

Heriot-Watt University

Department of Computing and Electrical Engineering

# The Human Factor

Course Work 1998-1999

"I must perish in this deplorable folly. Thus, thus and  
not otherwise, shall I be lost"

**The Fall of the House of Usher, E.A.Poe**

"The most deep-rooted fallacy...is that the conditions of a  
phenomenon must, or at least probably will, resemble the  
phenomenon itself."

**J.S.Mill**

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# Contents

1. Introduction.....	Page 3
2. The Propositional Model of Human Memory.....	Page 6
3. Web Design & User Models.....	Page 11
4. User (or Abuser?) Psychology.....	Page 22
5. HyperText/HyperMedia Critique.....	Page 25
6. Case Study.....	Page 31
• Introduction.....	Page 31
• Analysis.....	Page 35
• Propositions.....	Page 51
7. Conclusion.....	Page 52
8. References.....	Page 53

## Introduction

I have been roaming the ever winding and ever expanding threads of the World Wide Web for some years now. Over this time, the quality of experience of the daily journey into the constantly boiling waters of this quasi-chimera pond of omniscience has never been the same. It's been constantly varying from the very satisfying feeling of full (or seemingly so) exploitation of the Web's potential to serve my daily information cravings, to the extremely frustrating and disappointing feeling of inadequacy or bad design of a certain aspect of Web navigation or search that would hinder my attempts to get what I really wanted or would tempt me to invest considerable time in a task that promised more than it actually delivered. It has also been the case, sometimes, that the active engagement from my part in the analysis of meta-data structures that constituted the substrate of my given, at the time, information retrieval task would reveal inherent inadequacies or even logical fallacies in the design and implementation of a certain Web site or a navigation and/or search engine or "spider/bot".

Through the years I have come to realize that these problems could actually be roughly categorized as follows:

- **Bad HTML coding of WEB pages would result in frustratingly slow-loading web pages.**
- **Heavily loaded with links and options pages would promote cognitive overload and disorientation and make simple tasks take more time than they should while augmenting the ever present stress of the user.**
- **Incomplete, unreliable hypertext with many embedded links that would shatter its integrity to such a degree that any sense of context would be lost.**
- **Even well written and well transferred in hypertext form texts would be difficult to read and understand if I would not be able to easily print a serialized version of them. This in effect shows that hypertext should be used more as a means of navigation between different concepts than as a means of navigation between chunks of texts on the same concept or within the present context of discourse. This personal conclusion undermines hypertext's purported potential to become the new form of reading and learning material.**

It is with great pleasure then, that I undertook this project, as it addressed a subject that has been occupying my thoughts for some time and in fact on a daily basis.

Hypertext has been around for some time; not that much as a standard practice but as a proposed new way of organizing and interrelating data. The original idea is traced back to the 40's in Vannevar Bush's vision of the "memex" (as we will see later this is not entirely true), although the name "Hypertext" was coined much later by Ted Nelson(1962).

There is no doubt that hypertext was born to provide a viable solution to the need to find a way to organize the constantly (maybe geometrically) expanding world wide knowledge into a system that would provide the means for anyone to retrieve any single article on any existing subject in a relatively short time (i.e. certainly within his lifetime). Furthermore hypertext is supposed to aid the user in learning the subject matter, by mimicking the supposedly semantic net representation of the concepts in the user's mind.

Books have served the purpose of storing and imparting knowledge for centuries, but their efficiency as a means of knowledge impartment to this and the future generations is heavily impaired by the sheer volume of the accumulated knowledge.

It will be my main objective in this paper to show how well Hypertext serves its Aristotelian Final cause and if there is actually the possibility of hypertext and hypermedia becoming the infrastructure on which the, dreamed of, knowledge panopticon will be based.

Other objectives of this paper include:

- **A discussion of the propositional model of human memory and its relation to learning via reading plain text and hypertext.**
- **Assessments of how well the Web and of course hypertext maps the system model to the user model and a more general critique on its theoretical foundation.**
- **An overview of the cognitive and technological concepts underlying current Web design practices.**
- **A short discussion of the user psychology and its implications on usability design guidelines and computer interfaces in general. The importance of the volatility of the user's psychological status will be stressed as a major factor in the user's ability to effectively take advantage of any system based on interaction.**
- **A case study involving a certain site that I find very well designed. All previously stated concepts and any drawn conclusions will be discussed in the context of this site and I will attempt to propose a few re-design suggestions.**

Concluding this introduction, I have to express my frustration with HCI scholars and professionals alike because of their apparent inability to adopt a common, uniform if you like, technical language. I persistently searched the Internet for documents on HCI and Cognitive psychology, and reading most of what I found, I had great trouble establishing a vocabulary that would feel standard and purport, at least to myself, the impression that I actually say – or rather write – what I mean. It seemed that although everybody were talking about the same things, they chose slightly different terminology – in some cases even conflicting – that would baffle the student. In some cases I even found documents that were contradicting per se, as they violated the very principles they purported. It seems to me that before we resolve the Human-Computer Interface problem, we have to address a little better the Human-Human Interface problem first.

Of course, the subject of this paper involves an ever-present and fundamental philosophical problem. How does one go about criticizing writing or language itself by using that same language? How can one use his mind to grasp mind itself in its entirety? Any investigation of a subject that inherently involves introspection bears, in its very conception, the possibility of ludicrous extracted conclusions. It seems that hypertext itself may prove to be the intellectual offspring of seemingly logical conclusions based on such deep rooted delusions as the assumption that we can effectively engage any problem of considerable conceptual difficulty.

## The Propositional Model of Human Memory

The quest to investigate, chart and decipher the brain or mind structure is a very old one. A lot of theories have been formulated and all have failed to provide an adequately accurate model of the human mind and the way it works. It may be the case that the notorious, in experimental methodology books, “observer effect” is the primary reason for such failure. Specifically, it may be the case that by observing the way the mind works we actually actively participate in the way it works and we thus fail to see what really happens. This may well prove to be an unsurpassable obstacle.

The very distinction of brain and mind – if there is such a distinction – is an elusive if not artificial one. Modern treatment of the terms suggests that we should view the brain as “wetware” - an analogy drawn from the computer related term “hardware” – and the mind as the “software” of a kind that makes use of this wetware.

Memory is part of the human mind; it is in fact the most important part. That is because all mental actions, like decisions, judgement, problem solving etc. heavily depend on input that comes from the stored, in memory, knowledge. In the information-processing model of the human mind, there are three basic kinds of memory:

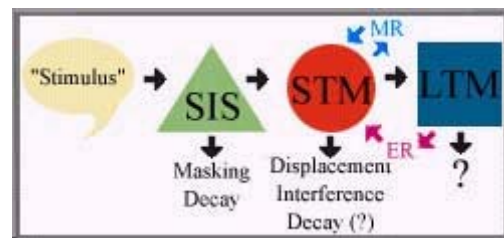
1. **The sensory registers (or stores):** which hold raw sensory data that needs to be attended before it is lost (overwritten or decayed).

2. **Short-Term Memory (or Working Memory):** which is used as a kind of

scratchbook for the human mind. The information that reaches the working memory is actively processed and

temporarily held, until it is transferred to Long-Term memory or lost through Displacement.

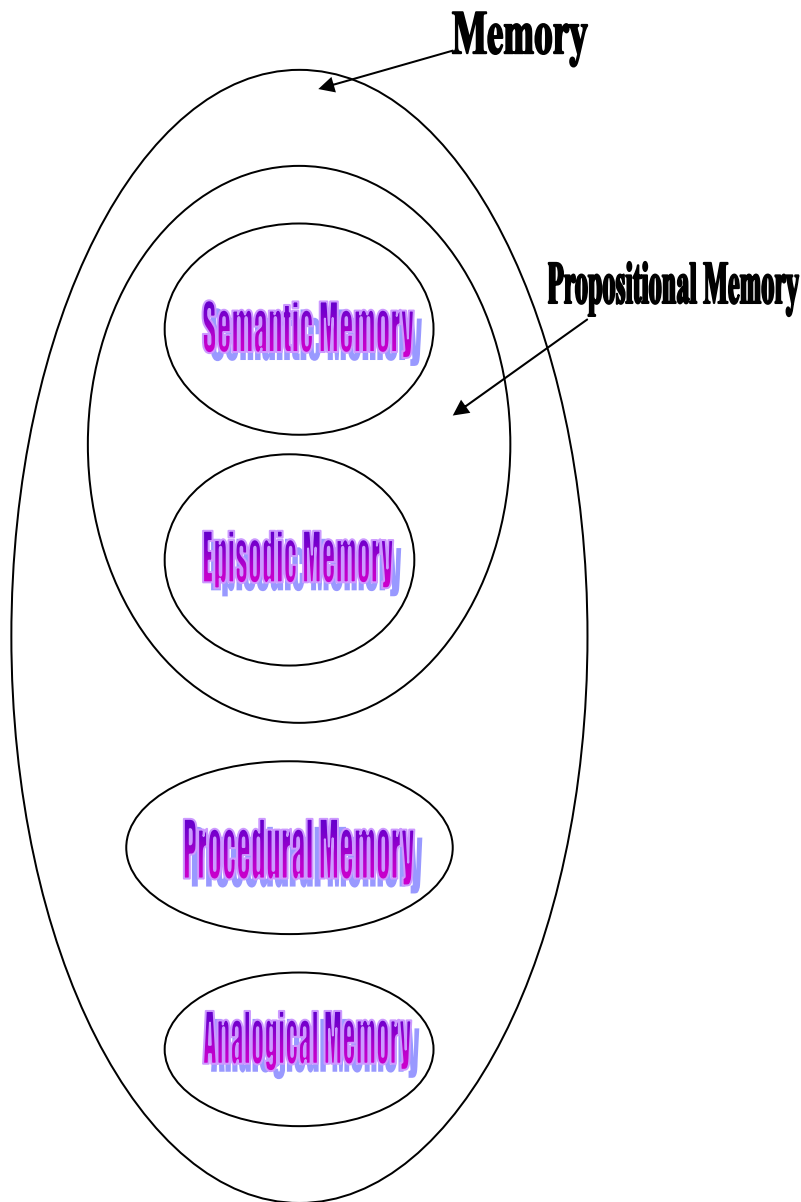
3. **Long-Term Memory:** is assumed to provide permanent and unlimited in capacity storage, although it may experience information loss through interference.



The propositional model is a model of knowledge representation that basically applies to the Long-Term memory, although it could perhaps be extended to include Short-Term memory too.

Before we take a look at the characteristics of this model lets turn our attention to the meaning of the term “proposition”. According to modern and contemporary logic, a proposition is the concept (the content) behind a declarative sentence that bears semantic value (a statement). In other words a proposition is what is actually said or expressed by a declarative sentence that can actually be tested to be either true or false (semantic value). In essence propositions are “bricks” of factual truth or knowledge that help build the “building” of our knowledge.

A statement is only the linguistic (wordly) construct or vehicle that delivers the proposition. The proposition, or the knowledge purported by the statement (the concept) is what is actually stored in memory.



Long-Term Memory holds three different basic types of knowledge representation:

- Propositional
- Procedural
- Analogical

Furthermore Propositional memory is divided into:

- Semantic Memory
- Episodic Memory

Semantic memory is the memory necessary for the use of language. It is in essence a network of symbols(words), their meaning and relation with each other, and basic rules for the manipulation of these symbols, concepts and relations.

Episodic Memory, on the other hand, is a system that stores information about temporally stamped episodes or events and spatio-temporal relations among them.

While Semantic memory registers knowledge conveyed by referential events and language, episodic memory registers immediate experiences.

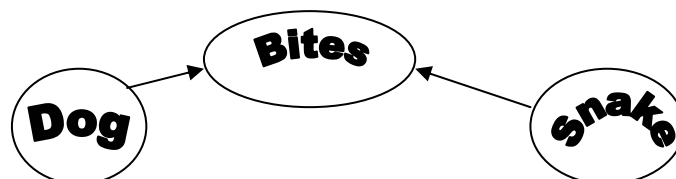
Procedural Memory is the simplest kind of memory. It stores simple “how to” knowledge, expressed in algorithm-like routines. It is the kind of memory that holds such knowledge as “riding a bicycle” and using an elevator”.

Analogical Memory stores memories that are picture-like, resembling their subject matter.

Another important issue in memory models is that of memory organisation. Organisation is assumed to be a vital and necessary characteristic of human memory, given the fast retrieval of information that is exhibited even though the amount of stored knowledge is vast. In general the concept of Network is prevalent in all cognitive theories of memory organization.

Procedural, and more specifically Semantic memory is assumed to be organised as what we call a Semantic Network, which is in essence a conglomeration of Nodes and Links. Nodes are concepts or objects bearing some semantic value, and Links express the relationships between the nodes by interconnecting them in an appropriate way. A simple Semantic Network expressing the following two basic propositions

- Dog Bites
  - Snake Bites.
- would be the following:



Another theory of memory organization is that involving Schemata. Schemata are still network like, but are in a sense more specialized, as they involve a network of general knowledge based on previous experience about a specific object or class of objects or a certain type of situation.

Schemas are of seminal importance in cognitive and developmental psychology. Jean Piaget's genetic Epistemology theory is in fact based on the theory of schemata.

Piaget's biological study led him to believe that all species have two innate, inherited basic tendencies, or "invariant functions." These functions are:

**Organisation:** Combining, arranging, recombining and rearranging of behaviors and thoughts into coherent systems. What this means is that human beings have a need to organise their thoughts and knowledge into workable groups, or schemas. For example, children are seemingly born with a schema for suckling. They can suckle their mother's breast, and when you present a child with a bottle or pacifier, they apply that scheme to the bottle or pacifier. As we learn more and more information, our schemes become more and more complex--from the simple (suckling) to the complex (preparing this paper on Microsoft Word).

**Adaptation:** Adjusting to the environment. Piaget believed humans are constantly adjusting or adapting to the environment, making things work better. We are on an ongoing mission to understand more, and to understand better. Adaptation involves two processes:

**Assimilation:** Assimilation is the process of using existing schemes to incorporate new information. This is the example of the child adapting to the bottle or pacifier, or the student learning how to use a different aspect of Microsoft Word. *To achieve this, however, we often distort the new information to make it fit. For example, if the above-mentioned baby were handed a cactus, he would be likely to try to suckle it. Or, a child who has a dog schema and has never seen a cat is likely to say, "Dog! Dog!" when he sees a cat.*

**Accommodation:** Altering existing schemes or creating new ones in response to new information. *When the child who confused the dog and the cat learns that dogs are dogs and cats are cats, he will build a new schema for cats. This is accommodation.*

A type of a schema is the script, which is a knowledge network that represents and describes in as much detail as is possible a certain scenario of behavior in a particular setting that seems to repeat in our life.

The resemblance that the semantic networks bear to set theory is neither accidental nor superficial. It is generally admitted and understood that classification of all kinds of objects underlies all knowledge. In other words knowledge can only be defined if there are distinct classified objects, forming classes with certain attributes. One can now easily see that the semantic net representation is just a simple expression of the naturally occurring process of classification. Specifically, links between objects actually form sets or classes of objects, that overlap, intersect, are nested or even identical. Through this classification process which is always active, new classes emerge and general abstract classes are formed.

## **Web Design & User Models**

The information contained in the WWW is vast and covers all aspects of human interests. How this information is organized as a whole is not exactly known and furthermore its organization varies from day to day as it is in a constant state of revision and dynamic update. This fact comes as bit of shock to anyone that is used to the static nature of a book. Even though a book itself is usually re-edited and re-published still its nature, which is concrete in essence, has been conveying a feeling of status-quo pertaining to the knowledge involved and an accompanying feeling of security, which is in fact much needed for humans to function to their fullest.

One first level of WWW organization is that of Web sites. Web sites are not as much part of a conceptual organization of information as they are a necessary domain distinction decreed by the very nature of the network technology underlying the WWW itself. Still it is a fact that in a many cases a site contains info on a specific subject and may thus be regarded as part of a very basic knowledge organization throughout the Web.

Each site makes public the knowledge it contains by means of a hypermedia system based on the HTM (HyperText Markup) Language. It is through appropriate HTML programming that the textual and other kind of information contained in the site is chunked into pieces and interconnected with links that are so selected and implemented as to map the information's logical structure into a web of interconnected Nodes which are "browsable" by the user.

It is a generally accepted fact, that the common user ("common user" is a term of dubious meaning, but it is usually defined by means of statistics) rarely reads long contiguous passages of text from computer screens, and most people who are seeking a specific piece of information will be annoyed to have to scan long blocks of text to find what they are after. This is one of the main arguments that leads to an organization of the information into small chunks of related information that all share a consistent organization scheme. It is this organization scheme then that forms the basis for hypertext links within a Web site.

The customary basic steps of organizing information this way are:

- Divide information into logically distinct units.
- Establish a hierarchy of importance and generality among those units.
- Use this hierarchy to structure relationships (expressed by links) among chunks.
- Finally, analyze the functional and aesthetic success of your system.

Although these general guidelines may seem, at a first look, fairly clear-cut and easily implementable, they are far from that. This is not surprising once one starts asking questions like:

- What is a logically distinct unit?
- Are you sure that what is important for you, is also as important for me?
- How does one go about analyzing the aesthetic success of his system?

In addressing some of these questions, web designers tend to adopt attitudes expressed by “cute” little statements like “Let the nature of the content suggest the best ways to subdivide and organize information”. Yeah, right! And may the Force be with you Luke Skywalker!

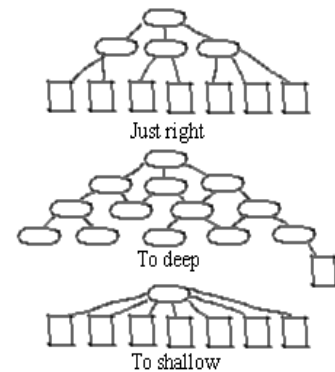
As with most things in this life, trial and error seems to be the way out of bad site design situations, and this is very easily understood once one notices how many times, even big firms that invest a lot of money in design, have to do a general redesign of their sites.

Thus, more out of accumulated experience and not understanding of the principles involved, inside the chaos of the Internet, one can occasionally find a well designed site and thank the universal entropy for being so kind. On the other hand, one also has to acknowledge that some basic understanding of the way the human mind works may help make the design process shorter and thus more successful.

It is a fact that when confronted with a new and complex information system, users begin to build mental models on the structure of this system, and then use these models to assess relationships among topics, and to make guesses (some like to call them educated) about where to find things they have not seen before. In most cases,

these guesses are based on previous unsuccessful attempts. If we have a system that the user can access and guess where to find what he wants without or with limited errors, then we have a successful information structure. It is in this case that the mapping of the system model to the user model is successful. In such a system consistency of methods of grouping, labeling, and graphically arranging information allow users to extend their knowledge from pages they have visited in the past to pages they are unfamiliar with. Unfortunately, such kind of consistency is many times not maintained within the whole of a site, and of course consistency between different sites even with the same subject matter is only a fleeting fantasy.


In any case, Web site design has as a primary goal the building of a hierarchy of link-menus and web pages that feel “natural” to the user. “Natural” here means that the user is able to intuitively find the right way through the hypertext structure and thus find what he is after without waste of time. Establishing this Web site hierarchy the designer has to be aware that there has to be a well-established differentiation between those nodes that are informative, such as data pages, and those that are structural, such as menu pages. Also, the need for



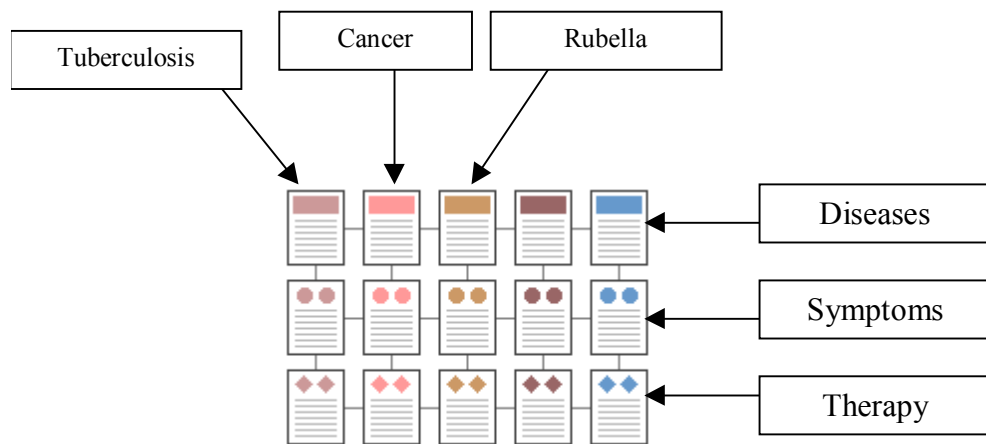
Depth of menu/content in a Hierarchy

balance between breadth and depth of the ensuing hierarchy is of seminal importance to the effectiveness of the site structure. Depth, is the number of consecutively linked menu pages, and breadth is the number of options or offered links in each one of them. Usually, a combination of a depth of 3 to 5 and a breadth of 5 to 10 is efficient.

Although the hierarchical scheme of site organization is by far the most popular, it is not the only one. In fact there are at least 4 different site-structuring schemes:

1. **Sequence** is the simplest way to organize information. Here information is presented  in a sequential narrative. This sequential ordering may be chronological, a logical series of topics progressing from the general to specific, or even alphabetically sequenced, as in indexes, encyclopedias, and glossaries. This scheme is usually implemented in small size sites.

2. **Grids** are a good way to correlate variables, such as a time line versus historical information in a number of standard categories such as “events”, ”technology”, “culture”, etc. To be successful, the individual units in a grid must share a highly uniform structure of topics and subtopics. Unfortunately, grids can be difficult to understand unless the user recognizes the interrelationships between categories of information, and so are probably best for experienced audiences who already have a basic understanding of the topic and its organization. A classic example of a grid-like structure is that of a database of different medical diseases:



3. **Hierarchy** is the classic and most common way of organizing web site information. Since web navigation as we have come to know it usually starts from a single page and users are naturally familiar with hierarchies, most web sites are designed as hierarchies of pages that offshoot from a single home-page. On the other hand, a hierarchy is well implemented only when the subject matter of the site is easily classifiable into logically distinct units (classes). This is not the case most of the times. Still this organization scheme is common place in the Web, mostly because hierarchical diagrams are very familiar in corporate and institutional life, and thus users find it easy to build mental models of the site.



It should be mentioned here that the Hierarchy scheme does not bear much resemblance to the propositional memory model and given the fact that this is the prevalent site organization scheme of the Web I think that the argument of this paper must be sought on a different level of organization than that of the Web site. Probably one will find more similarities between the hypertext structure of the Web as a whole – beyond any site boundaries – and the propositional model of the human memory. This is very different and it bears the added difficulty of possible loss of context and relevance as the site boundaries are abandoned in favor of the two structures (user and system model) coinciding as much as possible. One has to ask, is it the whole web that resembles human memory or just parts of it? If the first, then how does one ever grasp enough to form an accurate mental model (oh..the vastness of it) and if the second how does one maintain a sense of consistency, coherence, relevance and context in what he sees, reads and in general perceives (don't forget hypermedia).

4. **Web-like** organizational structures pose few restrictions on the pattern of Site design. The goal is often to mimic associative thought and free flow of ideas, where users follow their interests in a heuristic, idiosyncratic pattern unique to each person who visits the site. The linkage associated with such a site structure is very dense and the underlying principle is the full exploitation of the Web's power of linkage and association. On the other hand confusion and fuzzy thinking, on the part of the user, are also promoted. Ironically, this seems to be the most impractical structure for Web sites, because they are highly unpredictable. Most of the times they can provide the user with a good game of trivia, but their value as to being able to impart specific information is highly questionable. Basic understanding of any topic using a site designed like that is very difficult.



The issue of Web site design becomes very important because a system's usability depends fundamentally upon whether it takes into account the user's mental

model. A user will form a mental model of the system whether the system is designed to facilitate such a model formation or not. The user's mental model is the idea the user has about how the system works and how it will respond to him in the future (mental simulation). A computer system, such as a web site, must be consistent with the model it suggests. If the system does not help the user create a process that includes making a mental model of the site, forming a plan of action and understanding what to do in order to reach a particular goal, then the system is less usable.

If the web site is educational, the structure should support how learning is facilitated by the formation of node-link structures in the learner. This can be done by incorporating concept maps of the subject matter in the web site, having composite maps of varying scale, provide intelligent help based upon the user's path traced through the information space, use an interface that adapts itself to suit the individual user while matching the user to several user interface classes.

This in essence means, that current web design practice suggests that the web site's structure should mimic the information it contains and how it can be understood. However, to make it easier to design, a web site's structure should be seen and understood as different from the information it holds. It is here that we see the fundamental distinction between a site's information space and a site's navigational structure, as we have before.

At this point, we have to understand that helping the user establish a mental model of the system does not mean that the system itself should graphically or structurally suggest its logical interrelations. To be more specific, a high usability system does have to be designed as a hypertext one, just because the hyper-links may reflect the logical structure of the subject matter. Such a claim would constitute the logical fallacy, common in medieval times, that the cause should resemble (visually at least) the effect. The fact is that we still have not found reason enough to believe that a hypertext system would be more usable than some other system. For relatively small amounts of text it is very doubtful that hypertext would be more usable than plain text.

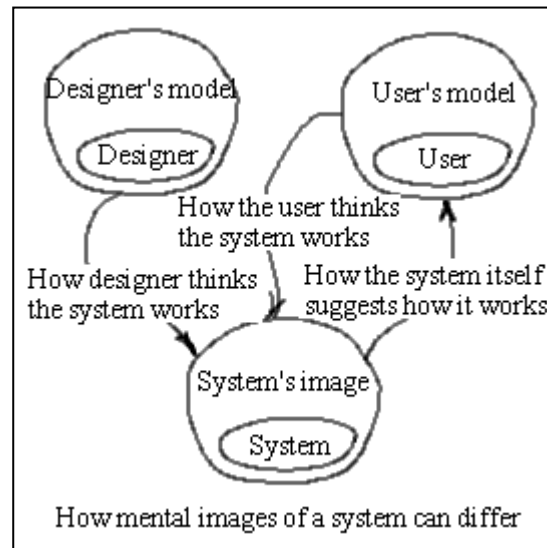
Reinforcing this argument I might add that some researchers feel that there should be some amount of disorientation and cognitive overload in a web site in order to facilitate exploration and learning. This suggestion is based on the assertion that exploration facilitates learning, which in fact is a well proven (in the field of school

education) educational principle. This again makes any previous claims for site designs, that are as clear-cut and straightforward as possible, irrelevant. It is truly ironical, at least in my mind, to see a medium like hypertext, that was invented to promote easy understanding of concepts and powerful and successful browsing of the concept space, to be actually used in little “hide and seek” games. Then again, except ironical it could also be inevitable as current experience with web sites shows that in all cases a certain amount of “heuristic” navigation – less in well designed sites - is expected from a first time user until he gets a “feel” of a site.

Another educational principle that seems to be implemented with some success to many sites is that of “peer interaction”. This is usually implemented through a “virtual chat” feature where users can meet, share experiences and talk about various problems that they have concerning the site or information space at hand. The need and often high success of such systems suggests that the web and its design is sometimes less efficient in guiding users itself, than simple text based chat is. The enormity of such a conclusion is usually ignored or underestimated by designers.

It is my opinion that the main reason for the success of the WWW as we experience it today is exactly that inefficiency to perform up to its acclaimed theoretical potential, and the rewarding mystical experience that comes from mastering one more of its supposedly “so easy to use” features. Hey, the next time a pretty girl asks you: “hi there...do you know how to do this?”, you will be in a position to answer “but of course...it is so easy..let me show you...”. Working hard to know just enough; that is the secret of the enticing power of the Web in spite of its inadequacies. My belief is that such ultimately alien to technology but very human tendencies and psychological predispositions will always find their way in the interfaces humans design for humans and make our interaction with any machine or artificial system a fetishistic experience.

Returning to the normal course of this paper, it has to be mentioned that designers strive to make their mental model of the system they design (designer model) reflected the best they can on what is called the system's image (how the system actually works). Whether the mental model that the user will develop for the system as he/she uses it, is close enough to the system's image or the original designer model, is not known. This can be a big problem for the designer.



This strife for congruence between three different images or models, is strongly reminiscent of the Rogerian personality theory where the “ideal self”, “true self”, and the “self image” are in a constant strife to coincide thus producing a state of inner balance or congruence. This makes me think of two possibilities:

- It just so happens that this is another manifestation of the universality and omnipresence of basic natural laws, involving bipoles, dualities, trinities, and other basic building blocks of reality's texture and their dynamic interaction.
- Some people force similarities into the multidisciplinary field of HCI just in order to feel more at home. (i.e. Psychologists striving to approach the “obscure” world of computer systems).

The fact that a static system image would never be implemented well enough to map the designer's model to all possible users (note here the introduction of user differences – differences in perceptive abilities, knowledge etc – as a main factor influencing system design. Such a thing as a “normal” user does not really exist. The fact is that a system should be customizable. Otherwise the system may fail infinitely to map its image to the user's model) was recognized soon enough. The result was what we now call dynamic HTML creation. This way every user has or will have in the future the possibility to reorganize the structure or presentation of a site's contents in the way that is most compatible with his user model or his needs that are usually a

subset of what a site has to offer. Here the whole argument for consistency between designer-system-user models just becomes irrelevant, as the user finally forms his model out of experience with system interaction based on his own ulterior motives and needs which may actually prove quite alien to what the designer had in mind. The simple fact remains: one can never predict the uses or interpretations of any subject matter. This, at least in my mind, provides reason enough for full customization of any system interface and consequently of the structural-logical presentation of the system's content.

Today only big sites and search engines implement dynamic HTML creation, either based on cookies or specific user queries. As we will see below the case of search engines is irrelevant to the just stated argument. However, it demonstrates the feasibility of dynamically created content on a large scale.

It is widely accepted that every web site should have a good search feature since the best navigational support is never enough. Take for example a vast site like that of microsoft.com. The very size of the offered information makes that little "Search" button very enticing, however well implemented a hypertext navigation system would be. Although some argue that the search feature for such sites, can often be the last attempt, for a majority of users, at finding what they want, I think that it may well be the first choice for seasoned users.

While navigation or browsing is sufficient for small hypertext systems, more powerful information retrieval (IR) techniques become very important in large scale hypertext databases. It is not hard to predict that hypertext systems will increase in size and complexity as they store more and more information. This, surely, will further diminish the efficiency of "traditional" hypertext navigation and consequently make users rely more on search engines and other related techniques in order to find a page of interest, even within the same Web site.

Effective access to information stored in such large hypertext databases requires query-based access to complement or even replace navigation. In fact researchers often argue that "search and query" needs to be elevated to a primary access mechanism on par with navigation. Content queries can be used to retrieve the contents of nodes while structural queries can be used to retrieve subgraphs of the hypertext network that match a given pattern. Following this trend, many researchers have investigated the possibilities of separating index information from contents thus forming an index space (or concept network) on top of a content space (or document

network). This separation is implemented today too (as mentioned before), but in a way that is entirely determined by the designer (in an artificial way) and not by the system itself (occurring naturally due to system requirements). This separation would not only facilitate IR but also accommodate dynamic linking and independent maintenance of the two networks.

At the moment the WWW is a “hunting and gathering” environment. Users hunt for Web sites and then gather what they need. In the future Web sites may need to take into account “Push” technology, which brings the possibility of “farming” to the web. The information in this case would be brought to you in exactly the form and quality/quantity you want. This would of course be another step towards information structure customization, and again would make the whole argument of hypertext and Web sites irrelevant.

Let’s now move on to another aspect of computer system interfaces and the Web in particular; that of the metaphor used to introduce the users to the system. People develop new cognitive structures by metaphorically extending old ones (assimilation or even accommodation as mentioned before). Users of a new computer system can master it if they can metaphorically extend it to some real world objects or entities. A good metaphor not only helps the user, but also provides a rigid framework within which the hypertext author or designer must work to maintain consistency. Choosing an appropriate metaphor would also reduce both functional opacity (mismatch between the framework and the metaphor) and system opacity (mismatch between the metaphor and the implementation model).

Hypertext has been compared to an electronic encyclopedia, note-cards, journeys, browsing, windows, paths, guided tours, travel holiday, and survey-type maps. The travel (or surfing) between pages (or places) metaphor serves as an extremely powerful aid to hypertext-hypermedia navigation. At the same time, metaphors should not become too restrictive. In essence the system should improve upon the metaphor, not be bounded by it.

Although the travel metaphor serves as a means of quick introduction of users to the hypertext system, in order for designers to really understand hypertext, they must first understand writing and reading models.

Writing is cognitively described as the combination of three activities: **exploring, organizing and encoding**. This means that writing is the transformation of a network of related concepts (retrieved from long-term memory or external

sources) into an outline or hierarchy which is later encoded into a linear sequence of words, sentences, paragraphs, sections, chapters and illustrations.

Reading, on the other hand, is the execution of the above three processes in the reverse order. That is, a linear sequence of text is transformed into a hierarchy, which is later integrated into a network in long-term memory. Thus, both reading and writing processes are based on the non-linear nature of the human thinking.

Since hypertext browsing still involves reading in the classical kind of sense (and that in turn builds semantic networks in the mind of the user), the artificially imposed likeness of the hypertext structure to the logical structure of the subject matter, seems to be irrelevant to the primary objective of hypertext systems which is to make explicit the logical or conceptual structure of the subject matter. This fact makes it doubtful that text can ever be successfully converted to hypertext and it even can be thought of removing any clear incentive in one trying to do so.

This becomes quite clear once one thinks that text, as a means of concept encoding, does not retain all of its conceptual wealth once it is removed from the author's masterplan. Each written statement holds a unique spatiotemporal place in the flow of the narrative at hand. Chunking that narrative and thus removing the imposed by the author sequence just shatters the intended to be imparted knowledge. Although the chunked text cannot be considered, of course, alien in meaning to the original full text, it certainly loses in value and it can even lead to misunderstanding the author's ideas. I believe that this argument holds even for text that was originally written in hyper-text form, as sequence is imposed naturally to anything written.

Concluding this section of my paper, I have to say that in my opinion the fact that the web may be exhibiting some attributes or characteristics similar to those cognitive scientists have found in the organization of the human mind, is not as much related to how well the system model can be mapped to the user model, as it is related to the web itself establishing an underlying infrastructure that makes it suitable for future self-awareness and intelligence formation. In my view of things, all that is needed for the Web to become aware and intelligent (although it may be viewed as intelligent already under some definitions of intelligence) is some kind of interpreting agent that will form the core of consciousness in this "beast" of accumulated and ever changing and expanding knowledge.

## **User (or Abuser?) Psychology**

As I was studying all the HCI related material that my research yielded, as well as the fairly superficial, in its treatment of some important matters, book by Preece et al, I could not help but notice the complete or almost complete in any case lack of attention to the user as a being with various psychological problems. In fact I was dumbfounded to realize that probably the only thing that found HCI and design scholars and experts in accord was the treatment of the user as a well defined and pretty standard and predictable unit, that sits in front of a monitor and keyboard and happily reacts to every whim of the system, following standard patterns of behavior and having fairly well known capabilities and characteristics.

Of course such treatment was in no case explicitly stated but I found it to be implicitly ever present. So much thinking and work may be going to waste, if the Human Factor remains so alien to the human being as a “unit” that actually feels, loves, has fears, has family and maybe a frustrated sexual life. In a century where the humanistic trend in psychology has dominated culture development, HCI seems to me to be deep in its Middle Ages. Where is the consideration for human feelings? Are we trying to make the information technology environment adjust to us, or are we adjusting to it? Is the new millenium human being a being that stands rigidly and professionally behind a screen looking blankly (oh.. deep concentration of the unwitting) at a bunch of parading (hypnotizing?) hypermedia, while exhibiting in the most rigid of ways characteristics of the idealized, but not-existing on its own, “intellectual chap”? Attention, concentration, professionalism and some Internet surfing...Is that the Human-Machine system as it really is, or are we just kidding ourselves, immersing into a an era of unprecedented fascism where you interact as you are supposed to or you live on the streets?

It is a fact that advanced and of course socially dominant (in a global scale) technological societies owe a lot of their prevalence and power, to the stress environment that they have formed for their members. It is this “survival of the professionally fittest” attitude along with its obvious brutal antagonism implications that have determined the shift of power and dominance over the years. The victims of these policies have been up to now other countries, but given the globalization of western culture and the relaxed economic relations of different countries (mainly due

to the tremendous expansion of international corporations) this civilized cannibalism has shifted inwards, now consuming whole social classes within the same society.

I believe that this stress-factor trend has found its way (and maybe a perfect home) in the deployment of the web as the primary means of information retrieval for any purpose. I do not agree that the stress environment created by the constantly refreshed nature of Web information will lead to more creative thought. Instead it will create anguished and aggravated individuals with an assortment of psychological dysfunctions and an obsessive-compulsive behavior related to information storage and update. The first sign of this problem is already here in the form of an insecurity that manifests itself when your information gets old before it is even read.

It is this tremendous availability of vast resources of information that slowly turns and mutates the commonly regarded perception of good work in a set of criteria that are more concerned with the amount, reliability and currency of the Web information included. Author creativity is slowly surrendering its place to well established and updated comprehensive web information. Hey, very few (maybe nobody) are able to say something original, and that is painfully obvious because of the Web.

Considering all the above, I think that a web designer should include in his/her agenda of considerations the probable psychological state or states of the users involved. Will the user be happy? Will he/she be in a good mood? How can a user feel a kind of human touch in the interface? Will the site be accessed by panic stricken corporate officials? Will sexually deprived teenagers access it? How do you fight the user's stress? Are all the people who access the web, and the site under design in particular, of the same age, sex, ethnicity and most importantly age?

These are questions that I believe must be brought forward in any kind of web design decision. Concentrating on the last question, I would like to stress that the Internet is used by people of all ages, hence by people in different cognitive development stages. Are we sure that the hypertext-hypermedia system is cognitively appropriate for all ages?

My belief is that the most important psychological consideration by any system designer (or more generally artefact designer) should be that of establishing a feeling of security in the prospective or present user. A user needs a feeling of security when accessing information, not just an easy way to learn or understand that

info. This may be realized in a system that somehow safeguards the user's intellectual property, which is (in this context) whatever information the user has accessed up to now. In other words it is very important that the user is able to revert easily and with no significant effort to previously viewed information to review it, if needed. Situations where the user is not able to do that because he is unable to locate a previously visited page, either why it is not there or why it is virtually lost among other conceptually irrelevant pages (as in current browser history systems) are in my view totally unacceptable. It is at this point then that I propose that the systems structure should, rather than try to mimic the user's mental models, enhance and augment his long-term memory recall limitations by presenting him with an on demand efficient and complete method of accessing conceptually relevant previously viewed information. This means that the focus of attention should be turned to trying to design a system that will become the mental sidekick of every user. A system like that would of course involve the difficulty of devising a method of active and highly successful conceptual classification of visited pages. On the other hand I do not think that such a design aspiration presents us with inherently harder to solve problems than the one presently at hand (specifically trying to mimic the user's memory structure organization). Of course realization of such a system, would provide the user with the ability of total recall, which would in turn infringe a feeling of unprecedented security and comfort in our present information-hunting life-style.

## **Hypertext/Hypermedia Critique**

Before I start analysing the pros and cons of hypertext and hypermedia and consequently the WWW as we experience it today I find it useful to attempt a short discussion on the distinction between hypertext and hypermedia.

It is common for the hypertext to be viewed as a subset or limited version of hypermedia. This is not surprising once one realises that hypermedia is like hypertext with the important difference that nodes are not only textual but also audio-visual. In my view the main difference does not lie in the denotational definitions of the terms but in the connotational ones. Specifically I think that what separates hypermedia from hypertext is the ability to use nodes and links in a way that is complementary to traditional serial text instead of restrictive to it. For instance, with hypermedia, text can be accompanied by relevant or explicatory pictures, video and sound. Thus the true distinction lies in the possibility for hypermedia to be used in a conceptually different manner than hypertext, in the quest to enhance our information escapades.

Having said that I can now start my criticism of hypertext by first saying that hypertext threatens to upset the stability of language as property. Hypertext seems to be achieving this by eliminating the margins of each text it incorporates: in Landow's words, hypertext "blurs the boundaries of individual texts", so that "the notion of an individual, discrete work becomes increasingly undermined and untenable within this form of information technology". It naturally follows then that a text that is no longer demarcated by its boundaries is necessarily demystified. What this effectively means is that "a data base search...permits the active reader to enter the author's text at any point and not at the point the author chose as the beginning", and this is what in essence web browsing is: data base searching. We thus come across what has been termed as "the death of the text". What happens here is that an individual section of text loses its distinctiveness, being dispersed into other texts, or, as Moulthrop puts it, "reduced to multiplicity". In Hypertext a given text has no clear defence against the potential vastness of the network and its multiplicity, if not randomness.

This draw of attention, by my part, at the "dispersal" and "multiplicity" brought on by hypertext, strongly suggests the notion of entropy, thus echoing the intriguing formulation of Braudillard that INFORMATION = ENTROPY. "Information in which the event is reflected or broadcast is already a degraded form

of this event”. More systematically than Braudillard could have envisaged, hypertext reverses the negentropy of the (physically extended) printed text by unmargining it and making its fragmented constituents accessible to an infinite order of readings within multiple perspectives. As Geoffrey Nunberg puts it, equalising access to information has a tendency to “flatten” it.

Having treated the “hypertext case” from this philosophical but very fundamental and essentially critical perspective, I will now revert to considering some of the “acclaimed” basic characteristics of hypertext, that have been said to promote its educational value and knowledge organisation efficiency.

Hypertext and hypermedia have received quite a lot of attention within the various computer-related fields. They certainly offer an exciting and creative way to deliver engaging, effective material. However, they also offer a multitude of new ways to deliver confusing, ineffective material. Cognitive psychology principles have been used in the design and implementation of hypertext/hypermedia and the main claims that have been voiced about hypertext/hypermedia and their educational effectiveness are the following:

- Hypertext resembles the brain.
- Hypertext resembles the human memory structure.
- Either or both of these resemblances underlie the claimed educational effectiveness of this relatively new medium.

It is my intention to show, in the next few paragraphs, that all three of these claims are in fact based on what has been termed as the “homeopathic fallacy”. This is the, now commonly accepted as a logical fallacy, attitude suggesting that a cause should necessarily resemble its effect. Although these claims will be shown to be untrue, this does not totally diminish the educational or organisational value of hypertext but it does deflate it from its presently, seemingly universal, state of total and unquestioned acceptance or even appraisal.

Considering the first claim, we can say that neurons don’t seem to be anything like hypertext nodes. Disregarding the obvious physical differences though, there is still the belief that somehow one can derive useful information about structuring information for learning by studying the brain. Human behaviour, in general, can be described on a number of levels. At the bottom level is the neurophysiological level.

A level above are the ways that certain mechanisms within the mind operate. For instance we seem to have certain unavoidable short-term memory limitations. Above this we have a level that can be described in terms of knowledge, goals and what we understand about the world, and how these shape the way that we behave. Still higher, we can describe humans in terms of their adaptiveness to the environment, with little regard for the way in which the mind works. Here is where the following question becomes painfully evident: which of these levels is the most appropriate for the design of educational technology systems?

Although great progress has been made in understanding human behaviour at the biological level, particularly in areas of perception, it is still too poorly understood to be of much use in influencing the design of artefacts. Moreover, even if we had decent understanding of this low level, it is highly doubtful that it could inform us over and above what we can learn from higher levels of description. We do not need sophisticated models of learning at the neuronal level in order to devise effective educational material. What we do need though, is detailed knowledge of how people learn complex material from text and other sources.

Proceeding to the second claim about hypertext/hypermedia, one has to ask why people believe that hypertext is like the mind in some way. If we lay aside the previously stated arguments pertaining to whether text is inherently linear, we are left with the comparison that both the mind and hypertext store information by linking ideas that are meaningfully related. Such a model has been used to explain some of the properties of memory and learning and is usually referred to as the propositional or semantic network model. Semantic networks have been used to explain certain aspects of cognitive processing, but few would argue that this what the mind is really like. Rather associations are less stable and more dependent upon context than they may seem at first glance. Semantic associations are only one of the many ways in which we remember, integrate, retrieve and use new information. (Barsalou)

Although Vannevar Bush is often cited as the originator of the “hypertext-mind” analogy, in his vision of the “memex” system, it is probably true that he has been unfairly used as the justification for this putative resemblance. This is because he does not actually talk about the associative nature of thought and a possible relation to the organisation of on-line information. What he really proposes is that rather than a priori organising information for others to access, it might be more effective to allow people to form their own, idiosyncratic associations between the existing/accumulated

information (a vision that is actually closer to the “Push” technology as discussed above). This is of course quite different than claiming that, because hypertext is organised by associations, it therefore should be more easily read, assimilated and remembered by a reader, which is exactly what contemporary hypertext proponents claim. Basically, regardless of the fact that people are capable of using associations, it is higher levels of processing which seem to be most important for learning complex information and interpreting new facts. These processes simply cannot be adequately modelled by the simplistic associative structures.

Addressing the structural similarity between the mind and/or brain and hypertext/hypermedia as to its supposed augmenting of the user’s learning/understanding (claim 3), we can say that this superficial similarity cannot be considered adequate for such a claim to be made. As Charney more than clearly points out: “Because readers cannot import textual...structures directly into long-term memory, the putative resemblance of hypertexts to long-term memory is irrelevant.” There simply is no apparent reason to believe that hypertext is any more easily assimilated, with what a reader already knows, than a linear text. Assimilation requires actively comparing, contrasting, questioning, and applying what is being read and what has been previously learned. There is no reason to believe that simply because a subject matter is presented in hypertext form it will be more likely to invoke such strategies than a good book. In fact it is easily understood that in both the case of hypertext and books the real interface between the artefact and the user is reading itself; there simply is no essential difference between the two.

Addressing these issues, Charney further states that the order in which readers see information is important, but that readers do not always know which order will be better for them. The proclaimed freedom of choice, in following any “associatively” imaginable path to gathering information, offered by the hypertext structure may actually be working against the learner. Giving readers control over the information they read and the sequence in which they read it also gives them the burden of locating the information they need and relating it to other information offered by the network. As a result users can become overwhelmed by choices among links and by difficulties maneuvering through the text structure. These factors combine to create a situation of cognitive overload given the working–memory limitations, disorientation and a loss of sense of integrity of any given text in the network since the users may actually be unaware of crossing from one text to another. If we add to that the fact that

the users have to cope with the need to stay oriented (a most basic and unavoidable human need) within hypertext's structural network, inevitably sacrificing more valuable working-memory, then we are presented with a very bleak picture indeed.

Charney even cites evidence suggesting that readers are not very good at assessing the adequacy of the information they have encountered and are even worse at anticipating whether important or useful material remains in the portions of the text they have not reached. This is a very important point, as it marks the potential inability of hypertext to signify an end to the information on a specific subject. Given the not only important psychological implications that absence of an even temporary end can have on the user, but also the maybe archetypal value of it and even its importance in the proper or conditioned, over generations and generations, understanding of reality, the long-term repercussions of this problem may prove to be quite significant.

Some claim that allowing students to explore freely in hypertext may foster insights and critical thinking through the creative juxtaposition of ideas from multiple perspectives. However, Charney warns that instead of doing just that, this process may simply reduce itself to a guessing game as the user tries to figure out what the writer had in mind when creating the link. Imaginative links are unlikely to be remembered or to influence a reader's subsequent thinking. The consequences of following a whimsical link may be to obstruct conventional, durable processes of systematically integrating new information into old. Hypertexts that encourage free form browsing may interfere with the reader's efforts to make sense of the text and with efforts to find information relevant to some specific question. A hypertext system that allows users to choose among a fixed and probably small set of paths through the network may satisfy particular readers, but designers face significant challenges for creating the right paths and steering readers onto them. If this feat is not accomplished then hypertext becomes functionally identical to a set of linear texts, which is exactly how hypertext is implemented in many sites (especially of academic nature).

A basic inference that one can make at this point, is that the associations of information found in hypertext or a Web site, no matter how complex they are, cannot by themselves represent knowledge simply by implying a relationship between two or more items of information. Associating items of information does not equate to the

construction of knowledge. For knowledge to be constructed the reader has to make sense of the information association, by understanding the meaning of association.

Another potentially problematic feature of hypertext/hypermedia is that it can lead users to sub-optimal action, as sometimes attractive buttons will be pressed and amusing videos will be played regardless of the intentions of the user.

By presenting all the views above I do not propose that the hypertext medium be immediately replaced but rather that our understanding and use of it should change. This change in attitude toward hypertext from the potential user could in fact make some of the inherent good qualities of hypertext to emerge and be beneficial.

A good quality of the hypertext is that, when well implemented, it makes explicit the connections between conceptually distinct but within the same domain of discourse, chunks of information or web pages. Here the idea is that following the hypertext links gives the learner a clearer idea of the way that the information fits together in the domain to form a coherent whole. Of course this is entirely contingent upon the learner processing the links in a meaningful way. Merely moving from screen to another is unlikely to give the learner any insight as to the implied connection between the two screens.

Also, the multiplicity of offered paths introduced by hypertext might actually be used beneficially for the user if it is cleverly designed so that it promotes the browsing experience into a rewarding problem-solving exercise. In this case one of the learner's tasks would be to try to make sense of the relationships between the different screens encountered thus engaging in meaningful active processing of information. Notice though how this use of hypertext impacts on the other just mentioned potentially good use of it, where the connections have to be explicitly stated or explained instead of the user deciphering them through active information processing.

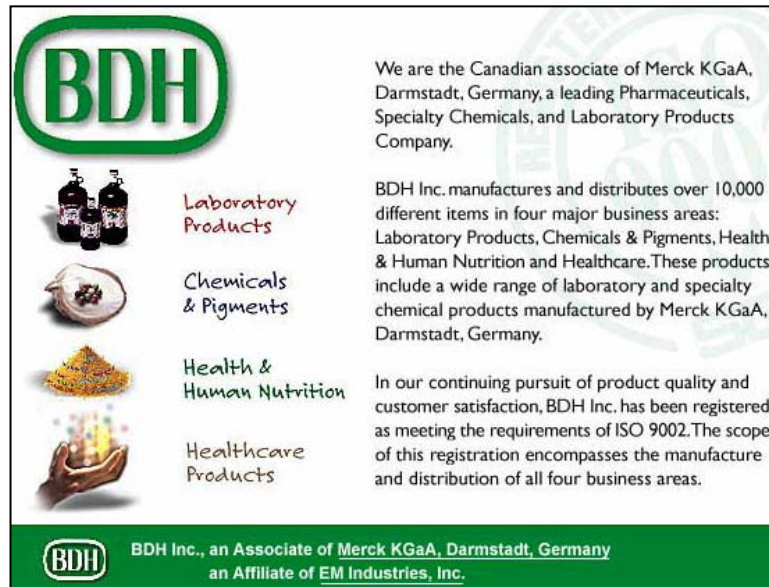
Of course a natural selection of hypertext would be the case of "naturally" segmented texts, such as dictionaries or even encyclopaedias (although the nature of the Encyclopaedia does not make as a good case of optimal hypertext use as dictionaries do).

# Case Study

## Introduction

The case study of this project will be based on a Canadian Web site. Specifically the [www.bdhinc.com](http://www.bdhinc.com) site. As we can see in the informative home page of the site (depicted on the right) BDH is a

Pharmaceuticals, chemicals and lab products manufacturing company.



**BDH**

- Laboratory Products
- Chemicals & Pigments
- Health & Human Nutrition
- Healthcare Products

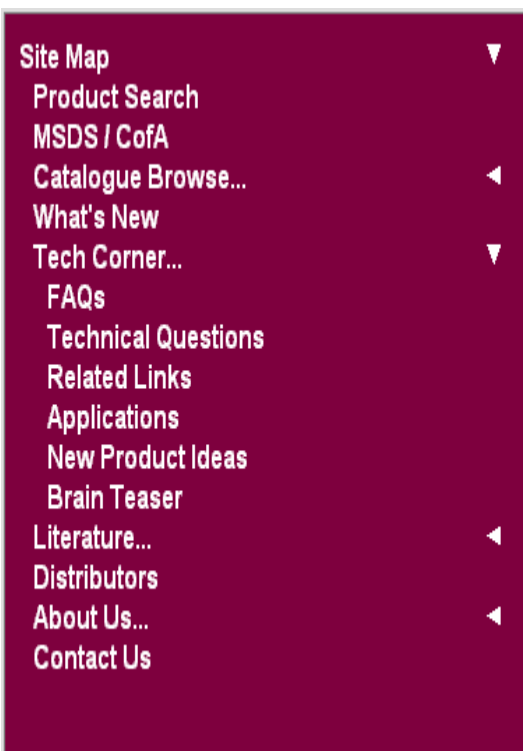
We are the Canadian associate of Merck KGaA, Darmstadt, Germany, a leading Pharmaceuticals, Specialty Chemicals, and Laboratory Products Company.

BDH Inc. manufactures and distributes over 10,000 different items in four major business areas: Laboratory Products, Chemicals & Pigments, Health & Human Nutrition and Healthcare. These products include a wide range of laboratory and specialty chemical products manufactured by Merck KGaA, Darmstadt, Germany.

In our continuing pursuit of product quality and customer satisfaction, BDH Inc. has been registered as meeting the requirements of ISO 9002. The scope of this registration encompasses the manufacture and distribution of all four business areas.

**BDH** BDH Inc., an Associate of Merck KGaA, Darmstadt, Germany  
an Affiliate of EM Industries, Inc.

What had initially drawn my attention to this site was the implementation of a site map via an embeddable on any HTML page Java applet that could be used instead of the usual frames. The obvious advantage to this is that a frame can become very long as the site grows in size and that results in a menu-frame that has to be scrolled



- Site Map
- Product Search
- MSDS / CofA
- Catalogue Browse...
- What's New
- Tech Corner...
- FAQs
- Technical Questions
- Related Links
- Applications
- New Product Ideas
- Brain Teaser
- Literature...
- Distributors
- About Us...
- Contact Us

down in order to present all the available options to the user, while on the other hand the “Exploder applet” by Beach Software (depicted on the left with SiteMap and TechCorner unfolded. Check [www.halcyon.com/beach/](http://www.halcyon.com/beach/) for details on the applet), presents the user with “explodable” classes or groups of options that can be unfolded or retracted at will. Although this applet could be used instead of frames for site navigation, the administrator/designer of this site has chosen to use a very well designed combination of two frames (one vertical, one horizontal) to guide the user’s

navigation over the first two depth levels of the site. In addition a central menu is presented in each depth level than becomes a frame when the user moves inside (deeper). The applet is reserved as an extra or alternative way to browse the site, while where extra depth levels exist they are accessed via plain hypertext links embedded in text. Also worth noting here is the availability of each menu in both a plain text and graphics version.

My final decision to use this site in my case study was based not only on the fact that this site used a nice site map feature, but also on the fact that it was easy to use, very friendly, provided a multitude of navigational aids and was based on a mixture of technologies and design principles without losing any of its usability and functionality, and finally because it was generally very user centred in its design.

In order to be able to better analyse and illustrate my points while commenting on the site features and structure, I decided to use a site mapper/analyser tool. After searching the Internet for a while I found about three of these tools that seemed to be worth downloading. My criteria in this search were:

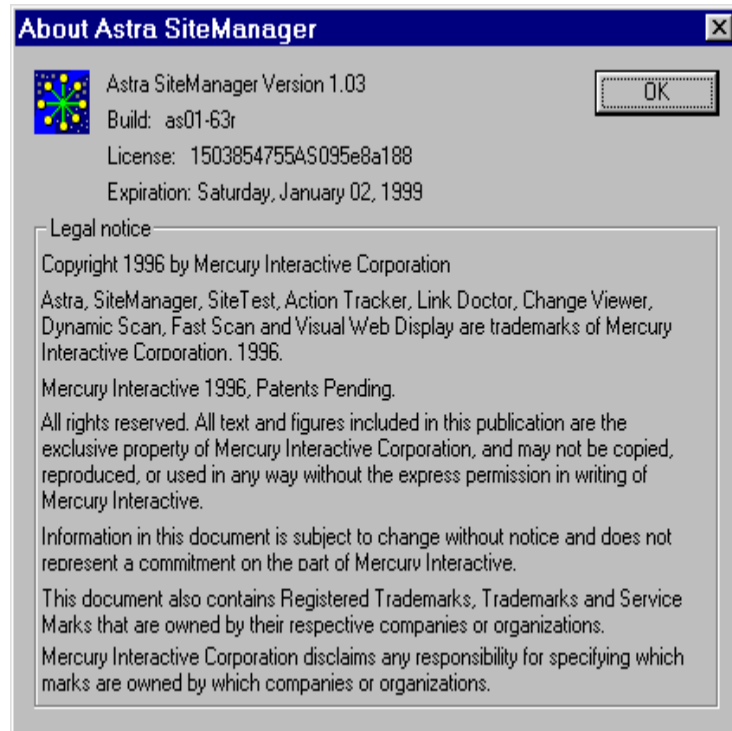
- I was looking for a tool that would not analyse the site structure in terms of web server directories but in terms of hypertext/hypermedia links
- The tool should be able to graphically represent the relationships or links between different links in a customizable and informative way.

Although there is a wealth of web spiders, bots, site analyzers etc. the requirement that the representation of the information structure be graphical narrowed the search enough for me to find no more of 10 search engine entries. Out of these entries only three lead to a software product that seemed to be doing exactly what I was looking for. The three tested tools were Power Mapper 2.0 Professional, by Electrum Multimedia ([www.electrum.co.uk](http://www.electrum.co.uk)), LinkBot 3.6b by Tetranet Software Inc., and finally the Astra site manager, which was selected as the tool of preference. All three of these products were tested or used in their limited-time or shareware downloadable versions.

Power Mapper is an easy to use tool but the graphical representation that it offers is not very flexible and in general the options that it offers to the user are very limited. Adding the fact that the shareware version was severely impaired by feature blocking from the developer, it was right away discarded.

LinkBot did not offer graphical representation at all and it was also right away discarded.

Astra site manager, on the other hand, turned out to be perfect for my purposes. It offers a very easy to use interface and a graphical representation of the Web space that is visually stunningly beautiful if not useful too.



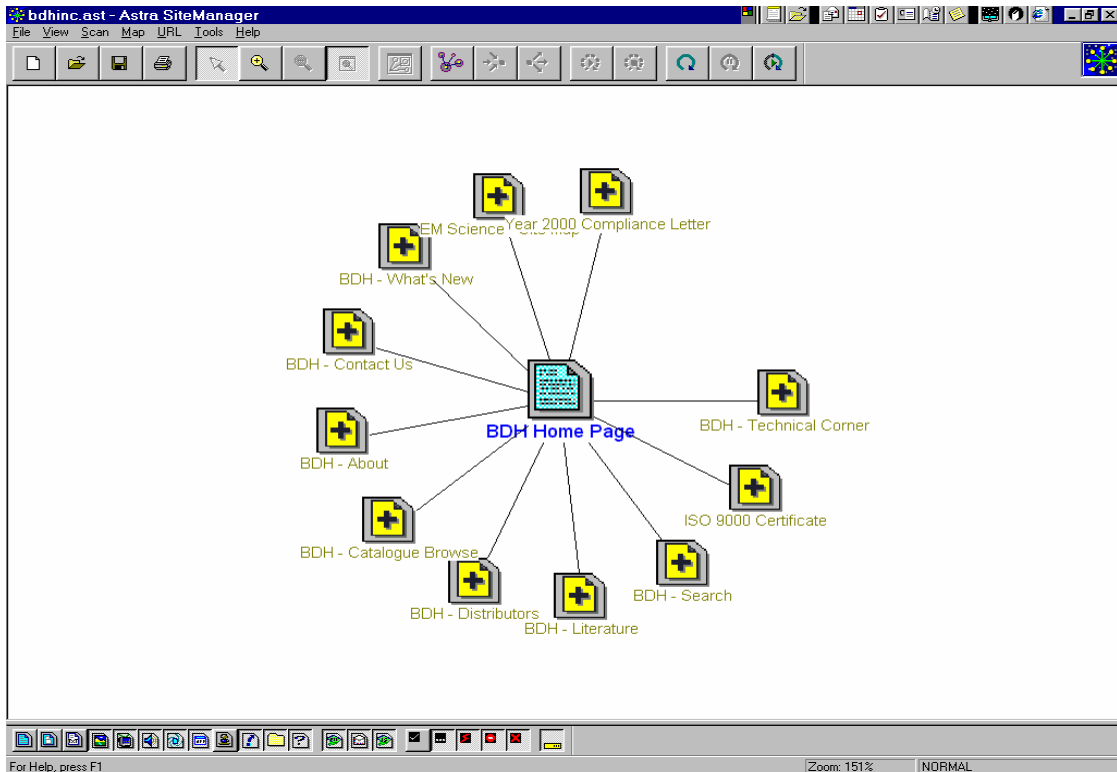
## Analysis

The site's home page ([www.bdhinc.com](http://www.bdhinc.com)) does not represent the real head of the site's page hierarchy. It basically contains four links of which the three are external (lead to other web sites) and only one leads to the site's "root" home-page, which is <http://www.bdhinc.com/ems-index.asp> as depicted below. As one can easily see, the home



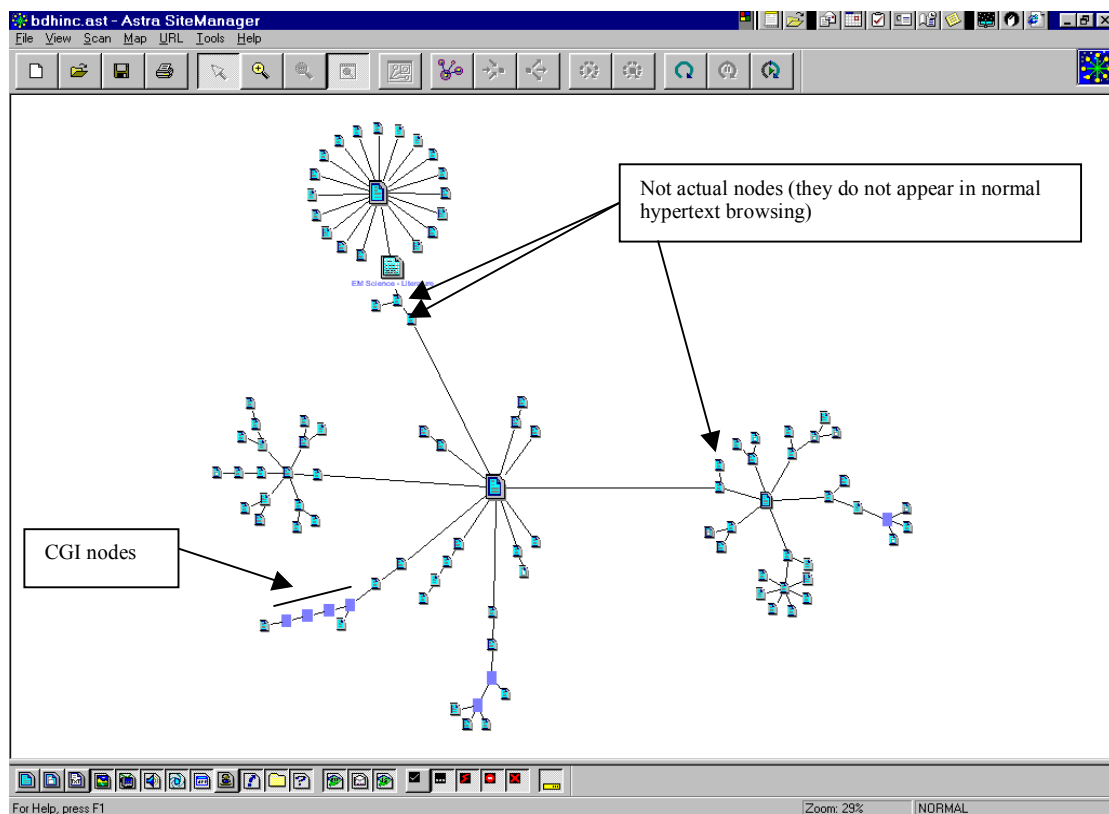
page is just a link-menu with no information presented (just part of the navigational space). Also notice that the menu is presented in both a graphical form and a text form (for those browsers that are not graphics enabled).

Below we can see how the BDH home-page looks like in the Astra site manager with all second level links collapsed. As we notice there are 11 links coming out of the home-page, a number which is right at the upper limit for the breadth of a site's hierarchical level as discussed above. Although the links are not few, I found that they could easily be cognitively “digested” after a while.

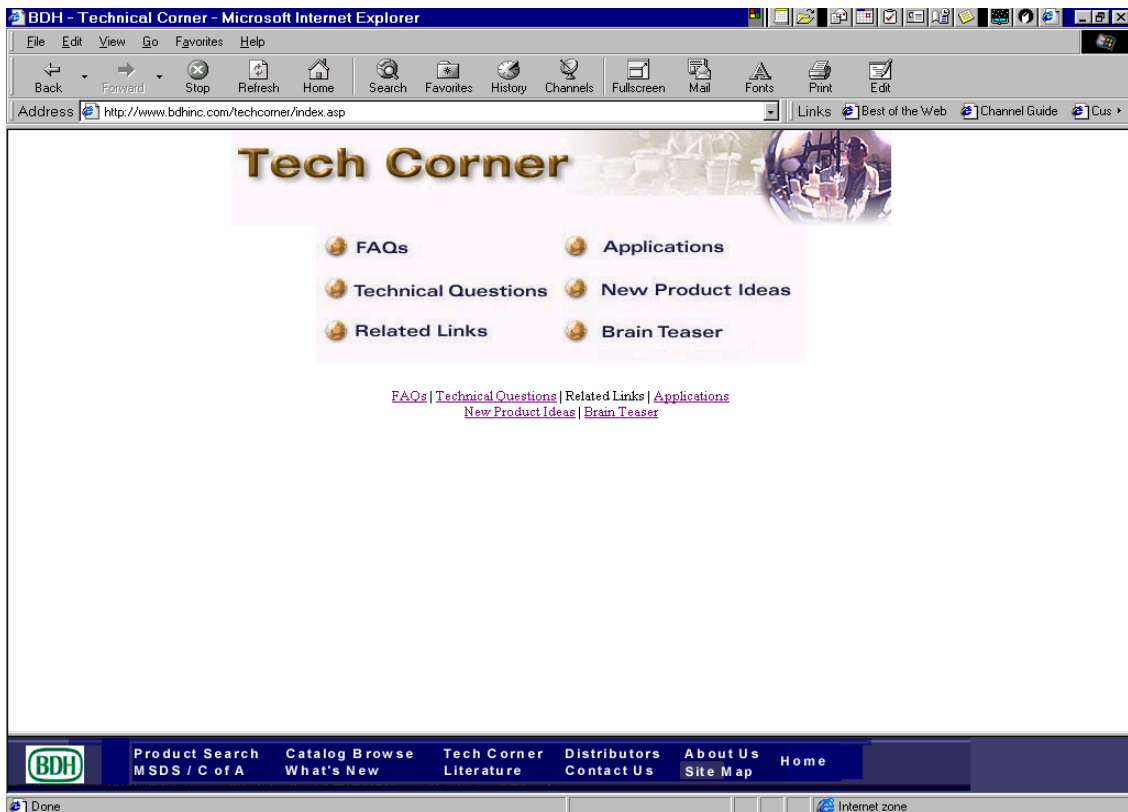


A nice feature of Astra is that it permits the user to have an overview of the overall information structure of the site at hand (depicted below). Although the schematics produced (site maps actually) are not very simple, one can immediately have an idea of the site's basic structure, like number of nodes, breadth, depth etc. The problem with this version of Astra is that it does not have any easy way to get rid of intermediate pages or nodes that although they exist in the actual linkage they do not appear to do so in normal browsing of the site. This is because HTML structural elements (such as frames or link menus) are allowed to appear in the map as nodes along with actual pages. This is a simple manifestation of a problem that HTML, and other site design technologies currently used, inherently bear and is usually referred as the “conceptual versus navigational space separation problem”. In its current incarnation, HTML has no foolproof way of separating the two. In fact what happens in most cases, is that web pages are a mix of the two, thus transferring the problem from the system level to the design level. As we will see, in this site the design is adequately good to separate navigational from conceptual (or informational) space in most cases.

Another case is that we may actually see a series of nodes that are not static (i.e. they are not necessarily there), as in this site (and in many others) there are nodes that are formed through CGI invocation.



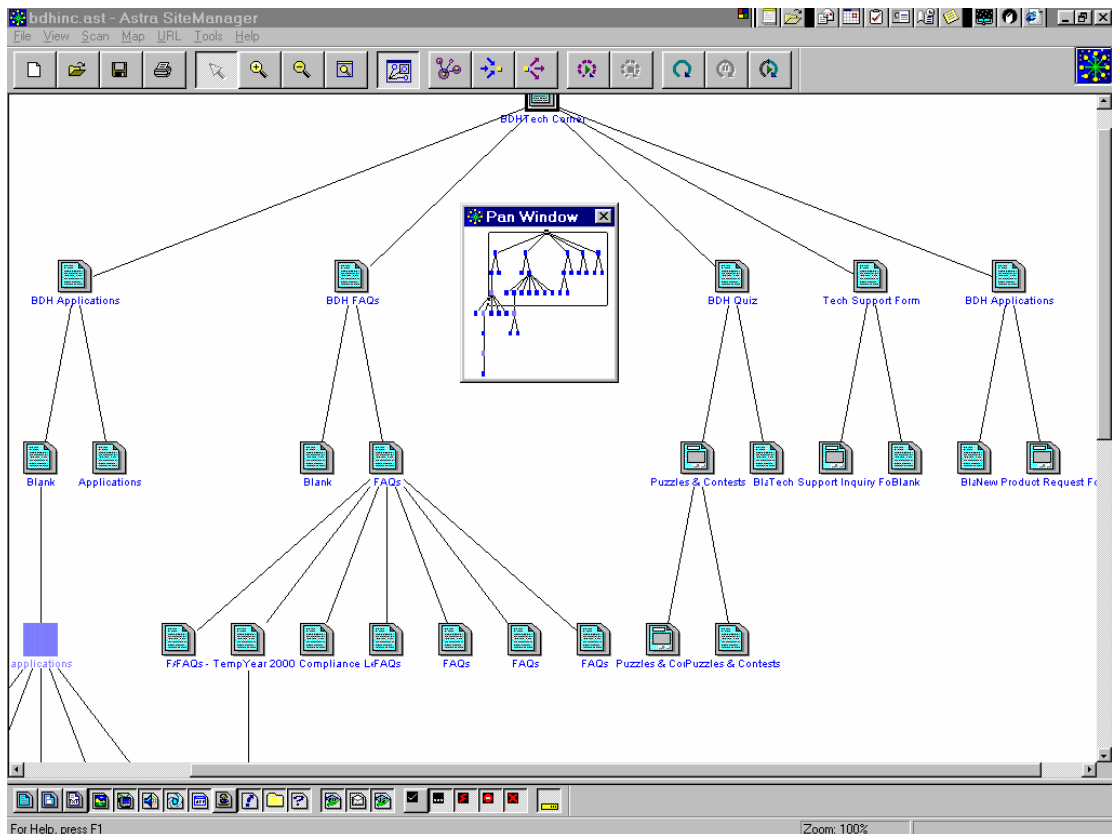
Let's now follow a characteristic link of the ones presented in the home page. The link is the BDH Tech Corner and it moves the user to the BDH Tech Corner



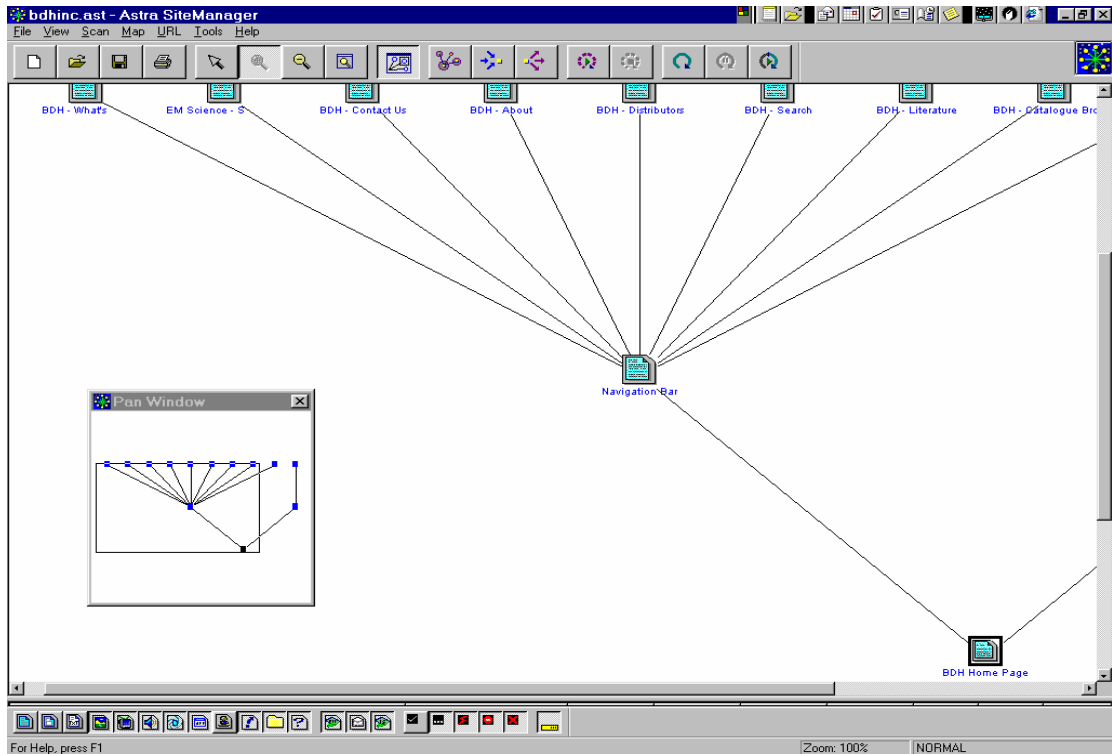
Node (page) which is also a link-menu (part of the site's navigational space). When this page (depicted above) loads we immediately note the following things:

- The page's name is shown in big imposing letters, letting the user know immediately where he is, beyond any doubt.
- Lots of white space and simple structure of the page reduce cognitive overload and relaxes user.
- The "Tech Corner" title is complemented by a relevant picture. The functional or utilitarian purpose of this picture is questionable but the aesthetic value of it is certainly high.
- The menu presented in this page is very simple, consisting of 6 links and is presented in both graphical and text forms.
- The previous page's (Home-Page) menu links have migrated into a blue colored horizontal frame along with an extra "Home" link. The user very easily locates the "Home" link as it set in a position that is not analogous with the positioning of the other links and thus immediately draws attention. This way anyone wishing to go back to the familiarity and security of the home page may easily do so. On the other hand through this frame or link bar a user can still access any of the links offered in the home page menu without actually going to the home page.
- The company's logo (BDH) is still depicted on the lower left corner, thus making it easy for anyone to know that he is located at the BDH Tech Corner page, even if this is the first page he sees.

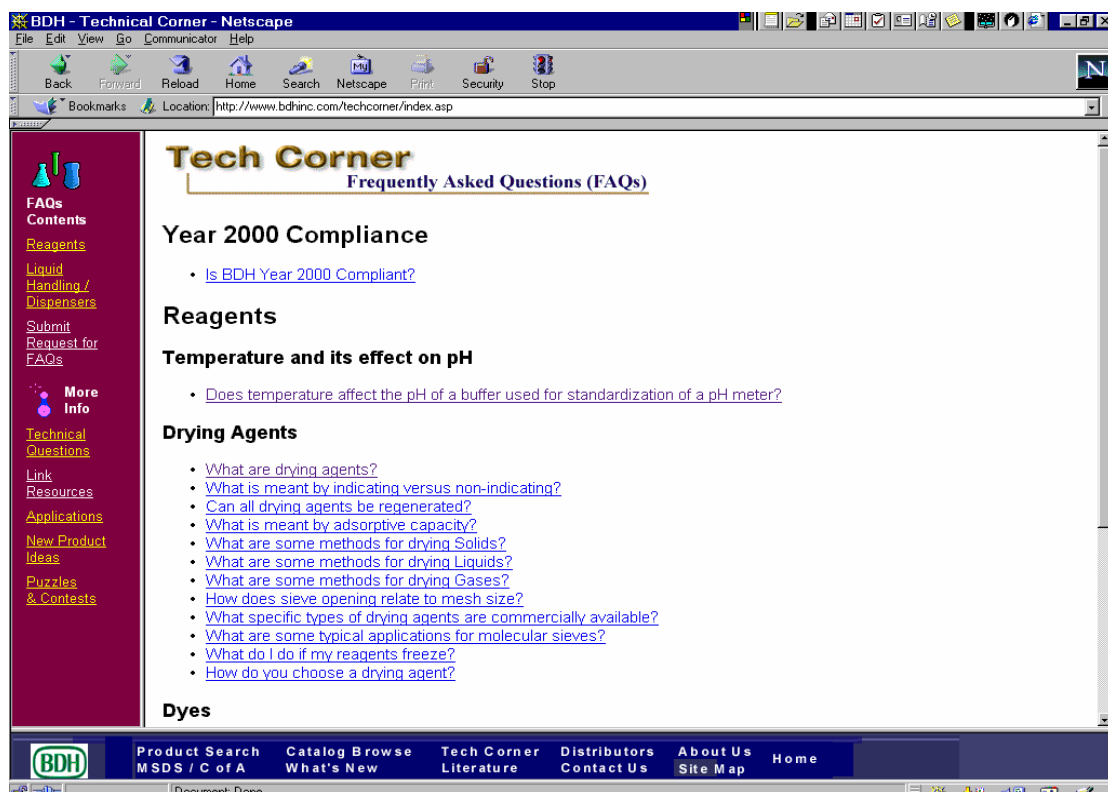
The screen below shows the outgoing links from the Tech Center page. You will notice that although there are 6 links shown in the Tech Center page there are only 5 outgoing links shown here. This is because one of the shown links is not activated yet by the site administrator (Specifically, “Related Links”). Also once again, the first level of nodes after the page at hand are just Web server directories and not actual browsable nodes. The actual nodes can be seen on the second row of nodes, as seen below, along with some blank pages that are irrelevant. Here we can easily see the “smooth” hierarchical style in which the site “blossoms”. Of course due to the link frames that are present at the first 2 depth levels of the site, the relationships between the different pages are much more, in fact relating all pages of the 3 first depth levels of the site with each other, in a web-like organization. Since the first 3 depth levels of the site represent only navigational space and not informational space, this is easily done without causing significant cognitive overload or disorientation, especially since the frames along with the page title are so well designed that user can easily determine what page and what depth of the site he is at, as well as easily find out which way to move around.



The Astra screen below shows the incoming (instead of outgoing) links of the home page. Here we can see how the nodes that are directly linked with the home page through the home-page main menu, link back to it through the link-frame (or Navigation Bar) which actually links one with another too.



Continuing deeper along the path we have chosen, we now choose the FAQs link from the Tech Corner page. Doing that we come up with the following page.



As we can see, a new link-frame of different color (and this time vertical, on the left side of the page) has come up. As before, the links present in the main menu of the previous page, have now migrated to this newly formed frame (under the “more info” title). The same frame also houses shortcut-links or links that are used for quick navigation within major sections of the current page (which is another frame of course, just the bigger one).

This page features a title and a subtitle. The title is Tech Corner (to indicate that it is part of the Tech Corner section of the site) and the subtitle is FAQs (to indicate the specific Tech Corner subsection we are at). This is the first time we come across normal hypertext (this is the 4<sup>th</sup> level) but we see that still this hypertext represents an intermediate level between navigational and informational space, as it is composed of hypertext links only, which are embedded on normal text in the form of questions of a specific nature.

Each question-hyperlink leads to the relevant answer, which, as we see below (when the “What are drying agents?” link is chosen), pops up in the same central frame along with the rest of the Q&As from the same FAQ section.

BDH - Technical Corner - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Stop

Bookmarks Location: <http://www.bdhinc.com/techcorner/index.asp>

## Tech Corner

Frequently Asked Questions (FAQs)

### Reagents - Drying Agents

#### What Are Drying Agents?

A drying agent is a substance that absorbs water. Drying agents are grouped into two major classes: chemically acting and physically acting drying agents.

There are two subdivisions of chemically acting drying agents:

**Chemically acting drying agents** are substances that bind the water in the form of crystallization and may be regenerated by warming. Examples of these types of drying agents are calcium chloride, sodium sulfate, or magnesium perchlorate. The second subdivision of chemically acting drying agents are substances that react with water. Regeneration of these drying agents is not possible since the drying agent has undergone a chemical change. Examples of these types of drying agents are phosphorus pentoxide, sicacide, metals, and metal hydrides. Often by-products are formed.

**Physically acting drying agents** are substances that adsorb water on the surface and in the pores of the drying agent. These drying agents can be regenerated by warming or applying a vacuum. Examples of these types of drying agents are t.h.e. desiccant, silica gel, molecular sieve, and aluminum oxide.

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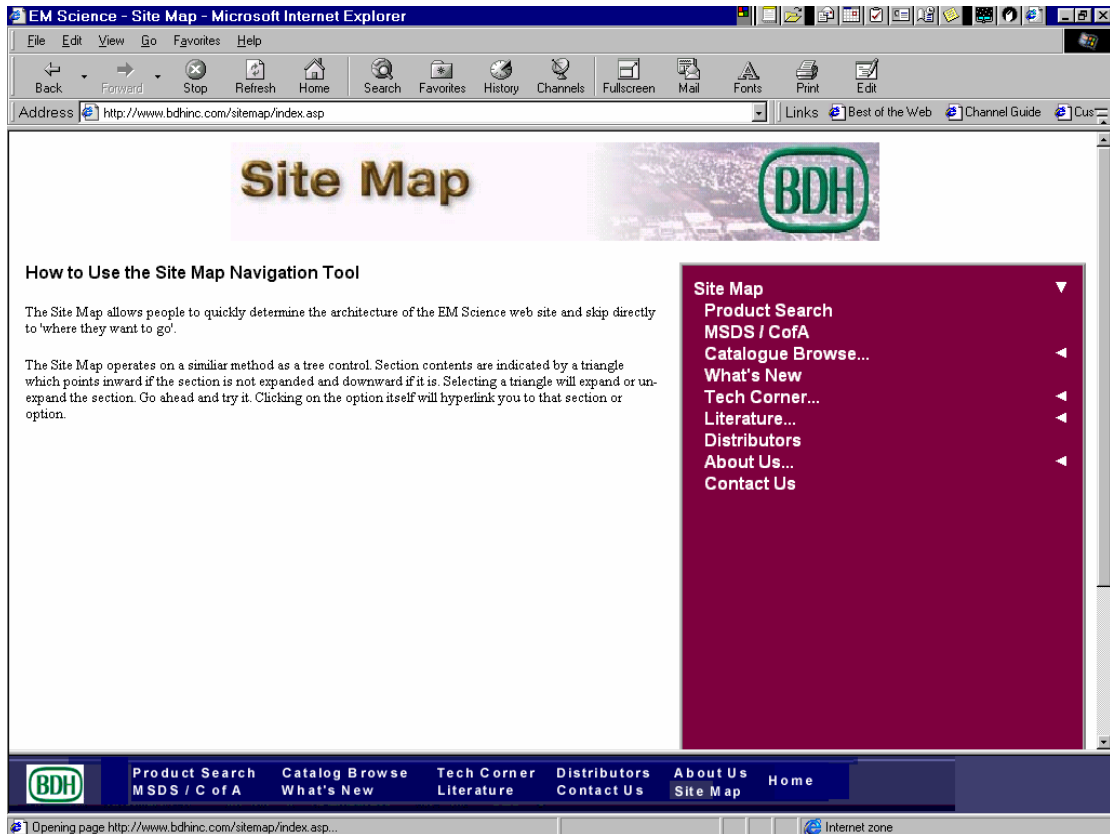
#### What is meant by indicating versus nonindicating?

When a drying agent is indicating, the drying agent will turn pink in the presence of water. For example, silica gel with indicator (blue gel) contains minute quantities of an indicator (cobalt (II) chloride) which is blue in the anhydrous state. Exhaustion of the gel is easily detectable from the pink color that develops upon saturation with water. After regeneration, the silica gel returns to its original blue color and can be used again.

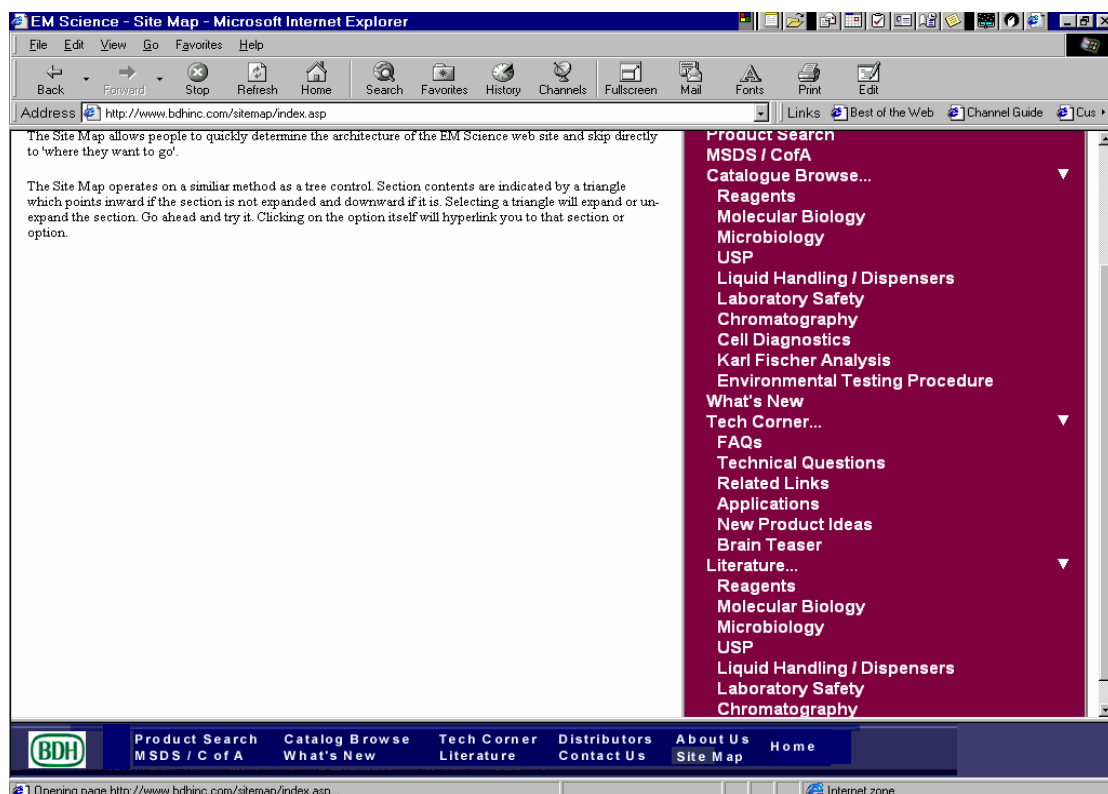
BDH Product Search Catalog Browse Tech Corner Distributors About Us Home  
MSDS / C of A What's New Literature Contact Us Site Map

As we can see, here all we have in the main frame is plain text in the form of specific answers to specific questions. The text is offered in complete scrollable sections thus aiding the notions of context and integrity. Of course this is the relatively ideal case of FAQs where a piece of text can be easily short and complete. Still the whole set-up, in my opinion, shows a case of optimal co-existence of plain text (with no embedded links) and hypertext-like navigational space (the two link-frames offered). For one to go back to the page right before, all that he has to do is a click on the relative link in the frame on the left. Any other page up to the 3<sup>rd</sup> depth level of the site (including the home page) is immediately accessible from right here (this is the 5<sup>th</sup> level).

The site's map is offered as an alternative way of navigation, and is linked straight to the home page (via the main menu) or through the lower frame links that are present in all of the site's pages. The Site Map page is shown above, and is nothing more than a host HTML page for the Exploder applet along with a simple remark.



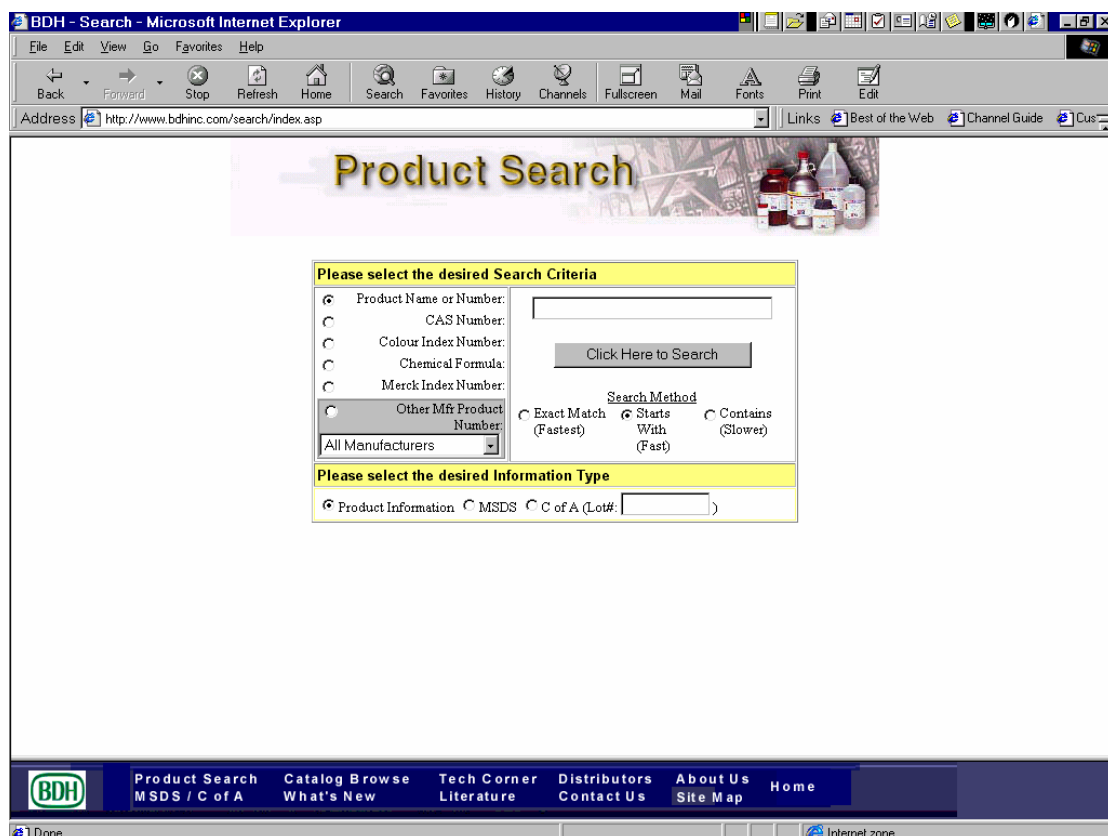
Right below we can see the Exploder Applet in a “kinda like a totally exploded state dude!”



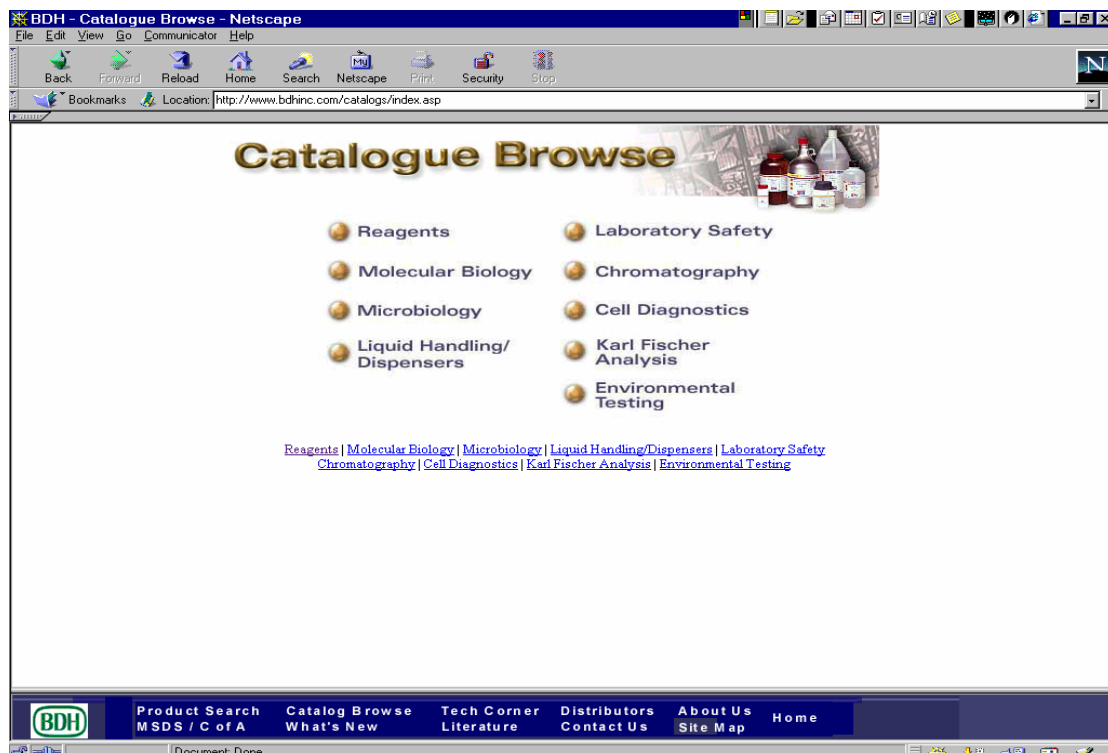
The exploder applet is very easy to use and provides the user with an intuitively easy way to hierarchically view the structure of the site and choose the page of his destination with a simple click. Paths that have been expanded (Exploded) can also be retracted (Imploded) with a single click so that the user does not have to scroll down to find the page of interest.

Of course the obvious problem here is that once one is determined to use the site map for navigation around the site, he/she has to go back to the site map page again and again, each time he/she wants to go to a different page.

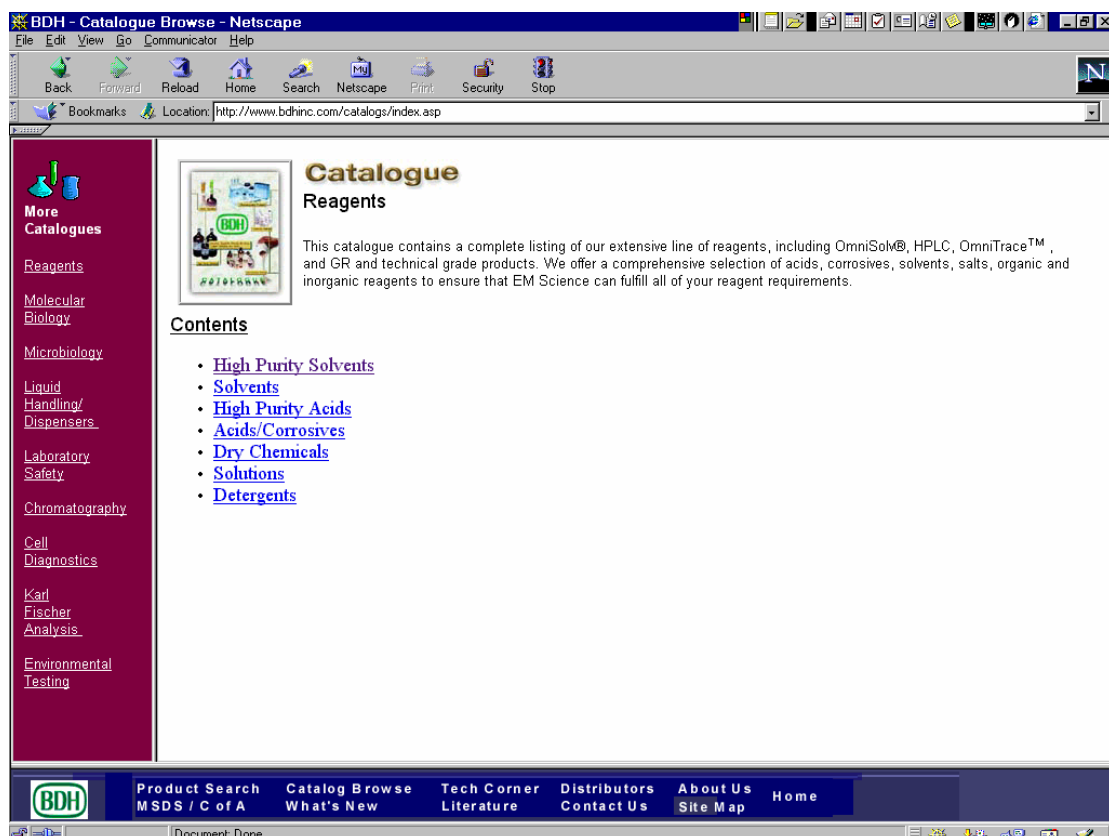
The primary purpose of this site is to allow customers of the company (present and prospective) to find specific products of interest, their characteristics, prices, etc. It is fair to say then that the site is primarily to be used as a database front-end, and thus it is only logical and expected that the “Product Search” link, in the home-page’s main menu, is offered as the first available option for the user. A screen shot of the “search” page can be seen below.



The site though, offers the alternative choice of browsing the product database's contents by means of hypertext (Through the "Catalogue Browse" option). Hypertext again is solely used as the means of linking sorted product lists to plain text CGI invoked product description pages as the following pages show.



Choosing “Reagents” from the first page we are presented with the second page (shown below) which holds in its central frame a list of the different types of reagents. This is an expandable hyper-linked list, that expands into alphabetically sorted lists of reagents under the specific type of reagent selected (clicked) by the user.



For instance choosing “High Purity Solvents” from the list above we are presented with the following page:



The screenshot shows a Netscape browser window titled "BDH - Catalogue Browse - Netscape". The address bar displays "http://www.bdvinc.com/catalogs/index.asp". The main content area is titled "Catalogue Reagents" and includes a small image of a reagent bottle. Below the image, a paragraph states: "This catalogue contains a complete listing of our extensive line of reagents, including OmniSolv®, HPLC, OmniTrace™, and GR and technical grade products. We offer a comprehensive selection of acids, corrosives, solvents, salts, organic and inorganic reagents to ensure that EM Science can fulfill all of your reagent requirements." The "Contents" section lists "High Purity Solvents" and provides a "Select from the index shown below:" with a row of alphabetical links: [A-C](#) | [D-F](#) | [G-I](#) | [J-L](#) | [M-O](#) | [P-R](#) | [S-U](#) | [V-Z](#). A bulleted list of reagents follows, each with a corresponding link: OmniSolv® Acetone HR-GC, Acetone Residue, Acetone HPLC, OmniSolv® Acetone, OmniSolv® Acetonitrile, Acetonitrile HPLC, DriSolv® Acetonitrile, Anhydrous, OmniSolv® Acetonitrile, Anhydrous Biosynthesis, OmniSolv® Acetonitrile, Non UV, OmniSolv® Benzene, OmniSolv® 2-Butanone, OmniSolv® Butyl Acetate, OmniSolv® Butyl Alcohol, OmniSolv® iso-Butyl Alcohol, OmniSolv® Carbon Disulfide, and OmniSolv® Carbon Disulfide, Low Benzene. The left sidebar contains a "More Catalogues" menu with links for Reagents, Molecular Biology, Microbiology, Liquid Handling/Dispensers, Laboratory Safety, Chromatography, Cell Diagnostics, Karl Fischer Analysis, and Environmental Testing. The bottom navigation bar includes links for Product Search, MSDS / C of A, Catalog Browse, What's New, Tech Corner, Literature, Distributors, Contact Us, About Us, Site Map, and Home.

Notice that the alphabetically sorted listed of reagents under the selected type, is further subdivided into sections that are directly accessible through hyperlinks, like “A-C”, “D-F”, etc.

All specific product links are CGI links and therefore involve database access. For instance choosing the “Acetone HR-GC” link from the previous page, we are presented with the following:

**BDH - Catalogue Browse - Netscape**  
 Location: <http://www.bdhinc.com/catalogs/index.asp>

**PRODUCT INFORMATION**  
[Specifications](#) | [Physical Properties](#) | [Sizes, Pricing & Packaging](#)

Product Name: **OmniSolv® Acetone**  
 Spill Kit Code:  [Click Here for More Info](#)  
 Hazard Codes:  [Click Here for More Info](#)

Grade: HR-GC  
 Chemical Formula:  $(CH_3)_2C=O$   
 Synonyms: Dimethyl Ketone  
 Suitability: For High Resolution Gas Chromatography  
 Storage: Flammable Hazard  
 Molecular Weight: 58.08  
 CAS#: 67-64-1  
 Merck Index: 12.64

**Product Specifications**

Appearance.....	Clear liquid, free from particulates
Assay (GC).....	99.7% min
Capillary ECD responsive substances (as C6 C16).....	
.....max. 2ppt each peak (or 50ppt total)	
Capillary FID responsive substances (as decane).....	
.....max. 1ppb each peak (or 10ppb total)	
Color (APHA).....	5 max
ECD responsive substances (as heptachlor epoxide).....	
.....1ppt max	
Filtered through 0.2 $\mu$ m filter.....	Passes test
Residue after evaporation.....	1ppm max
Titration acid.....	0.3 <sup>-</sup> eq/g max

BDH | [Product Search](#) | [Catalog Browse](#) | [Tech Corner](#) | [Distributors](#) | [About Us](#) | [Home](#)  
[MSDS / C of A](#) | [What's New](#) | [Literature](#) | [Contact Us](#) | [Site Map](#)

Recapitulating our observations in this site structure analysis, we can say the following:

- **The site's navigational and conceptual spaces are well separated. This is totally in agreement with what has been said in this paper about the advantages of such an approach.**
- **The site is very efficient in pursuing its primary goal, which is to easily and comfortably lead the users to specific information about products or any other option offered. This is achieved through a very easily and very intuitively browsable navigational space and a design that is pleasant and relaxing while aiding user orientation in all pages.**
- **The site's hyperlinks are only used in the navigational space of the site (not the Conceptual). The conceptual space is only implemented by means of complete plain scrollable texts. The use of hypertext in this site is actually implemented in much the same way that this paper has so far suggested as the optimal. That is, hypertext should be used for navigation between different concepts, and not for forming concepts themselves by making explicit the linking between their semantic constituents. This way the web site is used as an easily browsable database holding specific information, leaving the task of whatever semantic net representation formation to the user alone. Thank you for not messing with my head, BDH!**

## **Propositions**

This paper's objective, at this point, would normally be "a proposal for how the Web Site in question might be re-designed to be a 'true' model of Human Associative Memory." This paper's main objective has basically been a refutation of the paper's subject. I believe that I have presented my case well enough to suggest that any proposed direct analogy between the mind/memory and hypertext/hypermedia content is at least questionable. In accord with this attitude the site that I have selected makes use of the hypertext technology in a way that does not claim or even attempt to present the encoded information in a way that has any "special" kind of relation with semantic nets and human associative memory models.

I find this page exceptionally well designed and consequently do not have much to suggest. A few pointers would be:

- It is generally a good practice to make links visible only when they are available, or when an appropriate message shows when and how they will be available soon. I noticed a couple of links in this site that did not abide by this general principle.
- I would prefer if instead of the two frames, the Java applet site map were present in each of the site's pages. I believe that the main reasons that this was not done so, are that it would make the first page to take longer to load (after that the applet is normally held on memory and does not need to be downloaded again), and because there are actually still some browsers out there that do not support Java or some version of Java.
- It would be better, aesthetically and cognitively speaking, to have each "explodable" level of the site map marked in different contrasting color to make the hierarchical structure easier to visually perceive.
- The site map can easily afford a 4<sup>th</sup> depth level, thus making more of the site's pages directly accessible.

## Conclusion

This has been a very hard to complete project. Although I could just take the easy way of approaching the subject by just reciting what is in the book and what we have been taught in class, I just chose to really think on the problems at hand and to pursue the real and invariably hard issues that usually make their presence painfully known once one starts making questions concerning the essence of things.

I recognize of course that in doing so I may have reached false conclusions or that I may even have started off the wrong premises (any subject becomes very “tricky” once it is treated as a contingently meaningful one), but in any case I prefer to live with this uncertainty than to mechanically reproduce stale views and opinions that I do not really understand or even worse do not care to understand.

In any case, I cannot consider a non-holistic treatment of any subject that involves us humans (and virtually all do), a treatment at all. This is why once in a while the text above would revert to maybe seemingly not very relevant subjects of general social, philosophical, or psychological interest. In doing so, my motives were not inclined at impressing the reader, but at making him/her aware of the underlying complexities and implications of the matters involved. Although analysis has proven to be an invaluable problem solver, it has also created legendary confusions and misunderstandings. In the light of this, I sometimes find “straight to the point” and “very specific” (as they are called) articles at least idiotic and laughable.

In my quest to address (attack?) the subject to its premises I have found a lot of relevant material on the Internet. The textbook by Preece et al was mainly used as a handy and concise store of the principles involved although it lacked rigorous treatment of these in most cases. I was also very impressed by the work, on this very subject, of Dr.Charney whose mental imprint has been an invaluable ally in writing this paper as well as my sole guarantee that I was not totally “out of line.” Thanks Doc! You are one fine gal!

I ask the reader to excuse me for not explicitly citing my references whenever or wherever used in the text. This is mainly because the paper is already heavily overdue. All references used in this paper are appropriately stated in the next page. The last page contains a poem that I wrote while studying for the course work.

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# Awakening

One day,  
I entered a dark forgotten cave in my head  
and heard screaming; familiar meaningless words  
in sequences that seemed to mean something

The otherworld growling of a mighty beast  
conveying fathomless meaning, or none

I thought, I better listen!  
And then I felt this power  
putting me in a disorganized order  
that felt natural

In a dark chamber in us  
deeply hidden  
where  
meaning is a Gordian knot  
obvious is only a mystery  
dreaming is living  
There, I saw myself play,  
with the ease and decisiveness of a child

Blessed harmony of the unknown!  
Sweet wholesomeness of doubt!  
Most precious victory of loosing!  
Unyielding truthfulness of lies!

If I awake,  
Will you be there?