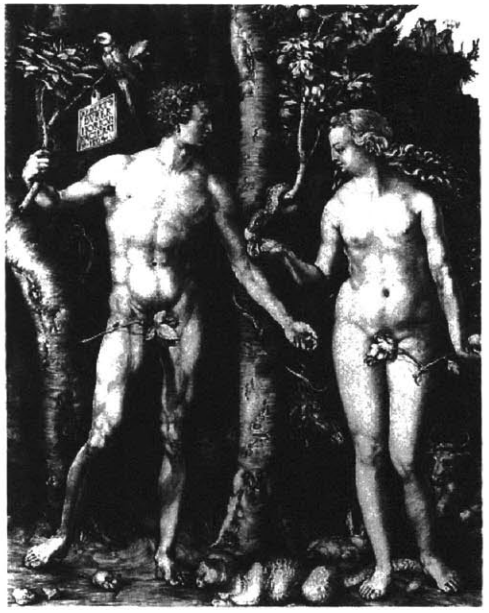


fig. 1.b Durer's *Adam and Eve,* (1504) symbolized the religious basis of the Organic Paradigm.

In turn, those under the guise of the Cartesian paradigm sought to control nature through scientific manipulation. It can be described by its view of the world as a hierarchical machine to be studied, broken down, and manipulated by man-kind, each element independent of its environment Within this shift of perception, people identified the rationale for all phenomena to be a linear form of cause and effect, identifying relationships between specific events but viewing them as independent actions which could be manipulated to effect yet confined to a single scale.

Systems View, derived from General Systems Theory and Chaos Theory (and later day Complexity and Catastrophe Theory), illustrates that individual events do not always have defined cause, but are pieces of different systems interacting with other systems at different non-local scales[Capra, 1982]. These systems are wholes with irreducible parts containing subsystems, which are wholes in relation to their subsystems, on to infinity. When extracted and viewed outside of their context, these subsystems no longer share the same relationships and become something completely different[Lazslo, 1972].
In his study of quantum mechanics, Neils Bohr believed that in the whole established the behavior of the parts--that it can be read as an ever-changing synergistic system of interrelatedness. These parts are connected to one another by non-local instantaneous connections and cannot be viewed as single pieces outside of the system they are in because this shift would upset their current structural makeup and their supporting environment would collapse.

This is further illustrated through the observations of Heisenberg's Uncertainty Principle which dispelled the Cartesian view that those investigating or recording a phenomena could consider themselves passive observers to it. Heisenberg showed that in fact, the viewers and their equipment entered into the systems they were observing, making them active participants in the observed phenomena. They became integral parts of the studied system, and therefore influencing the relationships they observed. [Capra, 1982] This validated Einstein's conjecture that all phenomena was relative to the time and space it occupied while being investigated by scientists and their instruments. These findings lead to a rise in the acceptance of the Systems View of understanding relationships among phenomena.

This inclusion of the time and space condition brings back the human element to the observation of our environment. It states that in any investigation, the process incurred is a triadic experience, meaning - THIS means THIS to ME, or in relation to my perception of it, rather than a dyadic experience --THIS means THIS, which illustrates a universal perception of WHAT IS. A Systems View tells us that definitions of observed phenomena are not absolute but are determined by the individual's perception of a collective environment and experiences, which make up our individual values. This view follows the conjecture of quantum theory which says there are no absolutes in phenomena, only probabilities that the phenomena will occur. It continues to say that if there are in fact, no absolute phenomena, then there is no absolute reality -reality is relative to the observer and therefore based on our individual perceptions[Capra, 1982].

fig. 1.c The Cartesian Paradigm saw Science as the new religion.

Our everyday experience makes up the components of our perception, what makes us each individual. Capra refers to these accumulated experiences as our "patterns of perception":

> In our interactions with our environment there is a continual interplay and mutual influence between the outer world and our inner world. The patterns we perceive around us are based in a very fundamental way on the patterns within. Patterns of matter mirrored patterns of mind, coloured by subjective feelings and values. In the traditional Cartesian view it was assumed that every individual had basically the same biological apparatus and that each of us , therefore, had access to the same "screen" of sensory perception. The differences were assumed to arise from the subjective interpretation of the sensory data... Recent neurophysiological studies have shown that this is not so. The modification of sensory perception by past experiences, expectations, and purposes occurs not only in the interpretation but begins at the very outset, at the "gates of perception". Numerous experiments have indicated that the registration of data by the sense organs will be different for different individuals before perception is experienced. These studies show that the psychological aspects of perception cannot be separated from the psychological aspects of interpretation. [Capra, 1982, The Turning Point, p. 294]

These "patterns" provide us with a truly unique perception of our environment, painting each one of us a very different picture. However these "unique pictures" are often clouded by an accepted need for a commonality used the way we communicate with others. These shared metaphors are locked into the Cartesian view of a universal reality in which we are all thought to share a common perception. As Systems View shows us that such is not the case, we must search for new metaphors, new methods of interaction and communication which can provide richer methods of expressing our own perceptions and comprehensions of information and knowledge.

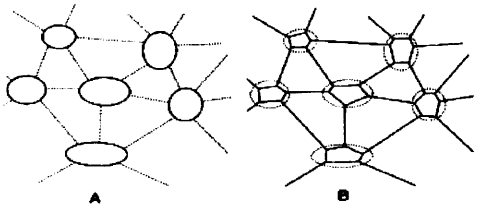


fig. 1.d On the left (a),illustration of Cartesian view of environment made up of different objects which relate to one another. On the the right (b), a Systems view in which dynamic understanding of the many relationships is primary to the view of the scaler systems making up environment [Capra, 1996].

Information/Knowledge (Content) Design

As the synergistic relationships found between Data, Information, and Knowledge is a fundamental aspect of the Systems View, it is important to come to an understanding of this relationship. This is accomplished through the definition of its components in relation to scale and perspective. Data can be described as a discrete element of a larger whole. Relationships identified and illustrated among data elements form information. Information which is interpreted in relation to other information is considered to be knowledge.

Individual perspective is important in determining the scale of the corresponding system. Dependent on point-of-view, a data element can also be read as an information structure. For example, the letter "a" in the word "cat" in the sentence, " The cat slept on the mat.", can be read as a very discrete element called "letter" which when assembled with other letters makes up the word "cat". The original element ("a") is read in relation to other elements ("c"and "t") which construct the word "cat", which can be read as information. When assembled with other information systems (words), these letters come together to form a system identified as "sentence", "visual description" or even "rhyme". This complex information structure, made up of simple elements, is then processed by the reader in relation to their collective perception, which forms its meaning, or knowledge of it.

But analyzed from a different point-of-view or scale of perspective, we could read the letter "a" as a very complex object built up of countless relationships over many centuries of communication development. This development resulted in the formation of a written language consisting of complex rules of notation with which we form words, of which the letter "a" is a product. Individual meaning is dependent on our perceived relationship to the data /information / knowledge.

Our interaction with perceived data/information/knowledge structures, or content structures, make up the processes of our lives. As we mature from birth, constant bombardment by socially adopted behavioral structures of accepted actions and reactions, instruct us on how we should function in response to particular circumstances. Over time we come to accept these structures as "the norm". New ideas about how we relate to our environment provides new methods of illustrating these information structures. A good Information/knowledge designer looks to assemble, analyze, classify, edit, and present these structures in a form that is most efficient and illustrative to the proposed recipient(s).

Information/ knowledge (I/K) design, or content design, is based on comprehending these structures and the elements of data that make up its parts. An I/K designer evaluates the behavior of different kinds of data and then organizes principles and thoughts on the basis of that evaluation. Information structures are wild, dynamic, and chaotic. As previously stated, their readings differ from individual to individual, dependent on individual perceptions and accumulated knowledge. The I/K designer's job is to recognize

these dynamic patterns and illustrate them in as clear and concise a manner as possible, keying in to as many individual perceptions as possible. This can be aided by the incorporation of many different tools and media.[Mok, 1996]

Clement Mok, who opened Studio Archetype, an international I/K design firm, identifies the three structural levels of the construction of knowledge as the following, upon which the author has superimposed the D/I/K structure:

an information art (data): Recognized as an element of data, or what we might consider the product of a technique or method of expression with which we can build up more complex expressions of data. These elements of data can read as systems of information themselves, depending on the scale of the viewer's point of view.
examples of products of an information art viewed at a particular scale: a note of music, a sketch, an image, a sentence, a graph

an information design (information): The organization of data, or the arrangement of data structures. Information/knowledge designers evaluate the relationships between different formats and scales of data elements and arrange them to form information structures, which relate to one another at different and non-local scales. information structures can be read as an information art arranged to form the next power of complexity.
examples continued from previous example: a melody, a diagram, a layout of images, a paragraph, a financial report.

an information architecture (knowledge): The assembly of the collective whole, the highest power of complexity of an arrangement of the products of the information arts and information design. Information architectures can be built up from combinations of very different methods of expression, or formats of data, with very different navigational structures, relating to one another at different levels of complexity based on individual perception.
examples continued yet again: a musical, a assembly manual, a product catalog, a book, an annual report

With these content elements, and structures in mind, it is now important to understand methods I/K designers use in the construction of such structures.

organizational models: Although referred to differently in various forms of expression, the seven universal organization models illustrated here support five data types: text or alphanumerics, sound, music, image, and moving image, providing the basis of all information presentation. Rarely are the seven principles applied singly to any information structure, but rather in combinations of multiple models. For every purpose there is an organizational model which facilitates its function. For example,

the web structure is ideal for a reference book but quite inappropriate for a fictional novel (unless it was a user driven storyline, which would be ideal as well). The challenge for the designer lies in selecting and integrating the appropriate combination of organizational models needed to convey the information to the user.[Mok, 1996]

the different models are as follows:

linear: method of sequential organization which illustrates information in a specific order, often used to illustrate a narrative, or events of the passage of time. i.e.: slide show, fictional storybook
hierarchical: organization of data which illustrates ascending and descending relationships. Connections are often branched as in a web organization but only in a linear respect.
i.e.: family tree, the basic structure of many web sites.

web: Used to describe complex relationships between autonomous and non-autonomous objects. Connect objects which share contextual relationships allowing the user to jump by way of associative links. i.e.: thesaurus, hypertext

parallel: Illustrates identical, similar, or related subject matter in tandem formats, providing the user with a different perspective of the same information.
i.e.: close captioned TV broadcast, satellite driver assistance systems.

matrix: expresses information of specific type in relation to multiple contexts such as a database, or quantitatively illustrates a phenomenon in relation to a single (or possibly two or more) contexts.
i.e.: database of production costs, illustration of fuel consumption over time measured in liters/month.

overlay: layers different levels or interpretations of an event or condition allowing the viewer to experience them in direct relation to each other. i.e.: multi-level maps, highlighted or underlined text
spatial zoom: Providing the user the ability to view information at different levels of scale, detail, and/or complexity, allowing the user to differentiate individual aspects from overall conditions.
i.e.: experiencing a seurat painting, city vs. state map.
[Mok, 1996]

It is important to point out that the examples cited are all two-dimensional in representation. As these organizational models do function well in a two dimensional environment, they could easily apply to a three-dimensional mode as well. As digital technology's abilities to simulate three-dimensional spaces continues to improve, I/K designers need to apply these concepts and identify others, within this new environment.

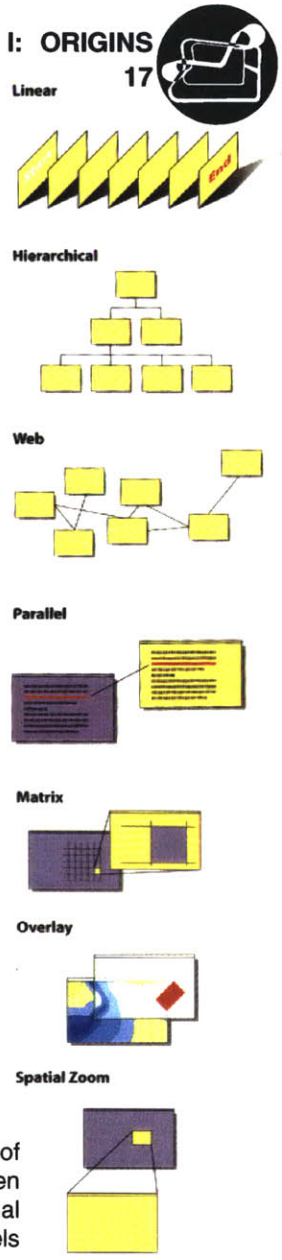


fig. 1.e diagram of seven organizational models

> No matter how extensive the artist's means, he must use them to provoke more of the spectator's participation, not less. For without the active participation of the spectator there can be no transfer of consciousness, no art.
> written by Mort Helig, from "The Cinema of the Fututre," 1955
> [Jacobson, 1992]

Today, and within this thesis' research product, the term multimedia, refers to the organization of different digital media sources with the desire to provide a rich understanding of a specific subject. These digital sources are catalogued and accessed by the user through a Graphic User Interface (GUI) which translates the complex collection of source data into a format the user can relate with.

But multimedia should not be limited in definition to strictly that which occurs on the computer screen. The concepts of organization which define digital multimedia are not new and can be found in various established forms of art and information organization. The term multimedia traditionally applies to a work which meshes "multiple media" in the act of description, combining different techniques of data illustration to form a more complete explanation of a subject matter. Working in concert, the various formats of information can provide the user with an understanding of the subject at multiple levels of meaning. These different sources' individual meanings relate to one another in such a way that the viewer is able to jump scales of complexity and recognize a new "whole" constructed from relationships between the related systems(information structures). It is the identification of these individual relationships found between pieces (data elements), that construct the complex representations of meaning (information), leading to a richer understanding of the subject whole(knowledge).

As pointed out before, multimedia is not a new concept, but has been developed over time in the illustration of new methods of communication and illustration. To familiarize the reader with multimedia conceptually, the author would like to discuss a few non-digital examples of multimedia.

an artistic example of multimedia is collage, in which the artist juxtaposes different elements of various media types to convey an overall theme made up from the relationships between individual subject matter. Some works of collages remain completely two-dimensional, using bits of photographs, drawing, painting, and other flat media to express the ideas, while others move into the third dimension blurring the lines between collage, sculpture, and installation. Multiple scales are often represented within a single work, forcing the viewer to reevaluate the overall composition in relation to each individual piece and relationships between groups of pieces.

fig. 1.f Duchamp's
"Nude Descending the Staircase"
(1912)

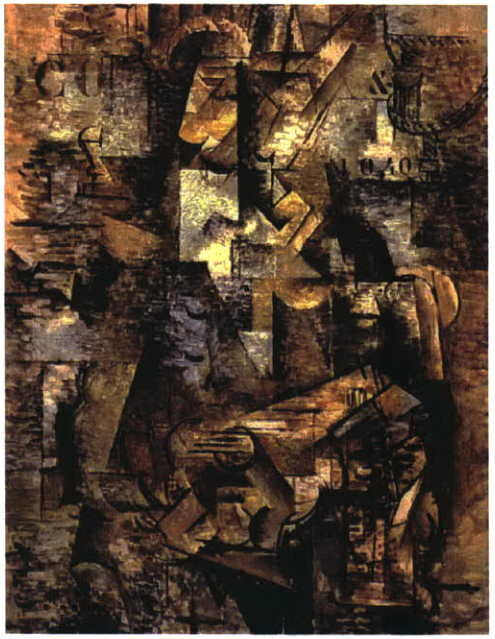
One of the first examples of multimedia collage can be traced backed to ancient Japan where calligraphers developed a style of copying poems onto sheets pasted up from pre-torn assembled pieces of delicately tinted paper. These formations, arranged to represent landscapes or rivers, with small cutouts representing animals and birds, reinforced the poem's written verse, visually contextualizing the reader/viewer with the subject matter [Wolfram, 1975].

Modern collage as a form of self expression began with the cubists in the early 20th century and is broken into different phases of its early development. The first phase, inspired by Cezanne, was characterized by a crystallizing of the formal structure of objects and landscapes through incisively geometric analyses. Subject matter was abstracted to pure geometric qualities, revealing the "essential signs" of objects, asking the viewer to reevaluate the everyday object within a new graphical context. The second phase, referred to as the "analytical" phase, explored the expression of "simultaneity", or the illustration of an object or scene from different vantage points or moments in time, juxtaposed together. This phase could be characterized by Marcel Duchamp's (1887-1968) Nude Descending the Staircase(1912). It troubled the artists that as the works become more and more abstract, they become less the representations of the original object reality, and more the documentation of the act of creating them, marks of paint on canvas[Bersson, 1991].

This concern brought about the third "synthetic" phase , which provided Georges Braque (1882-1963) the idea of inserting different materials into the pictorial space of the canvas, to exist as subject matter and as themselves simultaneously. By getting the viewer to recognize the alien materials as both, the artist had stimulated perception in very interesting way. Here, the choice of media itself and its juxtaposition with other media within the composition of the work, influences the viewers interpretation of the overall theme. In 1911 Braque inserted a flat typeset phrase into his work, The Portuguese, bringing a new dimension to his multimedia technique. The stenciled letter-forms' flatness was significant in their contrast to the spatial representation of the remainder of the work. It illustrated the viewers' ability to conceive a differentiation between that what existed within the spatial plane of the painting and that which did not, simultaneously [Wolfram, 1975].

This technique of representing the spatial, juxtaposed with the non-spatial, is a major tool in contemporary graphic, broadcast, and interactive design. In superimposing alphanumeric, diagrammatic, or other non-spatial data representation over or under a spatially perceived representation, the designer is able to convey multiple levels of contextual information to the viewer, who is then able to discern one form of representation from another. Creative credits on a television programs, game and player statistics, and blue-screen enhanced weather forecasting are examples of such techniques originating from Braque's multimedia explorations.

Another example of multimedia expression is cinematic montage in which independent film clips are sequenced together with the intent of conveying an overall theme when read in relation to one another.



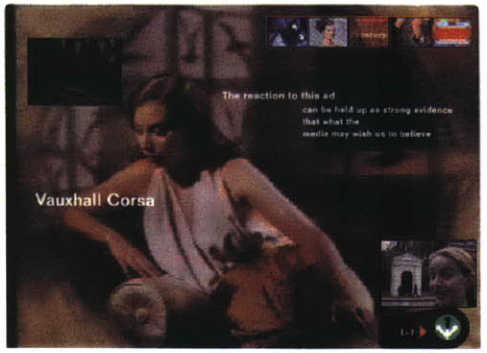


fig. 1.g and 1.h Braque's The Portuguese (1911), and broadcast advertisement

The adaptation of collage into the medium of film could be considered a major contributor to the development of multimedia as a technique used to communicate complex ideas. Russian filmmaker Sergei Eisenstein (1898-1948), began to examine the different components that shaped the way the viewer reads "film". He composed beautiful working diagrams which illustrated the correlation between image, camera movement, music and script, building a graphic language which could illustrate the film experience. These diagrams, reexamined today, can be read as the building blocks of the GUI's of digital imaging and video editing software such as Adobe Premiere, which provides the user tools with which to manipulate digital images and clips of video, constructing sequential image-based information structures.

Expanding on these graphic explorations, Eisenstein began to experiment with the collaging of film, in which the user's perceptual reading of the individual film clips (data/information) in relation to one another, leads to the construction of a entirely new idea or "image-whole". This technique was referred to as montage.

> "Two film pieces of any kind, placed together, inevitably combine into a new concept, a new quality, arising out of that juxtaposition. ...We automatically combine the juxtaposed elements and reduce them to a unity...a creation-rather than a sum of its parts."
> [Eisenstein, 1942, The Film Sense, p.4-5]

He goes on to delineate the correct formula for cinematic montage in which the individual pieces are carefully created to convey specific aspects of the overall theme. These elements must be created in such a way that the viewer can all relate on a very general level -regardless of their individual perceptual view. This hopes to insure that they will all be influenced in a similar fashion. It is through this constructing of easily identified relationships, that the theme is hopefully revealed to the viewer. Eisenstein states that the mental representation of a specific object or event is created by subconsciously identifying a long chain of known related elements constructing a single "image-whole" with which we contextualize the new event. This contextual construction affords the viewer a method of relating what we experience to what we know. Eisenstein saw this contextual chain eventually moving to the subconscious, allowing specific events to call up the "image-whole", providing the viewer with immediate identification [Eisenstein, 1942]. He uses the example of a mechanical clock as a representation of time that through our subconscious identification with events associated with the specified time, becomes an image of that time.

Eisenstein's "image-whole" is the result of what Nicholas Negroponte refers to as "semantic compression", in which the human mind compresses all incoming sensorial information into interrelated systems of identifiable triggers[Negroponte, 1970]. As an example, the word "carnival" for instance, immediately conjures up in our minds many different but related sensations, memories, meanings, which

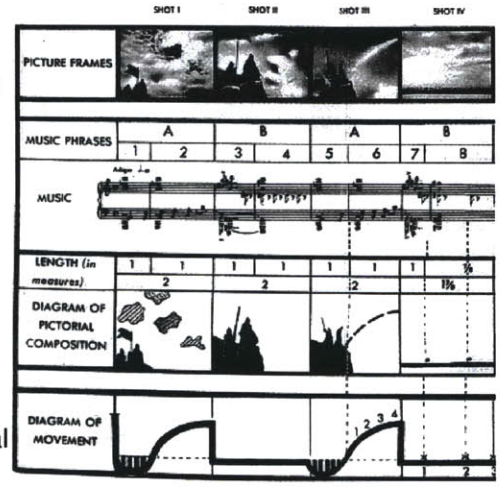


fig. 1.i and 1.j diagrammed sequence from Eisenstein's *Alexander Nevsky,* digital video editor, Adobe Premiere

combine to form or perception of the word "carnival", or our knowledge of it. These individual elements are related to many other information structures which form our perception of very different, yet related terms.

The author would like to provide a simple example to better express the concept of cinematic montage. Let's suppose three independent clips of film, the first illustrates a man crying quite actively, the second shows a freshly covered grave, the third shows a new born child. By placing the "graveside" clip after the "crying man" clip we could generally infer from our own perceptual experiences, that this sequence is meant to represent a tragic scenario in which the man is crying over a lost loved one. In placing the "newborn" clip after the "crying man" we could gather that the man is crying in joy over his newborn son. But if we then place the "graveside" clip after the "newborn" clip we could deduce that the man's wife died during childbirth and the grief of her death is mixed with the joy of his son's birth, leaving an ambiguous conclusion to our sequence. Each clip is individually very different but when read in relation to one another and in different configurations, triggers very different subconscious responses and quite a different story.
With constant exposure to its widespread use, the human mind has become accustomed to use of individual image/sequential montage, or what Marshall McLuhan referred to as becoming "film literate". In Understanding Media he recounts the attempt of western academics to teach African natives the western language of alphanumerics through films incorporating sequential montage, but realizing, that with no access to even photographic images, they would need to be educated on the way to "see" still and moving images. Upon first viewing various film-based explanations of words and letters incorporating camera pans and zooms, the Africans thought the westerners were magicians who could make the landscape move and buildings shrink and grow on command, unable to comprehend that space is continuous and uniform [McLuhan, 1965].

As we come to achieve the current level of sequential "literacy" which fully supports the comprehension of sequential montage, we begin to see advertisers incorporating new techniques of montage into their ever-current broadcast advertisements. We now see layering of still and moving images at different scales and levels of opacity -simultaneously, expressing two different thoughts or ideas. The use of simultaneous montage in conjunction with layered alphanumerics, diagramming, etc., currently the vogue in broadcast advertising and entertainment, brings into question the limits of human visual perception. However, similar techniques are successfully employed in augmented reality systems in which multiple levels of graphic information are superimposed onto the user's visual environment (see section titled: augmented reality).

A third method of multimedia expression is seen in the practice of exhibit design in which the designer incorporates multiple sources of media, to explain complex concepts in simple relatable terms to a very diverse audience of various ages and levels of education. As perceptual differences from person to person creates different methods of knowledge gathering, complex ideas are best expressed through

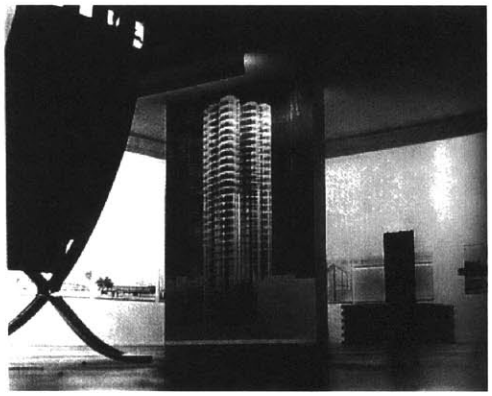


fig. 1.k Mies van der Rohe exhibit, NY MoMA, 1947

different types of abstracted example, allowing the different users to key-into a host of explanations that best fits their method of understanding. The author would like to cite two examples of exhibits designed by architects featured in the research project for explanatory purposes:

The first example is an exhibit designed by architect Ludwig Mies van der Rohe, at the New York Museum of Modern Art in 1947, exhibiting the range of his own interests and talents. The show utilized scale and perspective in the grouping and arrangement of illustrative objects. Spatial zones were created through the layering of elements at different scales, i.e.: a wall size blowup of a small pencil sketch behind a six foot model of the Seagram's high-rise, next to a production piece Barcelona chair, etc. These juxtaposed design representations pulled the viewer inside the fully immersive environment of Mies' design process by illustrating information structures at different scales of complexity and meaning, and challenging the viewers perception of the exhibit as more than just a collection of physical objects, but representations of conceptual ideas as well. Large scale on-site photographs, which were taken at the same perspective as they were positioned within the exhibit, transport the viewer into the surrounding landscapes of the various projects. As Mies' work explored ideas of transparency and place, the viewer could read the picture plane as another plane of transparency through which to view the designs conceptually. In this case, multimedia sources contexualized the viewer and positioned them within the designer's work and mind[Murphy, 1997].

The second example was designed by the office of Charles and Ray Eames for the California Museum of Science and Industry in 1961. Entitled, *Mathematica: A World of Numbers...and Beyond*, and sponsored by IBM, the exhibit was designed to explain fundamental mathematical concepts to viewers of all ages through the use of easy to understand texts, graphics, short films, and interactive devices. The exhibit, which still stands today, is enclosed by two 50 foot multimedia walls. The "Image Wall" which provides visual demonstrations of mathematical principles, and the "History Wall", a graphic linear chronology that tracks the development of mathematics from 1100 AD to the present through biographies of mathematicians and milestones in the development of mathematical principles. Enclosed free standing "peep shows" hold short films demonstrating mathematical concepts. Interactive demonstrations including an oversized graphical calculator which performs complex calculations through the illumination of hundreds of lightbulbs, and a Probability Machine consisting of 30,000 plastic balls falling through 200 pegs and randomly illustrating the classic bell curve. The Eames office, like Mies, expanded the vocabulary of their subject through the intertwining of different media, to form multiple connections with their visitors on different levels and succeeding in conveying their abstract ideas [Neuhart, Neuhart, Eames, 1989].

fig. 1.I *Mathematica: A World of Numbers...and Beyond,* Eames Office, 1961

Multimedia as a method of expression, continues to evolve as new media are developed. Digital technologies are for the most part, still limited to the two dimensional representation of the computer display which pales in comparison to the living, breathing, physical environment. Digital multimedia is however, often best suited for illustration of experiences which may not be readily accessible within the

immediate physical environment [Schlusselberg, Harward, 1992]. This includes experiences which are not just outside of the current physical proximity, like the documentation of a trip down the Amazon river, but those which are actually impossible to witness firsthand, such as a detailed animation of the development of a fetus in utero. Digital content designers need to identify the strengths of current technologies and look to emerging ones for new methods of expression and communication.

Hypertext / Hypermedia: Tools of Interactivity

> The human social process of knowledge creation is hypermedia in its most elegant form. The cognitive linkages, relationships, and context of information where new knowledge is created is a social, collaborative process which libraries have always nurtured.
> [Anderson, 1992, *Sociomedia,* p.107]

Interactivity is a product of a systemic, or non-linear, approach to information navigation, allowing the user to access information through associative connections. This rejection of the linear-Cartesian format of navigation provides the user the opportunity to shift their focus from one related subject to another. Hypertext and Hypermedia are two media types which capitalize on digital technology's dynamic ability to manipulate information structures at multiple scales of complexity.

Hypertext systems provide the user with a random access approach to the consummation of digital text-based information. This allows the user to navigate interior links from any position within the text to any other relevant (determined by the author) sections of the text. This "hyper-linking" allows users to constantly re-focus or "re-center" themselves in relation to what they are reading or have come to understand [Delany,Landow, 1991]. This method of shifting focus from one non-sequential position to another provides the user a great deal of flexibility in the navigation of a text.

But with this freedom comes issues not found in a linear format. As they are capable of navigating the text in the manner that best suits their associative train of thought, the reader is unable to judge their progressive position within the overall text (Bob had read half the book, or Sue had read up to chapter five). Traditional navigational tools such as page numbering or chapter identification are irrelevant in a nonlinear framework. This inability to gauge position within the overall structure, calls for new techniques in the organization and representation of information [Delany,Landow, 1991, Barrett, Redmond, 1995].

One navigational solution, which capitalizes on the digital medium's ability to dynamically manipulate the character of text, is a "bread-crumb" system in which information that has already been accessed, is treated in some way as to make it obvious to the user. The World Wide Web environment utilizes such techniques such that a user's visited links are colored differently than unvisited links for a designated

period of time before resetting to the original "unvisited" color. This however, only solves the problem of identifying previously read selections and does not address overall navigation itself.

This can be solved in a number of ways. One such method with limited interactivity, is the "site map" technique, which works well in semi-contained information structures in providing the visitor an overall view of the navigation system in an easy to follow diagrammatic structure. Each node on the diagram is representative of a specific "place" on the site, and will take you there if clicked. The success of such a technique is marginal in that it can clear-up internal navigational issues for the user but bogs down when illustrating large, complex, or dynamically-linked sites. As well, by limiting it's illustration to links found internally, the "map" does little to convey the interrelatedness of the entire Web [Bruinsma, 1997].

Another technique used is the implementation of a "web-view", as seen in the Hypermedia authoring system, *Intermedia.* This system allows the user to toggle between the local and an overall view, which illuminates all 2nd level connections from the selected link. The web-view is available at multiple scales to provide the user the most appropriate system view in their need to maintain adequate orientation [Delany, Landow, 1991].

As hypertext systems present the reader with internal connections, or those "contained" within the original text, they also incorporate external links to other related works which the author feels are relevant to the creation of the original document. These bridges between the original and exterior documents, in fact, increase the scope of the original to the extents of all documents connected. If the reader factors in all possible connections between linked exterior works and the original set of exterior connections, the combined scope between all subjects relevant, can be read as infinite. The World Wide Web is again, an excellent example of a unified hypertext/ hypermedia system of information navigation and organization which provides the user an easy-to-navigate method of access to the different systems in which a subject is a member. Navigating associatively, or according to their own desire of direction, within these systems at multiple scales provides the user the utmost level of freedom in their acquisition of knowledge.

The term hypermedia extends the definition of hypertext to include multiple formats of data at different levels of meaning, connected to one another through the afore mentioned hyper-, or associative, linking structures. Users can navigate these complex structures of data elements which provide the user with a rich expression of the information. The term Hypermedia, can refer to many formats of information, including everything from illustrated nonlinear printed materials such as newspapers and magazines, to fully immersive Virtual Reality and Augmented Reality environments in which the user haptically relates with the digital and physical environment through both digital and physical interface.

With its user driven, random access method of navigation and expression, it is no surprise that hyper-media has been found to be an excellent tool by which to process knowledge. When we speak of it as

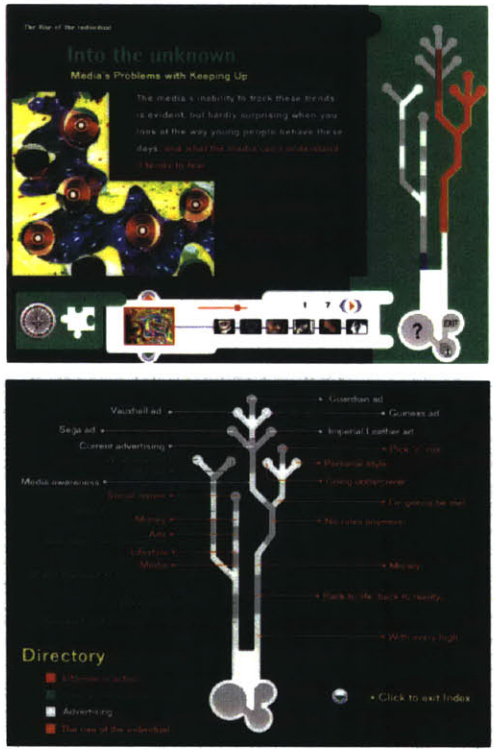


fig. 1.m example of a non-linear hypermedia document

a tool, it is actually a multitude of very different tools, allowing very different types of people, very individual ways of accessing, understanding, and communicating. It has become increasingly evident that people tend to learn more quickly and more effectively when information is available for their individual navigation in a variety of different media, and at a number of different levels of meaning and scales of complexity. Hypermedia theorists have long argued that interactive multimedia is the perfect educational tool, in that it can provide both structural navigation and free-form browsing tools to facilitate information retrieval, learning, and information management. (Cotton, Oliver, 1994)

Hypertext and Hypermedia systems are such powerful tools with which to convey and illustrate because they emphasize relational thinking in the minds of their users(Delany, Landow, 1991). By navigating between related sources and different representations of media, our mind is provided the methods with which to see relationships previously hidden. With such the case, clear and concise methods of navigation are necessary in providing the user these techniques.

Traditional texts in the format of books can be seen as containing hypertextual components. These are accessed when the reader non-sequentially navigates the text by utilizing functions such as the table of contents, page numbering, chapters or sections, footnotes, glossary, and indexing. These tools provide a greater level of insight into the static structure. The footnote, especially in the case of scholarly work, provides the user with a link to a host of other texts all together, expanding the reach of the original work, and connecting the reader with other texts and identifying a web of interrelated subject matter.

Children's books are rich in interactive or non-linear navigation. Developing children's decision making skills and imagination, the books offer their readers the choice to take their adventures down one path or another, illustrating very different outcomes based on their selection. These non-linear texts make absolutely no sense if read in a traditional sequential manner, relying on the user to move forward or backward, sometimes crossing back over familiar ground, in the process of traversing the text. Page numbers, or other graphic wayfinding, become the only navigational tools in such texts. Even young children's pop-up books introduce advanced concepts of decision making and interactivity. By manipulating one tab versus another, the illustrations take on new character and come to life. A seemingly innocent two dimensional picture, jumps out, off the page, pulling the reader deeper into the image-rich storyline.

fig. 1.n Children's Interactive pop-up book, *Gutenberg's Gift.*

Some avant-garde writers have explored the non-linear genre as experiments in story-telling. The beat writer William S. Burroughs (1914-1997)experimented with a method of narrative juxtaposition called the "cutup", which he adapted to literature from a similar painting technique used by Brion Gysin, in 1959. The technique called for the "cutting up" of a traditional text and randomly reassembling it to beread and analyzed as is. This unorthodox reading was meant to expose conventionally accepted "word and image controls", freeing the reader (and writer) from such controls, which otherwise "locked" them into conventional patterns of perceiving, thinking, and speaking, and therefore, determining the interactions

within their environment. He expanded this technique into other media such as recorded audio and film, sometimes mixing them together to produce strange multimedia features producing similar results [Skerl, 1985].

Another example of a traditionally linear medium with non-linear, random access leanings, is the vinyl audio record. Concentric grooves cut into the surface of a vinyl disc at different elevations caused a reading needle to translate the grooves into music. The album was constructed to run the needle from the outside edge, around towards the center of the disk playing musical arrangements in a linear fashion, one after another. By picking up the needle and repositioning it on the album surface, a listener could randomly access the music, re-arranging it as they chose to hear it. As is impossible to visually translate the small grooves into the music produced, it is equally difficult for the listener to reposition the needle in exactly the spot they were most interested in hearing. The "silent" space between selections of music was relatively easy to recognize from the rest as is was a significantly wider band of identical groves. This limited legibility illustrates the album as a poor interface for the translation of data structures to the user. As limited as the interactive navigation is, it still contains the potential of being non-linear and user driven.

The musical development of "sampling" or "mixing", the collaging of existing selections of music with other pre-existing or original portions to form entirely new pieces of music, relies heavily on the non-linear qualities of vinyl recordings. By memorizing (or notating directly on the surface) the exact position at which a specific selection resides on an album, a "sampler" (one who samples) can collage or "mix" different pieces of music in realtime. The needle, or playback head, is the artist's instrument, audibly sculpting a new sound from an existing information structure. This non-linear manipulation is another example of artists finding a new mode of expression within the limitations of a particular medium.

All art forms can be described as interactive to some extent, as the viewer's individual reading, or perceptual view, defines their understanding of it. We choose to enter into a dialogue with a work of art in which we examine it for ways in which we may relate with it. It is these identified relationships between our own experiences and the piece of art at different levels and scales of meaning, which provides us with a response to it. But some artists rely on the viewer's dynamic participation as an integral part of the creation and execution of their work. Hiesenberg's Uncertainty principle comes to mind again in describing the integral relationship between the work of art and it' audience.

Derived from Dadaist collaborative performance art of the late 40's and early 50's, *Happenings* focused on expressing the symbiotic relationship between art and life, and are fine examples of the Systems View illustrated. Artists constructed rich, sometimes bizzare, environments for the spontaneous combustion of expression and experience, fully exploiting their captive audience whose impromptu reactions to the pre-designed stimuli were seen as the true medium in which to work.

fig. 1.o and 1.p
London DJ mixes vinyl, 1998
A Summer Happening, 1961

The artists of the Happening movement used their art to actively illustrate these systemic connections between individual perception and individual reality, to their audience. Art was life and life was art. In an excerpt from Artist Allan Kaprow's 1961 essay, "Happenings in the New York Art Scene" we read an account of such events:

> ...You come in as a spectator and maybe you discover your caught
> in it after all, as you push things around like so much furniture.
> Words rumble past, whispering, dee-daaa, lawnmowers screech
> just like the I.R.T. [subway] at Union Square. Tin cans rattle and
> you stand up to see or change your seat or answer questions shouted
> at you by shoeshine boys and old ladies. Long silences when nothing
> happens, and your sore because you paid $1.50 contribution when bang!
> There you are facing yourself in a mirror jammed at you...
> [Bersson, 495, *Worlds of Art,* 1991]

Happenings were as random, plotless, and interactive as life, relying on the participants to guide the action. There were no boundaries between artist and audience, "gallery" and artwork, everything within the Happening environment was considered a medium in which to work.

The installation is an art form that blends the interactive qualities of the happening with traditional and non-traditional sculpture and/or painting, creating an entire environment into which the user forms an experiential relationship. An Installation environment usually fill up an entire room, gallery, or public space, encouraging the viewer's perception to fully interact with the artist's own vision, allowing the viewer to become a part of the installation itself.

For her 1989 installation, Initiation, Jashinsky constructs a visually immersive environment by covering gallery walls with painted perspective scenes which match the viewers point-of-view, and carry them through the physical boundaries of the actual gallery into the context of the artwork. Jashinsky's "environment" simulates the ancient, "Villa of the Mysteries" in Pompeii, in which she paints various present day artists and family members whom she admires or counts as influences. Greco-Roman style furniture is placed within the room, aiding in the translation of the two-dimensional painting into a three-dimensional perception, further engaging the viewer within the space. The "initiation" depicted, symbolizes her rite-of-passage as a woman and a developing artist. She blends the historic with the conceptual, the simulated with the impossible, constructing an on-going event modeled from both a past reality and her mind's eye. The viewers completely plunge themselves into the work as the initiate has committed to her passion. [Bersson, 1991]

fig. 1.q Jashinsky's two-dimensional installation, *Initiation,* 1989

The Flexible Interface

As new ideas and new technologies have influenced content designers to think systemically about the organization of information, this in no way guarantees excellent designs. Just as the design process itself is a constant reevaluation of current standards in relation to a changing environment, content designers need to rethink design strategies. Today, as technologies continue to advance at a breakneck pace, designers find themselves in the same position as past new-media content designers, who fell into classic traps of trying to do both too much with the new media for the sake of doing it, and bypassing the challenge of developing appropriate techniques for the new media in favor of "shoehorning" accepted techniques in their place.

Nowhere is this more apparent than on the wild frontier of the World Wide Web in which we find a gross overabundance of <blink> tags, and bandwidth bogging animated GIF's, linked to websites which look like business cards and magazine layouts. We are currently experiencing the same period of evolution as when no one thought to change the position of the movie camera, as it might no longer accurately represent the experience of the stage [Cook, 1990].

This is not to say that all accepted models of organization and illustration are inappropriate, or that designers should not push the limits of new media. It comes back to a matter of appropriateness in relation to content, and providing a transparent quality to a perceived boundary between the user and their data. It is the author's contention, that designers can benefit greatly from looking to the systemic quality of the specific content for inspiration in designing the navigation. This can be accomplished by providing navigation that is integrated with its content.

Too often do we see interfaces which try to provide the user with an "easy-access" icon for every possible operation directly available from a "dashboard"-style GUI. This notion completely discounts the computer's ability to "understand" the user's needs by looking to the active content, or to look to the user's ability to use more than a single mouse click in the fulfillment of an action.

A more appropriate solution looks at information from a dynamic systems point-of-view and provides only the relevant tools for the situation at hand. In the example of the interface of an unnamed word processing software, the user becomes easily overwhelmed by the abundance of immediately available options, icons, sliders, and selections. Rarely, if ever, does the user need simultaneous access to a complete set of text and paragraph formatting, drawing, spell-checking, printer and file management tools, which as the are presented now, constitute up to 1/3 of the total screen workspace.

Specific actions initiated by the user could easily prompt the software to modify the immediate interface to only that which is possibly needed. Whereas tools that are shown to be rarely used could fade to the background, providing less clutter, and more useable screen real-estate for the tasks at hand.

Content designers can take large steps in the development of so-called user friendly digital environments by applying a dynamic quality to their otherwise static relationship between user and data.

A basis for this argument can be made by looking to natural, or biological sources of self-organization for inspiration in the illustration of complex systems. In *The Turning Point*, Fritjof Capra draws a comparison between a man-made machine and a nature-made organism, as a method of explaining the concept of self-organizing systems. These organic systems self regulate in makeup and action, shifting, not as a result of an imposing exterior environment, but in relation to changes at multiple scales within the systems of which they are an integral part [Capra, 1982].

The author would like to look at these characteristics as they relate to the rejection of a static, and confining digital interface and the adoption of a more systemic, flexible multimedia format of digital navigation, which adapts with the dynamic needs of its environment. This adaptation takes place at all scales, including both at that of the system data, and the shifting desires of the navigating user.

> Machines are constructed, whereas organisms grow.
> [Capra, 1982, *The Turning Point*, p. 268]

A traditionally static information structure is just a container which can only hold a certain amount of information before it fails. It's fixed size can cause it to be both too large or too small for the dynamic systems it relates to. A flexible interface can increase or decrease in size and scope to accommodate the ever-changing scope of its dynamic environment (read user). This flexibility allows it to function as smoothly with ten pieces of information as with ten thousand or ten million. Its scaleability allows the interface to function efficiently at all times, regardless the amount of data it relates.

> Whereas the activities of a machine are determined by
> its structure, ...[the]organic structure [of an organism]
> is determined by processes.
> [Capra, 1982, *The Turning Point*, p. 268]

A static interface, in it's inability to change, holds its information and its user hostage, allowing them to relate with one another in only limited ways. This completely discounts the dynamic shifts taking place in the multiple systems in which the data relates to the user and environment . Understanding this, it is important to provide today's users the widest range of tools, or the ability to create their own tools, with which to access and process information/knowledge of many different formats, scales, and quality of relationship. The flexible interface is liquid, dynamic, adapting with the dynamic user's shifting needs and desires as they are both subsystems within the interrelated whole.

> Machines are constructed by assembling a well defined number of parts in a precise and pre-established way. Organisms, on the other hand, show a high degree of internal flexibility and plasticity.
> [Capra, 1982, *The Turning Point*, p. 268]

A static, inflexible interface is pre-determined to function in a very strict, limited manner. Structured to provide the user only specific methods of access, testing, and communication of the subject matter, the static interface forces the user to function within its confines, regardless of the negative effects. A dynamic, flexible interface shifts with the user's individual needs, seemingly adapting to the task at hand. The dynamic environment always maintains its "proper" relationship with the user, as they are inherent to one another.

> [A machine] is a relatively isolated system that needs energy to run but does not necessarily need to interact with its environment to keep functioning. Living organisms....are open systems...which have to maintain a continuous exchange of energy and matter with their environment to stay active,... allowing the system to remain in a state of non-equilibrium, in which it is always 'at work'. Living organisms are open systems that continually operate far from equilibrium.
> [Capra, 1982, *The Turning Point*, p. 270]

Just as the machine continues to function in a static, unchanging manner, unaffected by its surrounding dynamic environment, the static interface remains fixed regardless of the shifting needs of the user. This rigid quality eventually causes the system to fail, due to the degree to which the information structures around it has shifted. The dynamic, or "self-organizing", interface requires the constant input of its environment in order to survive, or remain relevant to its dynamic users. This self-organizing quality keeps the multiple structures of the interface in a parallel state of flux, or "at work", shifting in relation to its associate systems at different and non-local scales.

Systems View tells us that It is not only natural to adapt to our own environment in the way we learn and communicate, but inevitable as we are one with it. The conceptual ideas which define the "self-organizing" organic system is much more appropriate model for the shifting needs of the emerging systemic view of information /knowledge access and illustration.

Introduction

> The creation of knowledge happens in a context of other knowledge.
> Knowledge inevitably springs from the varied worlds surrounding us,
> and we incorporate these various natures into our creative process.
> [Anderson, 1992, *Sociomedia*, p. 109]

Although modern chairs are a focus of illustration within this research project, it is actually the identification and conveyance of the relationships found among the inherent data structures connecting them as a group, that is the focus of this exploration. This web of interconnected data structures illustrate to the viewer qualities which afford the perceptually reading of these elements of wood and metal as objects called "chairs", and part of a group called "modern furniture".

The question remains, how can we as information/knowledge designers, unpeel the layers of diverse contextual data which perceptually construct the existence of such objects within the individual mind? And more so, once identified, can we utilize these connections between data structures as a method of illustrating the objects which they represent, and as part of a larger interrelated group?
The author has selected modern furniture as subject of illustration because of its deep richness of associated data which positions it somewhere between utility , architecture, and sculpture. Specifically, pieces were selected which could be described as having been designed by a select group of architects in the 20th century who chose to solve the problem of creating an object in which to sit, very differently. This group which illustrates a wide variety of fabrication techniques and conceptual expression led to a very rich system in which to contexualize the individual object.

Process: From Object to Context

The selection of modern furniture as a subject of exploration was based on its richness of contributing information, and it's inherent lack of a method of interrelated illustration. As this group of objects sit somewhere between the purely functional use of the word "chair", the design of an architectural space/placemaker, and an exploration in abstract sculpture, they can be seen as having many different readings. They are in some cases mini-buildings, the conceptual ideas their designer's had about environmental space and form, squeezed into the confines of an object. Others are the end result of a sometimes exhaustive search for the solution to particular problem through the utilization of new or non-traditional materials, or even reexamining materials used by past designers. While others designers seemed to focus on capturing the spirit of the times and squeezing it into an accessible object, more sculpture than function.

fig.2.a and 2.b, digital models from project,
Eames Aluminum Group Lounge Chair
Jacobsen's Egg Lounge Chair

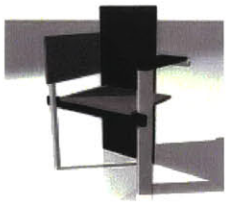
It became clear that to illustrate the object to the unknowing user, they needed to be positioned within the contextual space of the object, bringing them into the system of interrelationships which the object shared with other objects, situations, and ideas. Once a part of these systems, the user could come to identify the object by the relationships found between the data structure and their own. This identification of various local contexts when read in relation to one another, could be shaped and processed by the user, forming knowledge of that object, in relation to other perceived knowledge held by the user [Briggs, Peat, 1990, Capra, 1982]. As these objects could be best described through visual and text-based account, digital hypermedia was an ideal format for this illustration. The variety and integration of formats supported, combined with the advantages of a user driven navigational structure provides the user with a model environment in which to create knowledge.

It is very important to point out that the completely digital product of this thesis, through its organization, communication and representation of real-world information, is at this time, in no way attempting to replace a physical reality, only augment it. The digital techniques I have employed in the illustration of specific contextual information about the furniture, look to only expand the user's understanding of the physical object and the contextual relationships it shares with other pieces within the group, individuals, places, events, etc., thereby increasing their level of appreciation for it. In the execution of this digital tool the goal is to provide the user with an accessible virtual three-dimensional representation of the collection of objects, not a replacement for them. As digital technology is unable (to a certain extent, see immersive VR) to provide an adequate simulation of physicality, the author asks the user to seek out these unique pieces of furniture, and have a seat, experience them firsthand. This digitally based exploration acts as an information source to amplify such a physical experience, providing the user exposure to an interrelated collection of information which will provide a richer degree of interaction with the furniture itself.

As research began, it was disturbing that compared to other expressions of art and design, these contextually rich objects, were illustrated so sparsely. It was clearly very difficult for anyone to fully appreciate these pieces without access to the full range of factors which made them so unique and valuable. Many of the relationships which were so key to the understanding of these objects such as their association with other pieces, designers, architectural spaces, artistic movements, technological developments, etc., seemed of little consequence in their descriptions which were usually purely based on functional considerations. It seemed that all the previously addressed data which expressed why these pieces of furniture were considered more than just furniture, was trapped inside. Yes, it was possible to research each piece individually in various texts, but these texts were independent from one another, lacking the relationships which connected the pieces together.

fig. 2.c and 2.d
digital models, Mies' Barcelona chair
Saarinen's Womb lounge chair

red and blue chair
rietveld
1918
wood

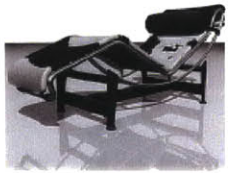


berlin chair
rietveld
1923
wood

wassily chair
breuer
1925
tubular steel

laccio stool
breuer
1925
tubular steel

MR arm chair
mies van der rohe
1926
tubular steel



chaise lounge
le corbusier
1928
tubular steel

grand confort grande
le corbusier
1928
tubular steel

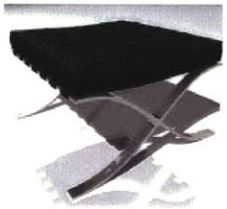
grand confort petit
le corbusier
1928
tubular steel

basculant
le corbusier
1928
tubular steel

cesca chair
breuer
1928
tubular steel

breuer lounge
breuer
1929
tubular steel

barcelona chair
mies van der rohe
1929
rect steel



barcelona ottoman
mies van der rohe
1929
rect steel

paimio chair
aalto
1929
bentwood

fig. 2.e (pages 33-36)
visual listing of digital models completed for
research project, arranged chronlogically

BRNO chair
mies van der rohe
1930
rect steel

tugendhat chair
mies van der rohe
1930
rect steel

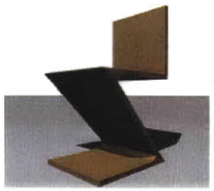
barcelona chair
mies van der rohe
1930
rect steel

3-legged stool
aalto
1930
bentwood

viipuri chair
aalto
1930
bentwood

MR chaise
mies van der rohe
1931
tubular steel

cantilever chair
aalto
1932
bentwood



zig-zag chair
rietveld
1934
wood

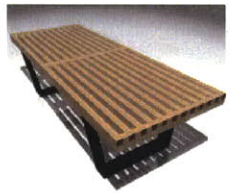
aalto arm chair
aalto
1935
bentwood

aalto chaise
aalto
1936
bentwood

DCM
eames
1946
molded wood

LCW
eames
1946
molded wood

womb chair
saarinen
1946
molded plastic



nelson bench
nelson
1946
wood

pension chair
aalto
1946
bentwood

DAR
eames
1948
molded plastic

the ant
jacobsen
1952
molded wood

fanleg stool
aalto
1954
bentwood

the tongue
jacobsen
1955
molded wood

eames lounge
eames
1956
molded wood

marshmallow sofa
nelson
1956
tubular steel

pedestal arm chair
saarinen
1957
molded plastic

pedestal side chair
saarinen
1957
molded plastic

pedestal stool
saarinen
1957
molded plastic

aluminum lounge
eames
1958
rect steel

the swan
jacobsen
1958
molded plastic

the egg
jacobsen
1958
molded plastic

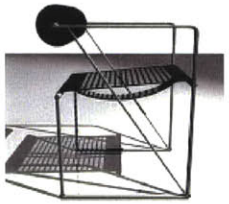
sling sofa
nelson
1963
tubular steel

easy edges chaise
gehry
1972
cardboard

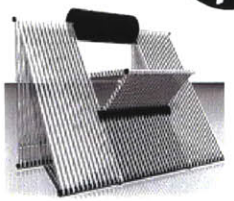
easy edges sofa
gehry
1972
cardboard

easy edges chair
gehry
1972
cardboard

prima
botta
1982
rect steel

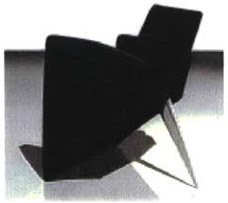


seconda
botta
1982
rect steel



quarta
botta
1984
rect steel

pratfall
starck
1984
bentwood



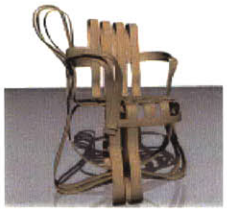
j. (serie lang)
starck
1984
tubular steel

sarapis stool
starck
1985
rect steel

latonda
botta
1987
tubular steel

dr. glob
starck
1988
molded plastic

histick side chair
gehry
1992
bentwood



cross check chair
gehry
1992
bentwood

power play chair
gehry
1992
bentwood

Product: Contextual Navigation

The scope of the project originally attempted to identify quantifiable characteristics to be used as sorting and organizational tools. These factors ranged from date of production to name of manufacturer. The aim, upon identification and classification, was to utilize such characteristics as connections between seemingly dissimilar objects, thus, the user could come o an understanding of the chairs as group through their web of shared quantitative connections.

The user could come to see each piece as built up of many components not limited to just "cushions" and "structure ", but "design concept", "technological advance", and "functional sculpture". These readings could also provided the user an understanding of each object as a complex information structures which related with one another at different scales of complexity to form larger systems such as "chairs designed by Eero Saarinen", or "upholstered lounge chairs" to which the aforementioned systems are inherently related. While at even broader levels of complexity these larger systems could be related with one another to be called "modern chairs". Each system of data elements at different scales of relation to one another, are non-reducible systems, meaning, once shifted into another dynamic context, they would be seen as something completely different, due to the shifted conditions of their contextual relationships.

After an initial investigation into the relevance of various criteria originally selected to be used in the linking of the different objects, it became clear that a specific number of the connections had little to do with the factors which set these chairs apart from all others, such as chairs which were related only by price range, or manufacturer. This resulted in an effort to reduce the number of identified relationships to that which best illustrated the chairs design-based qualities such as issues relating to the designer as his or her related work, the impact of the time period in which it was designed on the design, the original or reinterpretive use of materials used in its fabrication, and the way in which the designer balanced design concepts with typological affordances.

As the previously defined goal of the research project was to build a digital interface between representations of a group of modern chairs and a digitally literate user, which would position the user within the shared contexts of these objects illustrating them in relation to one another and to the user's own environment. This understood, it became clear that as the number of possible relationships to be illustrated could be seen as infinite, and the timeframe of this exploration and the capabilities of the tools utilized in its design were not, a number of compromised would need to be made in the hope that the ideas involved could still be expressed to fullest means possible. These factors were especially important in the selection of the tools to be utilized and the environment in which the project would be constructed. After much consideration, Macromedia Director was selected as the authoring tool to aid in the design of the interactive environment, as it currently provides the greatest flexibility and richness in methods of representation and navigation. However, the extensive use of highly descriptive, but

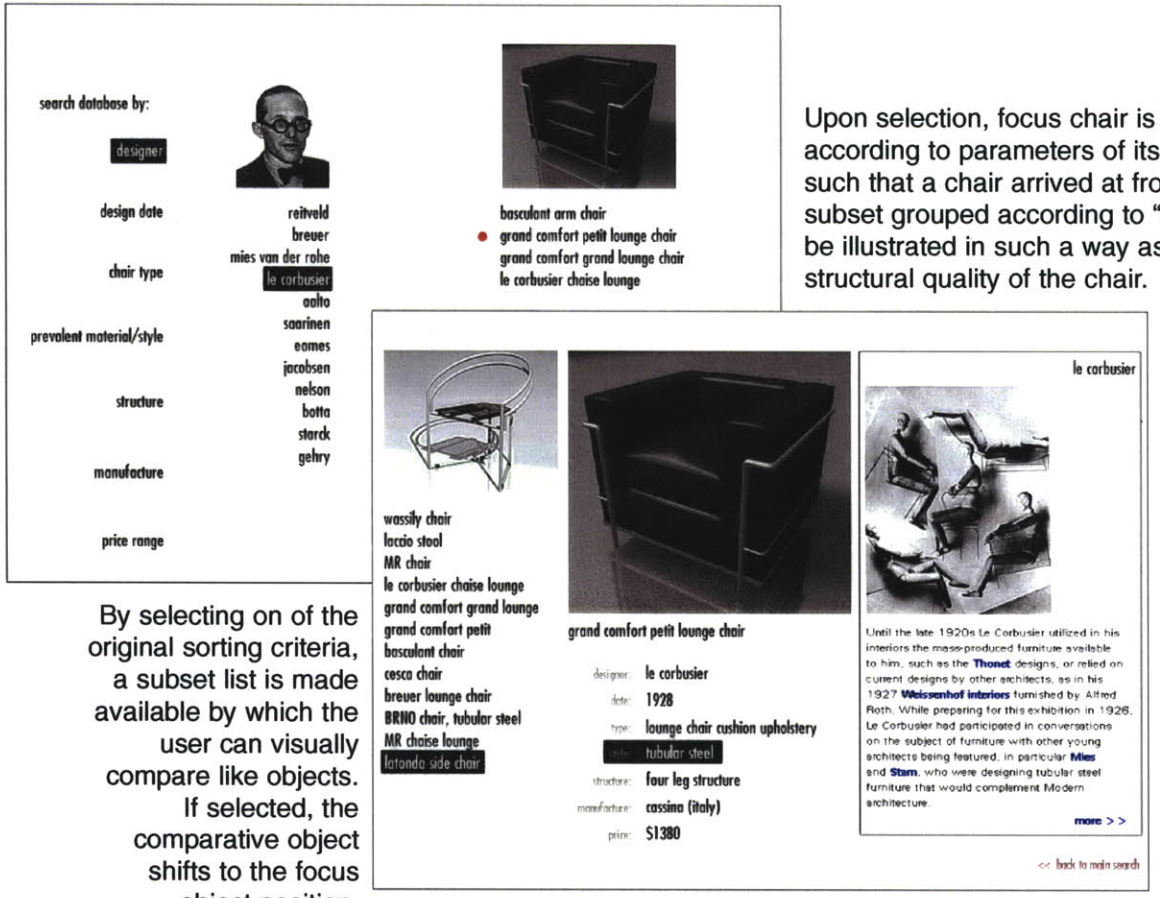
unfortunately memory intensive animations and digital images, limited the project to that of a non web-based structure, which would have illustrated the qualities of a systemic informatic environment to a greater extent.

As the product of this research project is a digital hypermedia document, the best mode of description is for the user to experience it firsthand, which this author urges the reader to do. Within this linear medium of printed page, the author will illustrate the progressional design of the relational structure, through a series of screen-captured images taken from different stages in the design, with accompanying text to illustrate various concepts.

fig 2.e -Extensive research into the original design process and physical fabrication techniques (scaled drawings, materials study, etc.,) provides means to digitally construct three-dimensional representations used for project illustration. Chairs are rendered in still-image and "VR-object" formats illustrating a number of features and material types.

fig 2.f -Once constructed and rendered, the chair images are organized into an online web format. Site visitors can cross-reference designers (top)with other pertinent factors (date, material, type) to display the chairs in various configurations. Thumbnail galleries (center) lead to larger images of chairs displayed in different positions, material choices, etc.(bottom)

fig 2.g -**First interactive exploration**, December, 1997. User is provided multiple sorting criteria which filter the group of 56 chairs down to a smaller subset then viewable above on mouse rollover. Selection set text is graphically inverted to illustrate the path from where they came. Navigation is very text based at this stage, not addressing the user's desire to navigate on a purely visual basis. Overall size of group is difficult for user to gauge.

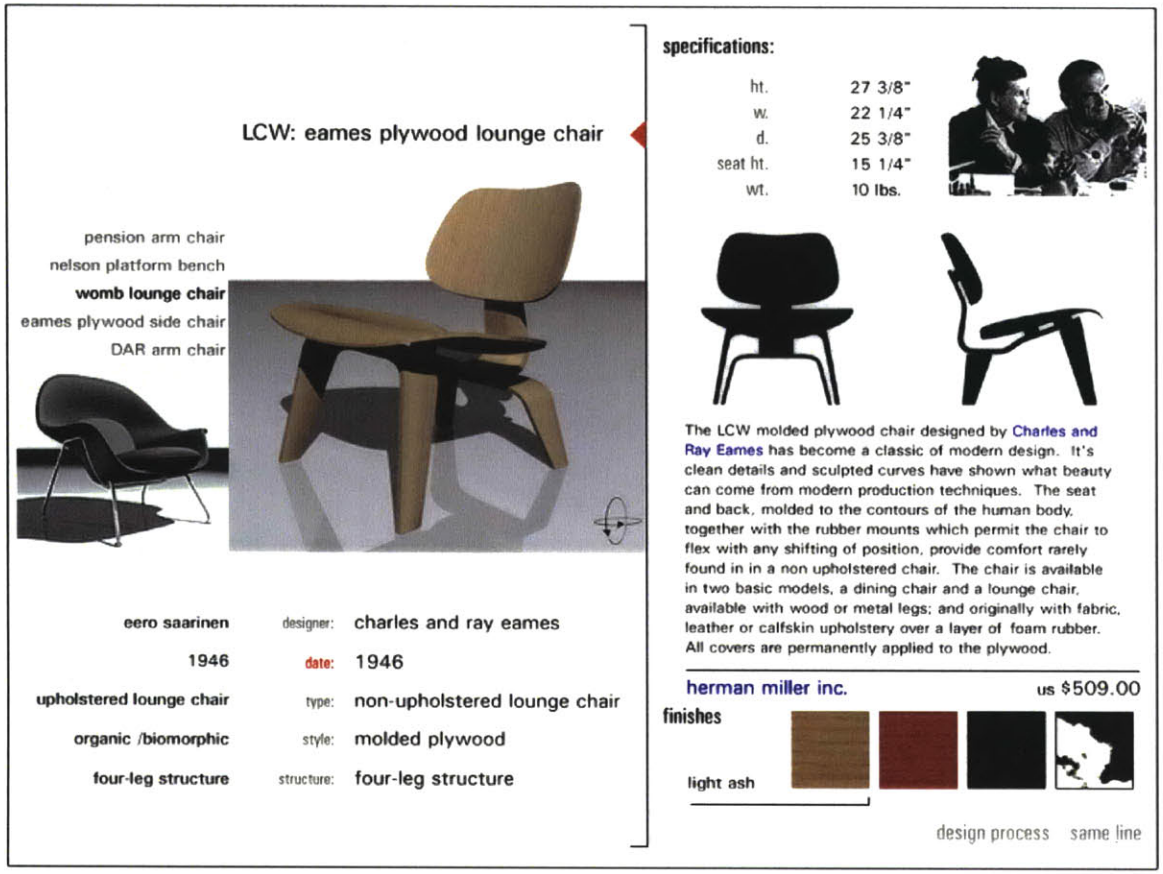


Upon selection, focus chair is illustrated according to parameters of its group selection, such that a chair arrived at from looking at a subset grouped according to "structure", would be illustrated in such a way as to express the structural quality of the chair.

By selecting on of the original sorting criteria, a subset list is made available by which the user can visually compare like objects. If selected, the comparative object shifts to the focus object position.

The user can also browse through an interrelated hypertext document which is automatically updated to reflect the qualities of the focus object. However, this cannot be used to navigate the overall document.

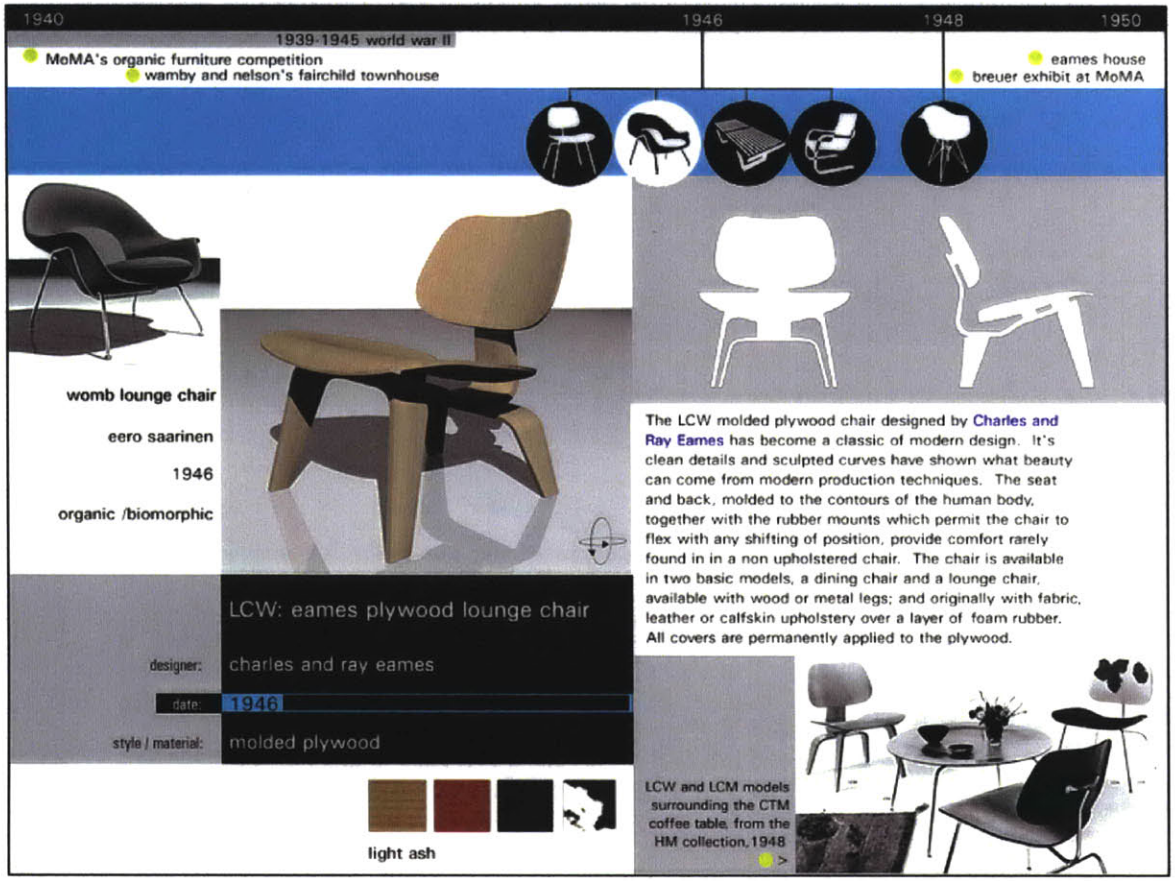
(fig 2.h) -**Layout/navigation study**, February, 1998. Applying a more unified feel to the overall navigation has both benefits and drawbacks. As the number of sorting criteria is reduced, the document begins to focus on design-based theme. Comparative objects are displayed with all criteria provided, allowing the user to compare on more than one level. Scaled-down comparative image and two-page catalog-look, puts too much emphasis on the focus object and not enough on the relationships between objects.



Scaled front and left profiles provide the user a universal view of the individual objects, but the overall singular view keeps the focus on the objects and noth the relationships between objects.

Material choices update main display and impact price listing if applicable. Pricing and exact measurements are only relevant to a specific furniture buyer, few others would find it of use. This brings into question, the scope of the target audience, calling for a greater reduction in criteria.

fig 2.i -**Layout/navigation study**, March, 1998. Major development is the implementation of the navigational timeline which reflects the time period of the focus subset dictated by the selected sorting criteria. Timeline orients the viewer within the time period by supplying contextual events in general history (grey line), and design history (yellow points) The user is able to navigate the group by updating the focus object from chairs available on the timeline's contextual view. Still focuses on a single object with little comparative data available to provide contextual weight. Iconic view of comparative objects allows the user to visually relate to the group in a glance without overwhelming them.



Graphic identity is beginning to formulate but color decisions carry mixed signals, calling for a systematic look at the issue. Color block areas provide a sense of distinct information zones but seem to have little rhyme or reason and do not illustrate the left/right approach.

Timeline and right side description block are updated with change in selected context but put too much emphasis on the single object.

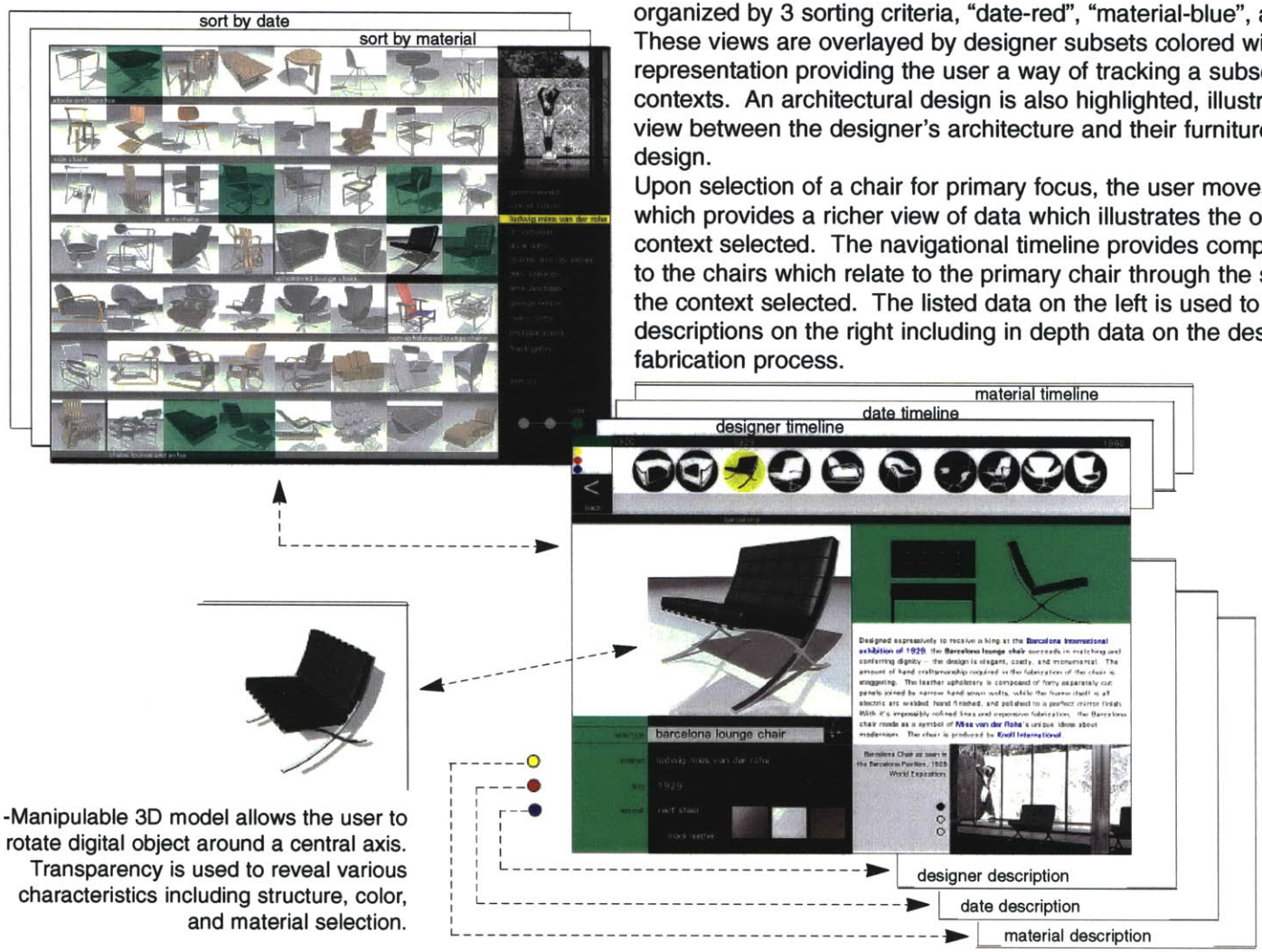
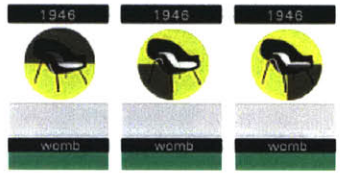


fig 2.j -**final hypermedia document**, May, 1998 -Group of 56 chairs is organized by 3 sorting criteria, "date-red", "material-blue", and "type-green". These views are overlayed by designer subsets colored with the contextual representation providing the user a way of tracking a subset through a series of contexts. An architectural design is also highlighted, illustrating a comparative view between the designer's architecture and their furniture or indesutrial design.

Upon selection of a chair for primary focus, the user moves to the next level which provides a richer view of data which illustrates the object in relation to the context selected. The navigational timeline provides comparison and navigation to the chairs which relate to the primary chair through the shared relationship of the context selected. The listed data on the left is used to navigate the nested descriptions on the right including in depth data on the designer, time period and fabrication process.

-Manipulable 3D model allows the user to rotate digital object around a central axis. Transparency is used to reveal various characteristics including structure, color, and material selection.



(a) (b) (c)

On user mouse rollover, the chair icons provide 3 views of the object.

a) updates both left and right side views with the selected chair in relation to the contextual view which preceeded it.

b) updates the leftside view with the selected chair in the same context as rightside view for comparison.

c) likewise but reversed.

The extensive research, design, and implementation, of this hypermedia document has proven to be an extremely exciting and valuable experience, providing great insight into different techniques with which to accommodate the very individual ways we learn and gain an understanding of our environment. As the author feels a level of success was achieved in the completion of this exploration, there is an understanding that the surface has barely been scratched. This was never more evident then while referring back to the various stages of the design prior to the last completed, and with the aid of hindsight seeing how absolutely poor the initial studies were in comparison to the final product. With this in mind, one shudders, and is encouraged, when speculating how this final product will appear with the accumulation of greater experiences, later on.

Introduction

As digital technology continues to break new ground in the areas of three-dimensional simulation and the reduction of interface between man and machine, content designers will be provided new means of expressing their ideas. If we recognize that the computers' abilities of simulation and representation of percepted realities are still in the infant stages of development [Mitchell, 1992], the possible implications of the influence of such technologies on the way we learn and communicate is staggering. It implies completely new approaches of experience-based learning and communication in which the user is sensorially transformed to a completely new or augmented environment specifically suited for these actions.

The author would like to examine a few of these technologies and speculate on methods of integrating them into a physically and digitally immersive environment geared towards the illustration the subject matter previously illustrated in the thesis research project.

Emerging Technologies

The first technology addressed is referred to as Augmented Reality(AR), which was developed from research into military weapons systems. AR uses heads-up display (HUD) technologies, or reflective/transparent "eyephones", to provide the user with layers of related data superimposed directly onto their visual and/or audible environment. Augmented Reality systems are ideal examples of parallel navigation in which the user's interaction with the outside environment is related through realtime illustrations of changing conditions, or results of various actions at different scales and/or levels of meaning.. AR applications include the use by Electrical engineers (providing them the ability to refer to circuit diagrams superimposed on the actual work surface), surgeons (reference to medical texts and/or view three dimensional representations of microscopic or difficult to visualize conditions, without leaving the operating table), Security (able to check Ids without direct interaction), and transportation (drivers could track their own movements, be updated with traffic reports, or change radio stations without their eyes leaving the road) [Cotton, Oliver, 1994].

Another example of AR technology closer to home, is the implementation of realtime special effects within the sports broadcast medium through the integration digital hardware transparently into the viewing experience. Named SporTVision, the company developed the FoxTrax system, which by placing a digital sensor in the too-fast-for-the-naked-eye hockey puck, allowed them to superimpose a glowing graphic over the puck, making it easier for novice viewers to follow the action (and enraging long-time watchers). Using motion sensitive high speed cameras, powerful workstations, and custom software, SporTVision is also able to measure events such as a basketball player's horizontal and vertical leap, and superimpose diagrammatic graphics onto the instant replays seconds later. Similar

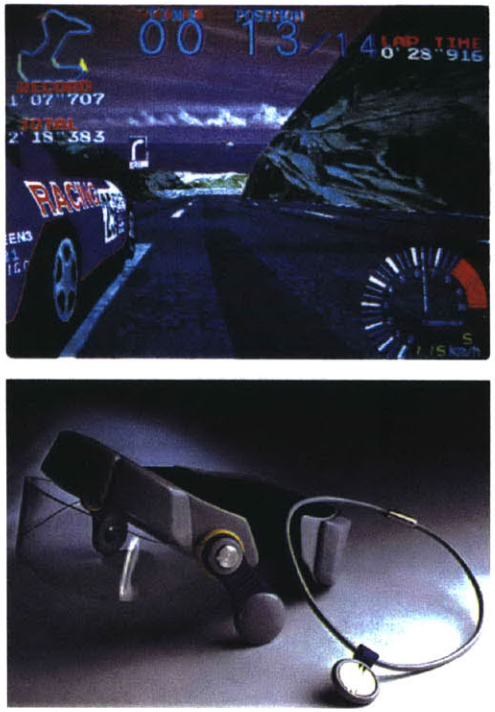


fig. 4.a and 4.b
AR representation as seen in video game
transparent HMD used in AR

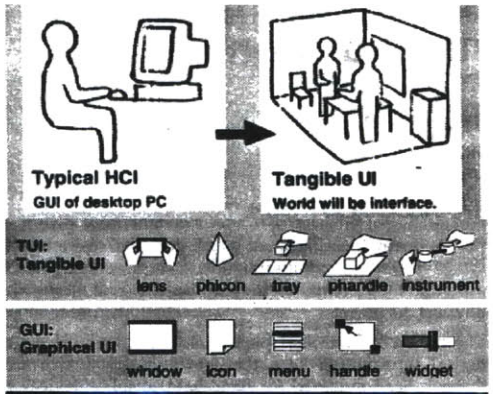
for various other spectator sports are sure to follow. The power of SportVision's technology is the speed at which they can process and produce the parallel data, providing a much richer augmented reality experience than the slow-to-update stats and score broadcasts of the past [Nickell, 1998].

A new approach to augmented reality, tangible bits technology, being explored at the MIT Media Lab by professor Hiroshi Ishii, attempts to bridge the gap between virtual and physical reality. By integrating physical objects with digital triggers (or accessible bits), real-world objects react digitally to physical stimuli. This new approach to AR looks to improve our physical relationship with technology, by using everyday objects as the digital interface. Ishii and his researchers recognized a lack of physical affordances in contemporary technology as compared to the richness found in historic scientific instruments. Using such tools, past scientists could identify direct relationships between the visible mechanics, the phenomena being measured and the data collected, whereas today's anonymous personal computers provide little more than what is confined to the video display. Tangible bits looks to reconnect digital computing with the physical richness of the past. A Tangible User Interface (TUI) or Graspable User Interface returns the interface from the display screen and into physical space, reclaiming and strengthening the metaphors we have adopted in the "desktop" digital working environment.

Ishii's metaDESK project translates accepted desktop iconography into physical objects with digital implications. As these physical objects are physically manipulated on the rear projected horizontal surface of the metaDESK, optical, mechanical, and electromagnetic field sensors translate the users physical input into digital actions within the TUI environment. "Windows", "icons", and "menus" all have physical counterparts which the user can physically relate to [Ishii, 1997].

Another emerging technology which may drastically change the way we relate to each other and the world around us is Virtual Reality(VR). Today, the term virtual has been tied to many different aspects of everyday life. From "virtual banking" and the "virtual corporation", to "virtual sex" and "virtual communities" the term "virtual" has come to encompass anything and everything having to do with digital communication. Jaron Lanier coined the term Virtual Reality in 1986, to describe a mutually expressive environment for people to share creative ideas, or what he called a "Ready-Built-for-2" (RB2). An avant-garde jazz musician, Lanier's company, Visual Programming Languages (VPL) patented many early components of cutting edge VR hardware and software including the dataglove, head-mounted display, and datasuit —with the purpose of integrating them into the construction of such collaborative work and communication spaces [Jacobson, 1992].

VR technology can be identified by "the three I's": Immersion, interactivity, and information intensity. Immersion comes from technologies which "isolate the senses sufficiently to make a person feel transported to another place. Interaction refers to computers ability to read and respond to the reactions of the user within an immersive environment. While information intensity refers to both the speed at



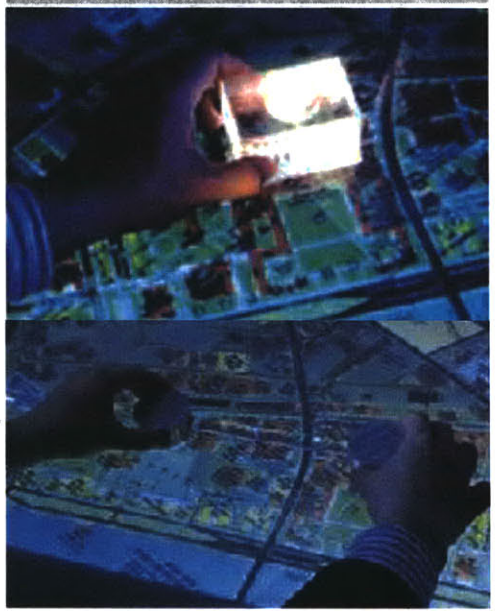


fig. 4.c terms of TUI
fig 4.d and 4.e, Ishii's metaDESK

which the computer must react in order to convey the proposed simulated experience, and to special qualities of such virtual spaces which provide the user tools for their navigation [Heim, 1998].
Their are two specific brands of VR referred to as telepresence (coming from the Greek word tele, meaning remote), which can be integrated in various ways to provide the user the degree of immersion or simulated reality they require. Teleoperational telepresence refers to a system which simulates an existing reality in realtime, allowing the user to "be" at the other location and manipulating tools within the distant environment. Artificial telepresence simulates a completely virtual environment which does not exist in physical reality and therefore does not adhere to traditional rules of nature. This quality provides the opportunity for the space to be only what it needs to be to best convey the information to the proposed user(s)[Heim, 1998].

The Immersive Information Space

From our discussions of various existing and emerging digital technologies the author would like to propose a future thesis which would combine these tools in the construction of a physical and digitally immersive information/knowledge space for the rich illustration of a selected subject, again in this case, modern furniture.

To restate, as physical objects alone, these chairs are beautiful to look at, and for the most part, comfortable to sit in, but little more than that. They are a group of inert objects which on their own can independently reveal little of the historical data which illustrates them as unique, or expresses directly how they relate to one another.

These interrelating systems of data are what we identify and process to construct our individual knowledge of the object, a chair in this case. We use this same knowledge to contextualize the chair in relation to other chairs, coming to understand each piece as a subsystems within a greater system, which constructs our conceptual understanding of a group. To think of viewing these chairs outside of these contextual systems is impossible, as it is our comprehension of the relationships among these systems which affords us our perceptual understanding of the "objects".

Once we have identified these systems and relationships between systems at varying scales, the challenge is to find the best way to illustrate them to the casual observer. This proposal would specifically call for the use of a user-driven, non-linear system of navigation (hypermedia), coupled with a part-time fully immersive sensorial input device (VR) and superimposed transparent information display(AR), activated through the physical interaction with the chairs themselves (TUI). This would allow the users to relate both physically and digitally with the objects, providing both a quantitative and qualitative-rich comprehension of the object and the group.

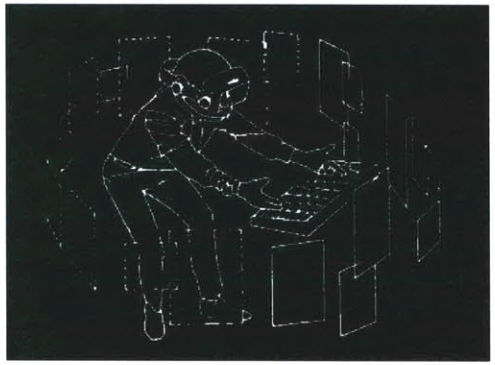
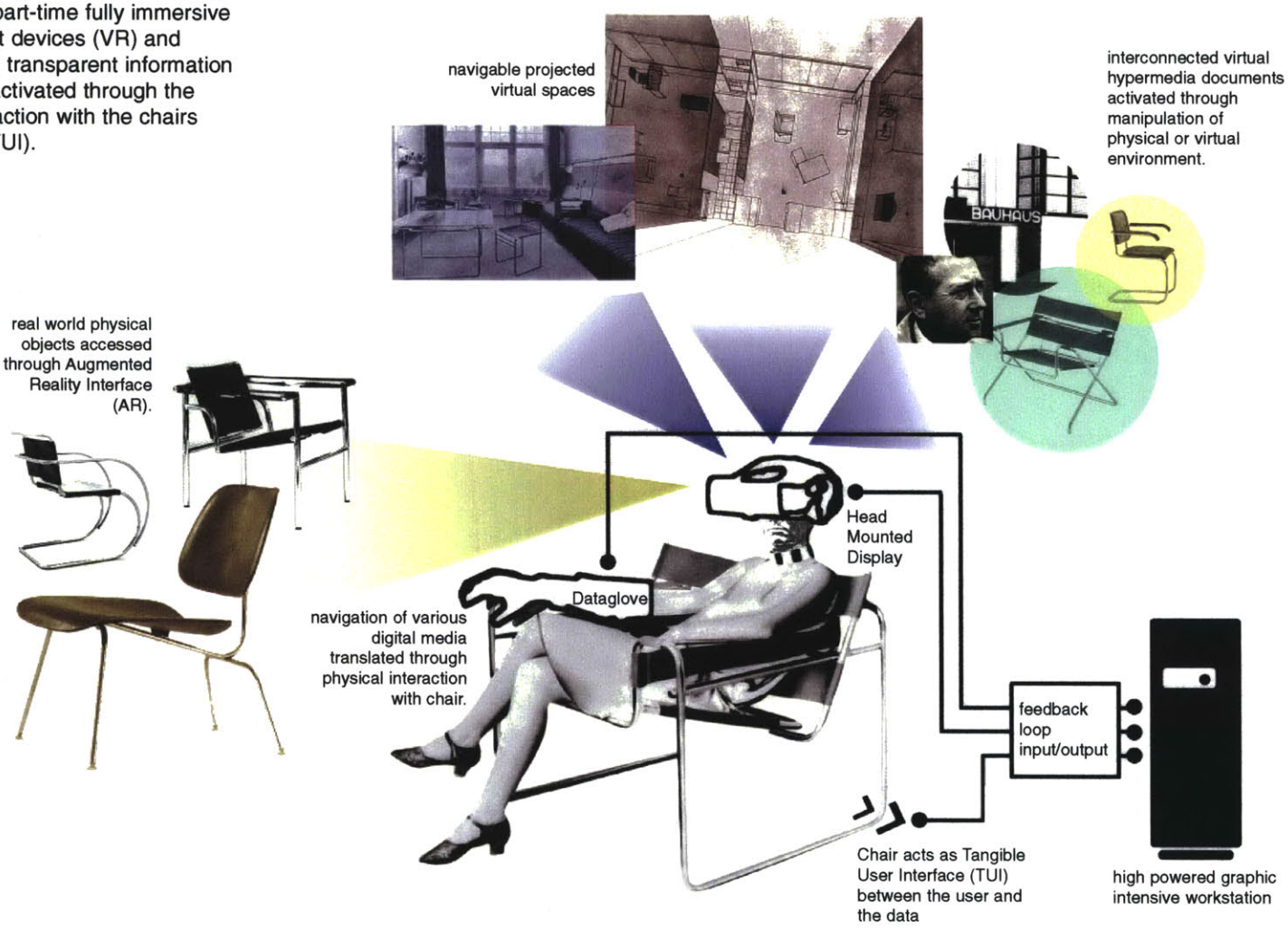


fig. 4.f Virtuality Standup Console
fig. 4.g VR environment, NASA/Ames Research Centre

fig. 4.g Diagram illustrating the "Immersive Information Space" concept.

a user-driven, non-linear system of information navigation (hypermedia), coupled with part-time fully immersive sensorial input devices (VR) and superimposed transparent information display(AR), activated through the physical interaction with the chairs themselves (TUI).



Upon sitting down in a particular chair, the augmented display would be activated through physical contact with the specific object, providing the user a number of methods by which they could navigate the various information structures related to the selected object. Haptic feedback from the user's physical interaction with different parts of the chair translated through a dataglove, datasuit, or relative positioning system, could be used to navigate the AR-superimposed data structures, allowing the user access to information which would relate to the area of the chair they are interacting with. For example, if the user would touch the "shock mount" joint of an Eames DCM side chair, the user could choose to view an illustrative animation or film clip, demonstrating how the joint is fabricated. Or read about how the technology was developed, semi-transparently layered on to their own physical reality. By sliding the data-gloved hand across the textured surface of a Frank Gehry cardboard composite Easy Edges Chaise Lounge, the user could navigate between a portfolio of Gehry's corresponding architectural work involving the reevaluation of inexpensive materials, or view a taped interview with the architect from 1972 in which he describes the design process behind the chairs.

As the user navigates through the architects portfolio, they could elect to shift from the augmented reality into a fully (or partially, dataglove vs. datasuit) immersive VR simulation of one of the architectural spaces. As they sit in the physical object (the chair), their perceived surroundings could reflect the designer's vision of the optimum space for which it was designed. Sitting in a Barcelona lounge Chair designed by Ludwig Mies van der Rohe, could bring to experience a simulation of the Barcelona Pavilion as it existed in 1929, digitally constructed from historic records and photographs. Or during a viewing of a film clip illustrating a particular fabrication technique, the user could call up a virtual window to the designer's current design studio, showing the goings-on in realtime.

The user could also choose to layer the augmented reality structure onto the virtual simulation, allowing them to reference various aspects of the actual space, digitally simulated, through multiple media at different levels of meaning.

This VR/AR/TUI environment could be used to illustrate the connections between different but related objects as well. By tracking the user's gaze, the system could provide relevant comparisons of distant objects in relation to the selected object. This comparative gaze could contextualize the selected object within the group, and lead them to shift their attention, and information/knowledge environment, to another chair.

By illustrating the group in such a way, the chair itself becomes the interface by which the user navigates complex connections between objects, while technology provides the window through which we can identify these contexts that surround and perceptually construct the object.

With the decline of the Organic paradigm (all powerful God or gods responsible for all phenomena) and the shift towards acceptance of a Cartesian paradigm (Science, the new god, explains all phenomena through localized cause and effect), a greater understanding of the world came into view. Now on the slope of the decline of the Cartesian paradigm, a new, more holistic approach to understanding our relationship to our environment has taken place—one concerned with applying a more integrated Systems View of experiential phenomena. The shift recognizes the relationships between dynamic systems of phenomena as building blocks of our own individual perception. This individual perception leads us to understand that we each possess a dynamic (ever-changing, fluid, shifting) concept of reality in which all phenomena is judged subjectively, and in context to it's relationships within time. A shift from a dyadic-- THIS means THIS-- view of an absolute reality (Cartesian) to a triadic--THIS means THIS to ME-- view (Systems) provides for this comprehension. A shift towards an understanding of the relationships of phenomena within a perceived environment can lead to new definitions for the process of obtaining knowledge, and new methods of expression which parallel this shift.

With this shift in thinking comes a need for the redefinition of the process of acquiring knowledge and greater understanding of the scaler relationships between the interrelated elements and systems of elements. Data can be seen as discrete non-divisible elements, which when read in relation to other elements, form systems of information. by "processing" these structures. Reading these information structures in relation to individually defined values and scales, allows for the ascertainment of a knowledge level. Content designers must look to identify these systems of related data elements and organize them in the most illustrative and efficient manner to a wide variety of viewers/users for greater understanding.

One limitation inherent within comprehension of this shift in thinking, is the Cartesian vocabulary that is utilized to define Systems thinking and the underlying process. This last statement is a case-in-point. Cartesian thinking states that man can explain, or "define" any phenomena by isolating and identifying the factors which caused it to happen. As the Systems View illustrates, our environment is a constant and binding state of flux within which we relate with other complex systems to construct our own individual realities. Thus, the traditional meaning of the term "define" is meaningless. [Capra, 1982]

A parallel can be drawn between these limitations of the Cartesian vocabulary, and the limitations of current Cartesian media. Hypermedia tools such as those used in the construction of the accompanying research project (Macromedia Director), offer powerful modes of expression as an internal navigation, but are still very isolationistic in their mode of relational dissemination by way of the CDrom. The World Wide Web (WWW), a potentially huge systemic media, is a powerful tool for the illustration and communication of information to a non-local environment. However, it is still very limited in its power to richly express content due to low bandwith and severely confining tool vocabulary with restrictive

processing abilities. Such are the current limitations of the media, but they are in no means a permanent condition. Promises of higher internet bandwidth, ever-increasing speed of digital processors, as well as the more powerful programming environments, will provide the capabilities of having the best of both. Complete and immediate access to a worldwide network of rich systems of contextual data, will make possible modes of representation and simulation that closely, if not completely, mirror our own realities. We stand before the base of the stepping stones.

In conclusion, changes in thinking about the formation of relational knowledge, and advances in technology used in such a process, are mere components of successful content design. Designers of such systems and environments need to identify these relationships between the specific user and the information being communicated, in order to design an appropriate method of illustration. Systems View tells us that the connections are present, and are recognizable at different and non-local scales. It is the task of the content designers to identify and illustrate these connections and relationships to the proposed user in the manner most appropriate to the given content or desired experience.

Marshal McLuhan said the medium is the message. One might say that the intent of my thesis is the message delineating the media. The systems theorist of the future will say that both views are accessible and that the unexplored periphery between them is seemingly quite wide, positively permeable, and ever changing.

Theory/Content

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