chapter 3

Mapping the Web
Whilst maps of infrastructure and traffic are the most commonly produced spatial visualizations of cyberspace, perhaps the most exciting projects are occurring in relation to mapping the informational landscape of cyberspace. Of all the types of mapping and spatialization we present, this is clearly the area where the most original research and development is taking place. Here, researchers from the disciplines of computer graphics, information design, human–computer interaction, virtual reality, information retrieval and scientific visualization, along with those working for commercial enterprises, are seeking ways in which to spatialize cyberspace itself, trying to find ways to:

- improve modes of navigation through, and searching of, the information spaces of the Internet;
- provide media that are easier to comprehend;
- document the extent and territories of different media.

In other words, different methods of spatialization – where a spatial structure is applied to data where no inherent or obvious one already exists – are being experimented with and developed in order to try to enhance the usability and comprehensibility of cyberspace, exploiting the fact that people find it easier to process and understand visual displays than large volumes of written text or columns of numbers.

Many of these spatialization techniques are being developed for future commercial exploitation, as it is believed that the first successful software will become a “killer” (i.e. pervasive and dominant) application, replacing hypertext-driven browsers with a hyper-visual mode of navigation. The reason why such a “killer” application has not been successfully developed or marketed to date is because, as noted in brief in chapter 1, developing effective spatializations is not an easy task. Cyberspace, although not spaceless as hypothesized by some analysts, does not have a static, easily measurable space–time geometry. This is because cyberspace is entirely socially produced – its form and structure are dematerialized and determined by its creators. Space–time, then, is discontinuous and relative and changes from media to media and site to site. Moreover, cyberspace is highly mutable – able to change form yet still possess the same content – and dynamic, with new material being constantly added and old material altered, updated and deleted, leaving no record. These changes are often “hidden” until encountered. As time unfolds, the mutability and dynamism of cyberspace will increase accordingly, so that its contents are continually evolving, disappearing and restructuring at ever increasing rates. Effective spatializations, especially for navigation and search, must be able to cope with such changes, automatically and seamlessly incorporating them. Furthermore, spatializations, if they are to be used as modes of navigation and query, need to be interactive, so that territory and map become one.

In the rest of this chapter we detail the methods so far developed to try to spatialize cyberspace and discuss some of the spatializations produced by these techniques. We focus our attention on spatializations of information, examining attempts to spatialize the social domains of cyberspace (e.g. email, chat, multi-user domains, virtual worlds, games) in the following chapter. In order to provide a structure to our discussion, we have sequenced our examples of maps along a scale continuum, starting with individual websites and progressing through to large sections of the Internet.

Information spaces of the Internet

A useful place to start this chapter is to examine the conceptual map of cyberspace created by John December in 1994. This spatialization provides a good overview of the conceptual spaces of the Internet at that time. It illustrates that the Internet supported a range of interconnected information spaces beyond the Web, each of which has differing virtual “geographies” (also see chapter 4).
John December is a successful Internet consultant running his own firm, December Communications, Inc., based in Milwaukee, Wisconsin. December has written and presented extensively about the Internet, the Web and broader issues of computer-mediated communications. He created a number of different conceptual cybermaps in the mid-1990s to try to give a “big picture” overview of the nature of cyberspace. The conceptual diagram shown opposite reveals the geographies of net spaces, providing a good way of conceptualizing them as distinct and self-contained domains, but with fluid and irregular boundaries and many interconnections and overlaps between them. The map also illustrates that other networks existed beyond the Internet, such as FidoNet and BITNET, that make up the larger, globe-spanning Matrix of computer-communications systems (see chapter 2).

December’s map is hand-drawn and has a sketch-like quality. The networks and information spaces are drawn as puddle-like “blobs”. There are several distinct networks, labeled in purple, showing the diversity of cyberspace in 1994. “The Matrix” is the largest “blob” and contains the Internet (and its information spaces running over TCP/IP) as the largest network, along with the notable, but much smaller, networks of FidoNet, UUCP, and BITNET. There was also a sizeable presence of commercial online services in the early 1990s (such as AOL, CompuServe, Prodigy, and GEnie) which were generally closed and proprietary in nature, and not really part of the Internet.

The heart of the spatialization focusses on the eight most significant information spaces in the mid-1990s as identified by December. These were the Web, Gopher, email, finger, WAIS, telnet, ftp and Usenet. Most of these information spaces are contained within the Internet, except for email and Usenet which spill over to other networks. The key landmarks for each information space are clearly labeled and the connections between spaces are represented by red arrows. So, for email space in 1994, one of its landmarks was the Publicly Accessible Mailing Lists (PAML) index, while the Web’s landmarks were the then new search engines and directories such as Lycos, Web Crawler, Yahoo! and CERN’s venerable Virtual Library.

What makes these information spaces different from one another are the modes of information exchange, degrees of synchronicity and levels of social interaction they support. At a fundamental level, the differences between information spaces are caused by the different protocols used by software applications to communicate over the Internet, which give rise to the different form and functions apparent to the end user. This kind of protocol separation is intuitively apparent from December’s map.

Since the map was drawn, the nature of the Internet has changed markedly, with certain information spaces dying off as they fall out of favor with users, particularly WAIS and Gopher. Undoubtedly, the biggest change has been the inexorable and exponential growth of Web space, which would now be a huge blue “blob” on the map, squeezing out and submerging many other information spaces. Other important information spaces have evolved and grown in prominence, such as instant messaging (e.g. ICQ), chat environments (e.g. IRC), multi-user game spaces (e.g. Quake) and streaming media (e.g. RealNetworks, MP3s). Also, large intranets have proliferated, creating important private information spaces.

December admits that: “In a way, my 1994 map was very naive – I didn’t really have a clear idea of global nets at the time, but I intuitively pictured the conceptual relationships much like ancient tribes did – I knew that there was ‘this place’ and ‘another place’ and ways to ‘get’ from one place to the other.”

Despite the naiveté of the map, it still provides one of the best conceptual views of cyberspace and today it has added historical interest.

3.1: Conceptual map of Internet information spaces

chief cartographer: John December (December Communications, Inc., Milwaukee, Wisconsin).

aim: to show the multiple, linked information space of the Internet, circa 1994.

form: Venn-diagram style, with different spaces shown as irregularly shaped blobs, key landmarks marked with symbols, and connections between spaces shown by red arrows.

technique: a hand-crafted diagram.

date: December 1994.

further information: see <http://www.december.com>
Mapping the web

CyberMap Landmarks
Copyright (c) 1994 John December

Searcher or Index
Gateway or Link
Subject Tree
Root List

The Internet

Web space
- CERN List
- CERN VL
- Yahoo
- Galaxy
- Lycos, Crawler
- CUI Catalog

WAIS space
- dir. of servers

Telnet space
- Hytelnet

FTP space
- Monster list
- Usenet FAQs
- Archie

Email space
- PAML

Gopher space
- MN
- Jewels
- Veronica

Finger space
- Finger info

Commercial Online Services

nrm1
agura@w3.org
gopher://host/2/2User

Courtesy of John December
Source: Tim Berners-Lee, Information Management: A Proposal

Atlas of cyberspace

for example

includes

describes

for example

unifies

describes

includes

describes

refers to

wrote

includes

describes

A Proposal "Mesh"

Hypermedia

"Hypertext"

ENQUIRE

Linked information

HyperCard

Computer conferencing

IBM GroupTalk

VAX/NOTES

uucp News

Hierarchical systems

CERNDOC

This document

Comms ACM

etc.

Tim Berners-Lee

C.E.R.N.

division

group

group

section

78
The beginning of the Web

It seems appropriate to continue by examining the conceptual map used by Tim Berners-Lee in his original proposal for a new hypertext system that would become the World Wide Web. Such spatializations are commonplace in the development of new systems, allowing designers to document the complex links between system components.

Berners-Lee invented the Web in 1990 while working at CERN, the European particle physics laboratory in Switzerland. The conceptual map was an important part of a document entitled Information Management: A Proposal written in 1989 to persuade CERN management to support the project to design and build a global hypertext system to better manage and maintain the large, complex and ever-growing information resources of that organization. The diagram opposite is a simple “mental map” of the ideas and concepts of the project using basic “circle and arrows” notation. The hypertext system at the heart of the diagram was called “Mesh” and it was only later that its name was changed to the World Wide Web once software development commenced in 1990. The idea was to provide a practicable and useful system that could seamlessly unify existing information resources and systems, and also be an open system to allow future development and growth. The ideas were built on many years of research into hypertext and information systems.

From the humble beginnings of this diagram and the supporting proposal, a rudimentary, but workable, text-only hypertext system emerged in the early 1990s. By the start of 1993, there were only perhaps 50 or 60 Web servers in the world. A critical turning point came in November 1993, when the Mosaic browser, a free piece of software developed by the National Center for Supercomputing Applications (NCSA), was released, providing a graphical way to navigate the Internet. Since Mosaic’s release, the Web has grown tremendously to become a huge information space, offering all manner of information and services, and spawning multi-billion-dollar industries. Subsequently, commercial browsers such as Netscape and Internet Explorer have become the main means by which people surf the Net, but those browsers are still based fundamentally on the open, distributed and scaleable hypertext system envisioned by Berners-Lee whereby anyone was free to contribute a Web page or two and link to other resources. Utilising the power of hypertext, the Web rapidly became one of the most significant information and communication developments of the twentieth century.

3.2: The original conceptual design of the World Wide Web

chief cartographer: Tim Berners-Lee (while at CERN, Switzerland).
aim: to show the potential of a global hypertext system (“Mesh”, later christened the World Wide Web) to unify disparate information resources in a large and dynamic organization.
form: a simple black-and-white “circles and arrows” diagram, sketching interrelations between ideas and concepts.
technique: a hand-crafted diagram.
date: March 1989.

Mapping individual websites

As soon as the Mosaic browser was released, the Web began to grow exponentially, with tens of thousands and then millions of new pages being added annually. Almost immediately, one of the key problems was trying to navigate efficiently and to search for particular pieces of information both within and across websites. Not unsurprisingly in both cases, a key strategy has been to explore and adopt spatializations as navigation tools, alongside keyword search tools and navigation bars. In this and the next section, we examine spatializations of individual websites, first detailing site maps and then mapping tools used in site planning, development and maintenance.

“Where am I?” is a question asked by most people when landed in the middle of a large website by a search engine, often followed by, “What else is available on this site?” and, “How do I get to that other information?” The site map is one of the key tools that site designers can provide to help surfers answer these questions and successfully navigate through their site. At their simplest, site maps are like a book’s table of contents, while more sophisticated examples use advanced, interactive spatializations. In all cases, site maps aim to communicate, on a single screen, a site’s content and enable a user to reach it with a single click. They are becoming increasingly important as websites become larger and more complex and are nowadays a common element of Web design, especially for large corporate sites. This is not to say that all of them are successful in their task or aesthetically pleasing to view.

The art and science of creating intuitive and useful website maps is still in its infancy. One of the most knowledgeable people in the nascent field of website mapping is Paul Kahn, a founding partner in the information design firm named Dynamic Diagrams. He commented: “I think website mapping is bouncing back and forth between two poles: it is absolutely necessary and it is impossible.” At present, too many site maps fail in their attempts to guide disorientated surfers to their destination. This failure is due to a number of difficult problems, such as deciding on the most appropriate level of detail for effective communication, trying to balance local detail necessary for practical navigation, whilst also providing a global overview of the entire site.

Moreover, there are many possible elements that could be used to describe a site, all of which could be spatialized: page title, URL, screenshots, depth from home, or access restrictions. Further, the site maps themselves need to load quickly and conform to standard screen resolutions. Then there are the problems of keeping maps up to date on a dynamic site.

The plate opposite is a simple “table of contents”, functional site map of Apple Computer’s website as at August 2000. It employs no spatialization, consisting purely of simple text hyperlinks to key site content, where the spatial layout of the elements has no inherent meaning. The blue hyperlinks are grouped into 11 major sections, which are laid out on the screen in three rows, the aim being visual clarity. It is a simple and effective way of showing, on a single fast-loading screen, a high-level summary of all the content of Apple’s huge website. This “table of contents” style is by far the most common form of site map employed on the Web today. This is because it is an effective mode of communication, but more crucially it is easily created and maintained.

3.3: A typical “table of contents” style of website map from Apple

chief designer: unknown (Apple Computer, Inc.).
aim: to provide a simple overview listing the major content areas of Apple’s extensive website.
form: clean-looking hierarchical table of contents, with 11 major groups in three rows.
technique: simple clickable hypertext links take a user to an appropriate section of a site.
date: screenshot taken in August 2000.
further information: try the current version at <http://www.apple.com>
further reading: Mapping Websites: Designing Digital Media, Paul Kahn (Rotovision, 2000).
More interesting than simple text maps are the use of spatialized site maps. The following site maps use a metaphorical approach to represent the content of a website, employing a familiar image to aid navigation. The first example, Yell Guide’s website (part of the UK’s Yellow Pages website), used the visual styling of the London Underground map to create a site map. Active in 1997, the spatialization used four color-coded lines to represent different sections of the site (e.g. red for London and green for gardening), and the standard London Underground map symbol for an interchange station to represent individual pages.

Although interesting visually, its effectiveness as a navigation aid when compared with a conventional “table of contents” listing is debatable. Moreover, the spatialization is not a scaleable solution, having to be redrawn to accommodate growth. As a consequence, it was soon dropped from the site and has been replaced by other navigation tools.

3.4: The Tube map as a metaphorical site map

- chief cartographer: not known.
- aim: to provide an attractive overview map on the Yell Guide website (British Telecommunications plc.) showing major content areas on a single screen.
- form: borrows the strong styling of the famous London Underground map.
- technique: simple clickable hypertext links take a user to that section of the site.
- date: 1997.
- further information: this site map is no longer online.
Another metaphorical site map is this striking and simple black-and-white chalk-style drawing of the human body, which is used to represent the content of a site. The “my body” site map is from Shelley Jackson's Web artwork entitled *My body, a wunderkammer* (a wunderkammer being a cabinet of curiosities, the forerunner of the modern museum, albeit with an emphasis on typology rather than chronology). It is more than just a functional map; it is an integral part of the actual artistic content of the website.

Shelley Jackson is an artist and writer who has experimented with hypertext writing and her “my body” site provides a hypertext narration on her feelings, memories and experiences of her body. The evocative sketch of the body used for the site-map is a self-portrait. Parts of the anatomy on the map, which are boxed and labeled, are linked to individual pages. Clicking on the “shins” area of the body map takes one to the page concerning her shins, described as follows: “My shins are slightly bumpy and when I get a tan, mottled with tiny white dots as with sunlight through leaves. The dots are faded scars, dozens of them of different vintages, criss-crossed and overlaid...”. Here, the map is the territory it seeks to represent.

### 3.5: “my body” as a metaphorical site map

**Chief cartographer:** Shelley Jackson.

**Aim:** To provide an overview map showing major content areas on a single screen, but also to act as an integral part of the actual content of the site.

**Form:** Stylized black-and-white sketch of a female body.

**Technique:** Simple clickable hypertext links take a user to a selected section of the site.

**Date:** 1997.

**Further information:** “my body” at [http://www.altx.com/thebody/](http://www.altx.com/thebody/)

**Further reading:** Shelley Jackson’s homepage, entitled “Ineradicable Stain”, at [http://www.ineradicablestain.com](http://www.ineradicablestain.com)
This example, Site Lens, similarly aims to provide a site map designed to help visitors find particular Web pages. Unlike the previous site maps, however, it uses powerful interactive graphics to show the extent of available pages and the overall hierarchical structure of a site. It has been developed by Inxight Software, a spin-off from the famed Xerox Palo Alto Research Center (whose work we will look at more closely later in this chapter). Site Lens is based on information visualization research in the mid-1990s that developed fish-eye distortion techniques in order to produce a hyperbolic browser of hierarchical graphical structures.

The technique works by warping the spatial view of the data under the “lens”, so that elements at the center of the map appear much larger than those at the periphery. The user is able to grab page objects and drag them to the center of the map, where that area will be enlarged smoothly with an animated transition. In this manner, a user can explore a large hierarchical website of hundreds of pages with simple point-and-click browsing, with local detail in the center of the map and wider context visible in the surrounding area. Indeed, the underlying technique is often described as “focus + context”. Individual pages are usually represented in the Site Lens by a rectangular block containing the title (but it could include an illustrative icon or thumbnail image). Double-clicking on a title or icon will load the corresponding page into the main browser window.

The figures displayed below and opposite show different examples of Site Lens maps, illustrating various aspects of this mapping system. The main images displayed show a stylistic demo of the Porsche website. The large image opposite is the default view and is centered on the Porsche homepage. Organized in a circle around this home page information is the branching structure of different segments of the site. In the second screenshot, a user has chosen to look in more detail at the “Boxster” portion of the site (one of Porsche’s models), and so the user has selected and dragged that node into the center. When it is at the heart of the lens, its subsidiary pages grow and become legible. Moving further down the “Boxster” path, the third screenshot focusses on the “Engine” page.

The two other examples are Site Lens demos of the online toystore eToys.com, which uses many thumbnail images of toys to illustrate the different sections of its site, and Lexis-Nexis, one of the world’s largest information archives. In the latter case, the site map provides a way to browse the 22,000 information sources that the corporation has access to – although, in this example, the map has become overly dense at certain branches of the hierarchy and is reaching the limits of its capability to present a clear visualization of the information.

3.6: Site Lens interactive fish-eye site maps

chief cartographers: Inxight Software, based on research by John Lamping, Ramana Rao and Peter Pirolli (User Interface Research Group, Xerox Palo Alto Research Center).
aim: to provide an interactive overview map showing major content areas of the website on a single screen.
form: arc–node tree structure viewed through a simulated fish-eye lens.
technique: hyperbolic-tree visualization.
further information: <http://www.inxight.com>
The second interactive site mapping system we detail is SiteBrain, developed by TheBrain Technologies Corporation. It too uses a hierarchical graphical approach to interactively map the structure of a site. However, it does not use fish-eye distortion and therefore cannot show the whole structure of a site on a single page. Instead, it relies on interactive graphics to enable users to navigate hierarchical pathways. The example screenshots show the application of SiteBrain to mapping a large online magazine called *Mappa.Mundi*.

The first screenshot top-left shows the top of the website’s hierarchical structure with the homepage highlighted. Sibling nodes show the organization of the four main categories of content on the site. These represent four different ways to navigate to actual magazine articles. For example, you can access the articles based on who wrote them (authors) or by date (monthly edition of the magazine) or by sections or by topics. Clicking on the “Sections” topic causes the map to be smoothly redrawn, bringing this topic to the center of the spatialization and revealing the various sections of the magazine as “children” positioned below the “sections” heading, whose siblings are positioned to the right-hand side (top-right).

Exploring further into the map by clicking on the “map of the month” section leads to another transformation to reveal a further level in the hierarchy (bottom-left). The individual articles of the “map of the month” section are now listed as children nodes, while the right-hand sibling nodes are the other sections. Selecting the article, “A Map of Yahoo!” reveals that there are no further child pages in this hierarchy and, instead, two higher levels are shown: “February 2000” (bottom-middle) and “Map of the Month”, with their siblings arrayed on the right-hand side. This offers a quick way to move sideways and access related information – for example, clicking the “February 2000” link redraws the map showing other articles that were published in that month (bottom-right). At any point, clicking on a particular item opens the appropriate Web page.

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**3.7: SiteBrain sitemap for Mappa.Mundi Magazine**

**chief cartographers**: Corinne Becknell, Rebecca Hargrave, Marty Lucas, Carl Malamud at Mappa.Mundi using the SiteBrain system.

**aim**: to provide simple overview map showing major content areas on a single screen.

**form**: hierarchical graph structures.

**technique**: based on “concept mapping” technology of the brain.

**date**: SiteBrain was launched in 1999. Screenshots of Mappa.Mundi Magazine’s SiteBrain output were taken in August 2000.

Dynamic Diagrams has developed an innovative visual metaphor to represent website structure, which it calls the Z-Diagram. It is a 2.5-D landscape view, with Web pages represented as small standing cards laid out across an isometric plain. This provides a sense of depth without a vanishing point, so that objects are of a uniform size throughout the map. The metaphor was conceived by Krzysztof Lenk, a designer and founding partner in the company, to display the structure of a multimedia encyclopaedia. Detailed, handcrafted, Z-Diagrams are widely employed by Dynamic Diagrams as planning maps when designing and redesigning large websites.

Dynamic Diagrams has also used its Z-Diagram metaphor in an interactive site map utility for surfers. The system is called MAPA. Using MAPA, surfers can request a simple Z-Diagram style of map from any page on a website. The Z-Diagram will then be displayed in a small pop-up window displaying the localised structure. An example of a sequence of MAPA maps is shown opposite. Importantly, the MAPA system also provides “back-end” tools to analyze the structure of a large site and to derive the key hierarchical structure, which is stored in a database. MAPA is, therefore, a data-driven website map rather than a handcrafted one. The top image shows a screenshot of the MAPA map of Dynamic Diagram’s website, with cards projecting vertically from the ground plain representing the pages. The cards are spatially arranged to reflect the dominant hierarchical structure of the site without cluttering the screen with multiple hyperlinks between pages. Differently colored carpets delineate different levels in the hierarchy.

Users can interact with the MAPA map in several ways. For example, passing the cursor over a card will cause it to be highlighted and for the title to be displayed as a flag. Users can also navigate within the map itself by refocussing the layout around a different page. This is achieved by clicking on cards with a dark bar on them, whereupon the pages rearrange themselves in a smooth animated transition – the bottom plates provide snapshots of this. This is one of the key “wow factors” of MAPA, according to Paul Kahn, who comments: “Moving from one view to the next without the animation would be incomprehensible. With the animation, most people can get it. And it is fun to watch the pages march across the screen and rise up out of the carpet.” Finally, MAPA can be used to move the user’s browser to a different page in the site simply by double-clicking on a card of interest. The MAPA system provides one of the most innovative and effective interactive website maps currently available.

3.8: MAPA Z-factor site map of Dynamic Diagrams

chief cartographers: David Durand and Paul Kahn (Dynamic Diagrams, USA).

aim: to provide interactive site map to aid navigation.

form: a Z-factor animated map with pages represented by small cards. These are arranged in a hierarchical structure by position and color-coding.

technique: custom-written applications to analyze site structure and create a suitable hierarchical representation. Java applet used in order to deliver an interactive map, centered on current page.


further information: MAPA at the Dynamic Diagrams site at <http://www.dynamicdiagrams.com>

Welcome to Dynamic Diagrams
Mapping tools to manage websites

Specialized website-mapping applications that are aimed at those who manage large sites are generally analysis and management tools rather than navigational aids. Their role is to reveal the underlying structure of websites by detailing the content and links between pages. In this section, we detail a number of examples, starting with hand-crafted diagrams before moving on to discuss interactive tools that provide detailed and sophisticated interactive spatializations.

Dynamic Diagrams specializes in consulting on information architecture for the design or redesign of large websites. A key tool it uses in working with its clients is high-quality planning maps showing proposed structures and pathways through Web pages. These are hand-crafted, taking skilled designers many hours to put together, and they are often printed as large poster maps to use as discussion tools in meetings. The most distinctive mapping style developed by Dynamic Diagrams is undoubtedly its Z-form diagrams. These use the same spatial concepts and representation as the company’s interactive MAPA package.

A good example of a Z-form diagram is that of the Nature overview diagram produced in July 1999 (opposite). It displays in a clear and concise manner the key elements of Nature’s information architecture on a single page, showing the key Web pages, routes, click depth and access restrictions. The site begins with the homepage at the bottom left and then pages at one, two and three clicks’ depth are drawn progressively further back toward the top right-hand corner of the page. On this particular website, not all content is free to access, and so, in order to show clearly the different access rights across the site, both height and strong color-coding are used. The green area at ground level is free for all visitors. The next level of access is the orange raised area, which is restricted to registered users. Full access to the journal articles is restricted to paying subscribers, and this is represented by the red plinth. Finally, there is some special language content that is limited to Japanese subscribers. Another useful feature of the map is the linking of thumbnail screenshots of certain key Web pages to their position in the structure.

3.9: Z-form website planning diagram

chief designers: Chihiro Hosoe, Nancy Birkholzer, Paul Kahn and Krzysztof Lenk (Dynamic Diagrams, USA).

aim: to aid the planning and design of the structure of the Nature website.

form: Z-form representation where Web pages are standing cards on an isometric plane. The distance from bottom-left to top-right shows the click depth, and the height above the ground plane represents increasing access permissions.

technique: hand-crafted diagram.

date: July 1999.

further information: <http://www.dynamicdiagrams.com>
further reading: Mapping Websites: Designing Digital Media by Paul Kahn (Rotovision, 2000).
Another example of Dynamic Diagrams’ large-scale website maps for planning and design is the Netscape software download-area diagram. This was produced as part of a consulting project for Netscape, analyzing how its site was utilized by browsers. The style of mapping used is very different from the Z-form and is reminiscent of a wiring diagram for an electrical circuit-board. The aim of the map was to highlight the route users needed to take to download different pieces of software – quite a complex task given all the different permutations of operating system, language and encryption levels that Netscape offers.

3.10: Wiring diagram of a website

chief designers: Piotr Kaczmarek, Paul Kahn, and Krzysztof Lenk (Dynamic Diagrams, USA).

aim: to show the possible routes to download a multitude of different software available from the Netscape website.

form: detailed wiring diagram.

 technique: hand-crafted diagram.

date: September 1998.

further information: see <http://www.dynamicdiagrams.com>

further reading: Mapping Websites: Designing Digital Media by Paul Kahn (Rotovision, 2000).

The start point for the map and the website is the download homepage, shown at the top-right. The map is divided vertically into sections based on three broad categories of software: client (browsers), server and tools. A user then follows a given pathway running from left to right on the map, selecting an operating system and language before finally reaching the “download point” from where the software is transferred. These points are indicated on the map by small blue dots. The designers of the map have developed a compact but effective way of representing the complex selection process as a series of check-boxes.
The final Dynamic Diagrams example that we examine is a detailed strategic-planning map that summarizes the relationship across websites owned by a single corporation – in this case the large international publishing corporation named Verlagsgruppe Georg von Holtzbrinck. This corporation owns an array of public websites and the spatialization shown here summarizes a great deal of information about the sites: who operates them, what content they hold, and how they are interlinked.

Each website is represented by a colored circle with various icons summarizing key attributes of the site. Websites are color-coded and spatially arranged in the map according to the publishing division that operates them. Each circle contains a thumbnail image of a screenshot of the website’s homepage, along with small icons indicating the company type (newspaper, scientific publisher, television station, etc.), the country of operation (shown by a small flag), and the language used at the site. Particular content and features (such as online advertising, catalog searching) are indicated by further icons on the bottom half of the circles. The spatial arrangement of the circles is reminiscent of a chemistry periodic table. Navigational links between websites are shown by the fine lattice of connecting lines. The color of the lines, their thickness, and the kind of arrow at their termini all carry information as well. A one-way hyperlink is represented by a thin line, whilst a bilateral connection is shown by a thicker line. Lastly, an alphabetic catalog of names at the top of the map is coded to a labeled grid to help the reader locate individual websites.

3.11: Strategic map of the multiple websites of the Holtzbrinck Corporation

chief designers: Piotr Kaczmarek, Paul Kahn, Krzysztof Lenk, Magdalena Kasman, Nancy Birkhölzer and Angelika Binding (Dynamic Diagrams, USA).

aim: to produce a strategic map showing 130 public websites run by major publishing corporation Verlagsgruppe Georg von Holtzbrinck.

form: complex wiring diagram.

technique: large wall poster map, hand-crafted.

date: May 1999.

further information: see <http://www.dynamicdiagrams.com>

further reading: Mapping Websites: Designing Digital Media by Paul Kahn (Rotovision, 2000).
Websites with rapidly changing content can be difficult to manage. For example, preventing broken links, managing page changes, tracking Web page sizes to ensure a reasonable download time, and understanding the interconnections of a website can be time-consuming tasks. One method to try to address these problems is to employ an interactive, visual website-management tool. In the following examples, we detail three such tools.

The top-left and top-right images opposite display the interface of Astra SiteManager. SiteManager is a standalone application that allows a manager to pinpoint website problems (such as broken links), to run Web scans, and to improve the organization of a site by revealing hotspots (achieved by monitoring traffic through a site).

The screenshot displayed top-left is a mapping of the Center for Advanced Spatial Analysis’s website. The pages are represented by nodes and the links between pages by lines. In the top right-hand corner is a small overview map that can be panned to see sites too big to fit onto a single screen. At the bottom of the screen, details about each node in the graphic are listed.

The image shown below displays the interface of FrontPage 98 Explorer. It is a companion utility to Microsoft’s popular FrontPage HTML (Hypertext Markup Language) authoring package, and it allows users to examine the hierarchy of their pages. The interface is divided into two, with the left-hand frame displaying link hierarchy and the right-hand one a graphical representation of the links, which can be expanded or compressed. If a page’s contents are altered, the package can be run to determine whether links between pages have been severed.

The final example, displayed bottom, opposite, is Mapuccino. This was developed by researchers at IBM’s Haifa Research Lab in Israel. It allows users to capture and view the overall structure of any online website, and to navigate visually through the site’s contents. It provides five mapping modes (tree vertically, tree horizontally, tree as a star, list, and fish-eye view). The example screenshots show a simple vertical tree revealing the site’s hierarchy of pages (bottom-left) and a fish-eye view of the same site (bottom-right).

3.12: Astra SiteManager

chief cartographer: Mercury Interactive Corporation.
aim: to provide a suite of visual Web management tools.
form: arc-node, hierarchical circular tree structures.
technique: displays page information and the links between pages as a scalable graph.
date: 1998.
further information: see <http://www.merc-int.com/products/astrasitemanager/>

3.13: FrontPage 98 hyperlink view

chief cartographer: Microsoft.
aim: to provide a visual Web management tool as part of a larger HTML editing application.
form: a hyperlink view, centered on the selected page, showing incoming and outgoing hyperlinks.
technique: a horizontal tree graph.
date: 1998.
further information: see <http://www.microsoft.com/frontpage>

3.14: Mapuccino

chief cartographer: IBM Haifa Research Lab.
aim: to provide a visual Web management tool.
form: provides several different graph layouts of the pages and hyperlinks, including tree structures and fish-eyes.
technique: custom-written Java application.
date: 1997
further information: see <http://www.ibm.com/java/mapuccino/>
The visual Web tools so far discussed are generally designed to help manage small-to-medium-sized sites. NicheWorks is a tool created for exploring and managing very large sites of 10,000+ nodes and, unlike the previous packages, also has many other applications (e.g. telephony and telephone fraud, software analysis, email patterns, information retrieval, medical data and market-based analysis). Originally a standalone tool, it is now part of the EDV (Exploratory Data Visualizer) environment.

In order to determine the structure and status of nodes (pages), a webcrawler is used. This information is then applied in order to construct large graphs using sophisticated spacing routines. Three layouts are possible: circular, hexagonal and tree. The first graph (below) uses the hexagonal layout of a typical website. Here, orange squares represent local pages; orange circles – local images; blue squares – offsite pages; yellow squares – CGI queries; light blue – avoided (generally email). In addition, key nodes have been labeled. The second graph (opposite) employs the circular layout and is a graph of the Chicago Tribune website.

**3.15: NicheWorks mapping of a large website**

**Chief cartographer:** Graham Wills (Lucent Technologies – Bell Labs, USA).

**Aim:** to explore the site structure of networks and sites with 10,000+ nodes.

**Form:** grouped, color-coded arc-node graphs.

**Technique:** uses MOMspider tool to determine links between nodes and edges between groups; custom software to construct visual graphs.

**Date:** 1997.

**Further information:** see <http://www.bell-labs.com/~gwills>

In contrast with Euclidean 3-D spaces, Tamara Munzner, then a graduate student in the Computer Graphics Laboratory, Stanford University, has investigated the potential of constructing spatializations in hyperbolic space. Hyperbolic spaces have advantages for visualizing the detailed structure of large graphs containing many thousands of nodes, such as the Web. As Munzner and research collaborator Paul Burchard comment: “The felicitous property that hyperbolic space has ‘more room’ than Euclidean space allows more information to be seen amid less clutter, and motion by hyperbolic isometries provide for mathematically elegant navigation.” The figures opposite display three examples of Munzner’s 3-D hyperbolic spaces.

The spatializations provide a novel way for exploratory visual browsing of the page–hyperlink structures of large websites. The structure of nodes and links is projected in hyperbolic space inside a ball, known as the “sphere at infinity” (top-left). The user is able to manipulate the graph, rotating and spinning it inside the sphere. Like the fish-eye distortion technique that we looked at in relation to Inxight’s Site Lens spatialization, hyperbolic space gives greater visual presence (in terms of screen-space) to elements at the center of the view. As objects are moved to the periphery, they smoothly shrink in size. At the edge of the sphere, the nodes are very small, but the user can easily drag them into the center to enlarge them and see them in detail. In this manner, the hyperbolic spatialization can provide a view of the detailed graph structure, whilst still showing the overall context.

An example by Munzner and Burchard from 1995 is shown in the large spherical image (top-right) that spatializes the structure of two layers of their department’s website. The pyramid glyphs represent pages, and the curving lines are the principal hierarchical hyperlinks. This spatialization was part of a Web mapping system called Webviz, which could gather the structure of a specified portion of the Web and then visualize it in a 3-D viewer called Geomview. Munzner undertook further refinements in the underlying hyperbolic spatializations, developing what is known as the H3 layout algorithm and a more powerful viewing system (H3Viewer) that enables interactive exploration of their graphs of 100,000 or more nodes.

The image top-left is a spatialization of part of the Stanford graphics group website drawn as a graph in 3-D hyperbolic space. The entire site has more than 20,000 nodes, and some 4,000 of them in the neighborhood of the paper’s archive appear in this image. In addition to the main spanning tree, the image shows the non-tree outgoing links from an index of every paper by title. The tree is oriented so that ancestors of a node appear on the left and its descendants grow to the right. Lastly, an example of the H3Viewer incorporated into a product called SiteManager from SGI is shown in the lower map on the opposite page. SiteManager is a tool for webmasters that provides a fluid and scaleable view of a website structure.

Munzner has also done interesting work on the geographic visualization of the Internet in mapping MBone, which we discussed in chapter 2 (page 37).

### 3.16: Visualizing websites in 3-D hyperbolic space

- **chief cartographer:** Tamara Munzner (while at the Computer Graphics Laboratory at Stanford University, USA).
- **aim:** to allow users to interactively analyze the structure and usage of a website.
- **form:** a fish-eye view of 3-D graphics, representing the pages and hyperlinks of a website and projected inside a transparent sphere.
- **technique:** hyperbolic visualization.
- **date:** examples from her research, 1995–2000.
- **further information:** see <http://graphics.stanford.edu/~munzner/>
Mapping website evolution

Nearly all of the mappings we discuss in this book fail to present the dynamically changing ecology of users and structures within the Net. In this section, we present Xerox PARC’s examples of attempts to visualize the evolution of a website over a period of time. This form of analysis, although under-researched, is of importance because it allows a temporal analysis that has great potential utility for Web designers, allowing them to plan future site development to meet expected demand and to also manage their resources. It is also of use to network providers, allowing them to gauge where new potential network growth might occur.

The three figures shown here display the evolution of a single website over time. In the top image opposite, four disk-trees are shown in chronological order, each a discrete time slice collected over a four-week period in April 1997. A disk-tree is formed by analyzing a site’s (in this case www.xerox.com) content (words in page and clusters of items), usage (frequency of page visits) and topology (hyperlink structure) (abbreviated to CUT), and plotting this data in a hierarchical circular pattern around its root page. The four disk-trees form a “time tube” presenting the site’s evolution. They were created with Xerox’s Web Ecology and Evolution Visualization (WEEV) software. By plotting the evolution over time along with usage, it is possible to investigate how well new material is being consumed, and to track and monitor particular trends. The frequency by which a page is accessed is denoted by line size and brightness. New pages are colored red, old pages are colored green, and deleted pages are yellow.

The cone-trees (bottom, opposite) also represent the evolution of xerox.com’s website over the same four-week period. They were constructed using Xerox’s Web Analysis Visualization Spreadsheet (WAVS). This software extends the CUT analysis to include a rating indicator that computes its similarity or relevance to other files. In the image, a rainbow color scale is used where red corresponds to pages with high usage and blue to those with low usage. The three rows correspond to a color threshold scale so that values between 0 and 100 are mapped in row 1, 100–500 are mapped in row 2, and 500–2,000 in row 3. The image shown below is a close-up view of part of the hierarchical structure.

3.17: Visualizing and analyzing website evolution

chief cartographers: Ed H. Chi, Stuart K. Card and colleagues (User Interface Research group at Xerox PARC, USA).
aim: to analyze the structure and usage of a website over time.
form: disk-tree displays arranged into a “time tube”.
technique: analyzes a site’s content, usability and topology at specific time slices and presents them in chronological order as a time tube.
further information: see <http://www.parc.xerox.com/istl/groups/uir/>
Mapping paths and traffic through a website

In addition to mapping the extent and evolution of websites, another development has been the implementation of software to monitor specific user paths and traffic flows within and across sites. These data are important as they reveal how websites are being traversed by users and thus reveal the effectiveness (or otherwise) of site design and the popularity (or otherwise) of the material on it. A number of different utilities have been developed that analyze such data, as set out next.

3.18: VISVIP – mapping how users move through a website

chief cartographers: John Cugini and Jean Scholtz (National Institute of Standards and Technology, USA).

aim: to visualize the path of a user through a site.

form: 2.5-D representation, with paths displayed as spline curves.

technique: uses WebVIP to log the paths taken.

date: 1999.

further information: see <http://www.itl.nist.gov/iaui/vvrg/cugini/webmet/visvip/vv-home.html>


The VISVIP tool developed by John Cugini and Jean Scholtz visualizes the hierarchical structure of a website and the paths that users take through that site. Individual pages are denoted by boxes, and the connections between pages are shown as straight lines. Boxes are labeled with identifiers and color-coded by type: blue for HTML, purple for directories, green for images. The paths taken by users are shown as colored splines.

In the case of the main image (opposite), two paths are shown, one green and one red, each representing a single user. Dotted columns represent the time that each user spent on each page, with the taller the column meaning the more time spent browsing that page. Whilst the package has wider application, it has been developed to provide an experimental setting in which to test how users navigate and search through sites.
Organic Information Design, developed by Ben Fry through his package named Valence, is an attempt to produce 3-D dynamic representation of how a site is being used and traversed by browsers. As such, instead of a typical Web usage report composed of bar charts revealing such information as “20,000 people visited the home page”, a self-evolving map of how people have been using the site is constructed. Fry details that this self-evolving map is driven by traffic patterns rather than the structure that the site’s designer has put in place. The result is an ever-changing image of how the site’s traffic evolves through time. Those sites that are linked are connected directly in the spatialization, with the sites most frequently visited placed on the outer parts of the composition.

3.19: Valence

chief cartographer: Ben Fry (Aesthetics & Computation Group, MIT Media Lab).
aim: to produce 3-D dynamic representations of how a site is being used and traversed.
form: 3-D, complex graphs.
technique: monitors site usage from the log and constructs the graph using a specialized algorithm.
date: 2000.
further information: see <http://acg.media.mit.edu/people/fry/valence/>
As a continuation of his organic information-design work, Fry has sought to map Web structure in relation to Web usage across a site. His 3-D evolving graphs of site structure and links grow as users traverse a site. As such, as a user explores a new part of the site hierarchy, these are added to the spatialization. The white links are the directory structure and the orange links represent the link structure. The tips of the branches represent individual websites. When a website is visited, the tip thickens to become more visible. This process can be watched, for example viewing the spread of users visiting from an external link as they move through the site. Branches that are not used frequently atrophy and slowly “die”, with areas that are not visited eventually removed from the graph. A “movement rule” within the algorithm ensures that a set distance is maintained between individual nodes and their parents. A second rule maintains a distance between nodes and their neighbors to try to minimize overlap. Areas of the structure are labeled and the user can click on nodes to find out which website they relate to.

The images displayed here show the structure and usage of the Aesthetics & Computation Group on the MIT Media Lab’s website as it develops over time.

3.20: Anemone

chief cartographer: Ben Fry (Aesthetics & Computation Group, MIT Media Lab).
aim: to produce 3-D dynamic representations of how a site is structured and used.
form: 3-D complex graphs.
technique: monitors site usage from the log and constructs the graph using a specialized algorithm.
date: 2000.
further information: see <http://acg.media.mit.edu/people/fry/anemone/>

HyperSpace was an early experimental system developed in the mid-1990s to provide a graphical history of browsing trails through the Web. It used 3-D, molecular-style models to display hyperlink-topology structures. Rather than being developed for site managers, HyperSpace was developed in the belief that users could navigate the Web more effectively if they understood how their current location related to the local structure of pages and links. The 3-D models were constructed inside a virtual-reality environment working alongside the user’s Web browser, and they were manipulable so that users could inspect the models from any angle. As users moved through the Web and loaded new pages, they were automatically added to the 3-D history graph.

HyperSpace used solid spheres to represent individual Web pages, and arcs for the hyperlinks between them. The size of the sphere was scaled to the number of hyperlinks from the page. The layout of the model in three-dimensional space is achieved using a self-organizing algorithm based on attraction/repulsion behavior of individual lines and spheres – the Web page spheres repulse each other and this is counteracted by the hyperlinks, which attract each other. Starting from a random placement of a clump of interconnected Web pages in the 3-D space, through a series of iterative steps, the spheres and hyperlinks push and pull each other into a stable and coherent spatial arrangement. The result is self-organized equilibrium that provides a distinctive structure of the browsing trail. Only pages that have been explored by the user’s browsing are displayed in HyperSpace. The pages at the edge of the explored space are just single nodes, with a single arc back to the parent. This gives the edge spheres a pincushion appearance.

The example images here show various 3-D history graphs formed by a browsing session (the green and white images are ray-traced and not actually generated in real time by the HyperSpace system). One can see how pages that have not yet been explored tend to lie on the edges of the 3-D structure. Unfortunately, HyperSpace did not develop beyond an interesting research prototype.

3.21: HyperSpace visualizer

**chief cartographers:** Andrew Wood, Nick Drew, Russell Beale and Bob Hendley (School of Computer Science, University of Birmingham, UK).

**aim:** to provide users with a graphic history of their Web surfing.

**form:** 3-D graph of sphere and lines to represent Web pages and their hyperlink connections. The graph grows as you surf and add new pages.

**technique:** tracks movement through a site, generating the graphical structure through a self-organizing algorithm.

**date:** 1995.


Like HyperSpace (previous page), WebPath is an example of a “surf map” providing a 3-D graphical history of trails taken by a user through the Web. The angular graph of cubes and pipes representing the browsing structures hangs weightless in a stylized purple cyberworld. It works as a real-time visualization within a virtual-reality environment, working alongside a conventional browser. Individual Web pages are represented by cubes. Cubes were used rather than spheres as their flat surfaces are easier to read from a distance. The page represented by the cubes is indicated by labeling (with the title or URL (universal resource locator) and pasting an image on the faces of the cubes. This image can be the background image of the page, or an image on the page, or background color of the page, depending on the user’s choice. Clicking on a cube of interest will load that Web page into the browser.

The positioning of the cubes in the space is used to encode various attributes about the Web page, including when it was accessed. The user can tailor which attributes are active. The three orthogonal dimensions of the space allow one to display three distinct attributes to be used. The vertical axis is used exclusively for the time at which the Web page was accessed so that the cubes at the top of the spatialization are always the most recently visited. The x and y horizontal axes can be used to encode a variety of attributes, such as loading time of the page, page size or number of hyperlinks, which can be selected by the user. The user can change the meaning of the x and y dimensions at any time, and the cube positions will then be automatically recalculated. WebPath can also position the cube according to approximate real-world geography rather than using an abstract coordinate space. A base map is provided on the “floor” of the information space, and the cubes are positioned in the appropriate country based on the domain name of the website.

The links between Web page cubes show the paths the user has taken via hyperlinks. When a user visits a new Web page, a new cube is created, and a tube connects this back to the previous cube. The color of the tube is used to indicate whether or not the pages are from the same site. Repeat visits to the same website at different times are indicated by multiple cubes that are vertically separated but are connected by solid yellow columns. For a user’s most popular Web pages, the column turns from yellow to red to indicate repeated accesses. Distinct browsing sessions are also separated visually using semi-transparent horizontal planes. This divides the space into separate layers.

3.22: WebPath browsing history

Chief cartographers: Emmanuel Frécon (Swedish Institute of Computer Science) and Gareth Smith (Lancaster University, UK).

Aim: To provide an interactive and tailorable graphic history of Web surfing trails.

Form: 3-D cubes and pipes represent pages and the routes traversed by the user. Images on the cube faces are taken from the Web page.

Technique: Tracks movement through a site, generating the graphical structure through a self-organizing algorithm.

Date: 1998.

Further information: See <http://www.comp.lancs.ac.uk/computing/users/gbs/webpath/>


<http://tina.lancs.ac.uk/computing/users/gbs/webpath/webpath.html>
"The view from above": 2-D visualization and navigation of the Web

So far in this chapter we have considered attempts to map relatively small sections of the Web. But how do you map the wider Web? An obvious approach is to spatialize the hyperlink structures as some kind of graph, either in two or three dimensions. This is quite easy for individual sites, as we have seen, but to map the many millions of Web pages and their interweaving hyperlinks is an altogether more challenging task. One could argue that it is also a foolish task, given that the Web is in fact its own map. This idea draws on Jorge Luis Borges’ famous Cartography fable, recognizing the Web as being both territory and map: by re-mapping it, one simply ends up creating it anew.

While the Web as map and territory is conceptually true, there is clearly a need for new mappings across a range of scales. The Web is now an enormous enterprise consisting of billions of pages. Navigating and searching through this vast information store using simple hypertext “maps” can be difficult, confusing and time-consuming. Site maps and Web management tools seek to address navigation issues at a micro scale. These have been complemented by spatializations that seek to provide a much broader overview detailing the relations across and between large “chunks” of the Web. In general, these types of spatialization can be divided into two broad categories: 2-D and 3-D. In this section, we consider the first set – 2-D spatializations – and examine 3-D spatializations in the following section.

Two-dimensional spatializations adopt a metaphor of the “view from above”, of gaining a bird’s-eye view. Here it is argued that browsing for a particular piece of information on the Web can often feel like being stuck in an unfamiliar part of town, walking around at street level looking for a particular store. You know the store is around there somewhere, but your viewpoint at ground level is constrained. What you really need is to get above the streets, hovering half a mile or so up in the air, to see the whole neighborhood. In this way you gain important contextual information that allows you to reorientate yourself. This kind of bird’s-eye view has been memorably described by David D. Clark, Senior Research Scientist at MIT’s Laboratory for Computer Science and the Chairman of the Invisible Worlds Protocol Advisory Board, as the missing “Up button” on the browser. In this section, we examine a number of examples and prototypes for Clark’s view of information space.
Yahoo! is the undisputed king of Web directories, providing one of the key information-navigation tools on the Internet. Over several years, it has maintained its popularity as the most-visited website because it does such a good job of shifting, cataloging and organizing the Web. Even so, Yahoo! is a very large site to navigate. ET-Map sought to provide an interactive map of Yahoo! in order to examine whether a map interface, rather than the conventional listing of sites, would be a more useful and effective means of navigating the site. Developed by Hsinchun Chen and the research team in the University of Arizona’s Artificial Intelligence (AI) Lab, ET-Map is a hierarchical set of “category maps”, which are essentially visual directories.

ET-Map charts a large chunk of Yahoo! from the entertainment section, representing some 110,000 different Web links. The map is a two-dimensional, multilayered category map. Its aim is to provide an intuitive and visual information-browsing tool and to provide the browser with a sense of the lie of the information landscape – what is where, the location of clusters and hotspots, and what is related to what. Ideally, this big-picture all-in-one visual summary needs to fit on a single standard computer screen. ET-Map can be browsed interactively, explored and queried, using the familiar point-and-click navigation style of the Web to find information of interest.

The example shown on page 117 reveals how the spatializations work to reveal information on jazz music. Each “category map” displays groupings of associated Web pages as regularly shaped, homogeneous “subject regions”, which can be thought of as virtual “fields” that all contain the same type of information “crop”. The spatial extent of the subject regions is directly related to the number of Web pages in that category; for example, the “MUSIC” subject area contains over 11,000 pages and so has a much larger area than the neighboring area of “LIVE”, which only has 4,300 or so pages. If a region has more than 200 pages, then a sub-map of greater resolution is created, with a finer degree of categorization. Clicking on a subject region with less than 200 pages takes one to a conventional text listing of the page titles. In addition, a concept of neighborhood proximity is applied, so that subject regions that are closely related in content are plotted close to each other. For example, “FILM” and “YEAR’S OSCARS”, at the bottom left of the top layer, are neighbors. The hierarchical nature of the maps, with the ability to “drill down” to different levels, is illustrated over the page.

ET-Map was created using a sophisticated AI technique called Kohonen Self-organizing Map (SOM), which is a neural-network approach that has been used for automatic (i.e., no human supervision) analysis and classification of semantic content of text documents such as Web pages. Chen and his colleagues believe “… that [the] Kohonen SOM-based technique … can be used effectively and scaleably to browse a large information space such as the Internet”. However, it is also a challenge to automatically classify pages from a very heterogeneous collection of Web pages, and it is not clear whether the SOM categories will necessarily match the conceptions of a typical user. From the limited usability studies made on category maps, it appears they are good for conducting unstructured, “window shopping” browsing, but are less useful for undertaking more directed searching.
Atlas of cyberspace
3.23: ET-Map

chief cartographer: Hsinchun Chen and colleagues (Artificial Intelligence Lab, University of Arizona, USA).

aim: to provide an intuitive visual information browsing tool.

form: 2-D interactive land-use map.

technique: uses a neural-network approach called Kohonen self-organizing map (SOM) to automatically classify information.

date: 1996–1998

further information: see <http://ai.bpa.arizona.edu>


<http://ai.bpa.arizona.edu/papers/som95/som95.html>
NewsMaps.com has produced one of the best examples of information mapping available on the Web today. It was initially developed as a high-profile “show-and-tell” website to demonstrate the power of ThemeScape information analysis and mapping technology, developed by Cartia Inc. (Based in Bellevue, Washington State, Cartia is a high-tech spin-off formed by information-visualization researchers at Pacific Northwest National Laboratory (PNNL) in 1996.)

NewsMaps’ products are among the most map-like of information maps, borrowing literally and liberally from the cartographer’s toolbox. The attractive and interactive NewsMaps maps provide a big-picture summary of large volumes of textual information represented as hills, valleys and snow-capped mountain peaks — a cartographic form common on topographical maps of the real world. Here, though, the hills and valleys are used metaphorically to represent the volume of textual information, with peaks representing a large number of news stories discussing the same topic (labeled with keywords). The valleys are the natural transitions between one topic and another. The spatial concept of “neighborhood” is also used, so that the closer together two hills are on the map, the more similar their information content. The actual location of the news articles used to construct the spatialization is indicated by small black dots. The maps are created using proprietary algorithms and techniques that intelligently summarize the key topics and the relations between them (as with ET-Map — see last example).

A range of NewsMaps is compiled daily to cover international news, US news and technology news. They are delivered over the Web in a fully interactive viewer that allows users to explore each map on their desktop. By passing the mouse cursor over an area of interest, the top five topics within a small radius are displayed in a pop-up window. Clicking once on the terrain will cause a pop-up list of available articles in the area to be displayed. Clicking on an article title of interest allows the full article to be opened in a new browser window. Users can zoom in on a region of the map to see greater local detail, and also to perform a keyword search for articles of interest or select articles from a topic list. The results of such searches or selections are shown prominently by large blue dots on the spatialization, numbered according to their relevance ranking. It is also possible to stick small red marker flags into the terrain to identify documents of interest for future reference and to zoom in and pan around the spatialization to reveal more detail.

3.24: NewsMaps – revealing the topography of Web content

chief cartographer: David Lantrip and colleagues (Cartia, USA).

aim: to show the content of hundreds of online news articles in a single overview map, so as to give users a sense of key stories and themes.

form: two-dimensional landscape of mountains, hills and valleys using shading and contours to give an impression of a terrain. Height of the terrain represents volume of articles.

technique: custom software, known as ThemeScape, which uses proprietary algorithms and techniques that intelligently summarize the key topics and the relations between them.


further information: see <http://www.newsmaps.com>; <http://www.cartia.com>

Another excellent example of an interactive information map is called “Map of the Market”, which aims to display a big-picture summary of the dynamic state of the US stock-market in a single visual snapshot. It does this by mapping the changing stock price and market capitalization of more than 500 major publicly-traded corporations. On a single map, one can quickly gain a sense of the overall market conditions, yet still see many hundreds of individual data elements. This overall picture is very difficult to comprehend from more conventional listings of stock prices. The spatialization was developed by Martin Wattenberg, director of research and development at SmartMoney.com, where he specializes in designing novel ways to visualize financial information.

Map of the Market uses a visualization technique called treemaps to generate the spatializations. This technique was originally developed in the early 1990s by researchers Ben Shneiderman and Brian Johnson at the Human–Computer Interaction Lab at the University of Maryland. Treemaps are a compact way of representing hierarchical data using a space-filling technique of nested, regular tiles. In Map of the Market, the stock market is visualized by a regular quilt of tiles where each tile represents the performance of one corporation (see top-right map). Three key visual components in the map – tile size, color and position – are used to encode attributes of the corporation. First, the tile size is scaled to the market capitalization of the company, so that the bigger the tile, the more valuable the company in stock-market valuation. The color, of the tile represents the percentage movement in a company’s stock price. The color scheme used runs from green to red and is familiar in financial markets. The brighter the color the bigger the change (either positive or negative) in stock price. The tile is shaded black if there is no change in price. One can interactively choose the time period over which the stock-price change is calculated (from the last market close, to six months or a year).

Company tiles are grouped into familiar hierarchies based on classifications of industries (e.g., software, networking, semiconductors) which in turn form broader sectors (e.g., technology, energy, financial). Within these groups the spatial arrangement of individual tiles is organized using a neighborhood technique that places similar companies near each other. In this information map, similarity is a metric based on historically similar stock-price performance.

Map of the Market also provides many useful interactive features. Information relating to individual companies can be viewed by brushing the mouse cursor over the tiles (see bottom-left). This causes a small pop-up box to appear containing summary data. Clicking on this box provides access to detailed background news and information from other pages at the SmartMoney website. It is also possible to zoom into the map to focus on a particular sector and industry of interest. For example, in the screenshots opposite, we have clicked on the large green square tile representing the networking company Intel (bottom-left). Then we zoomed into the sector map for technology, containing seven different industries (bottom-middle). Finally, we zoomed into the software industry map which is dominated by the large tiles of Microsoft and Oracle (bottom-right). Other interactive features include the ability to change the color-coding, to turn on and off the labeling of news headlines associated with particular companies, and to highlight the top five winners and losers.

SmartMoney is also developing further implementations of its information mapping technology to different financial information. For example its Mutual Fund map, shown top-right, visualizes the performance of 1,000 mutual funds in the United States. The example screenshot was taken in August 2000 and uses the alternative blue–yellow color scheme. It is also possible to map a personalized stock portfolio once registered as a SmartMoney user.
3.25: Mapping the money in cyberspace – “Map of the Market”

chief cartographer: Martin Wattenberg (SmartMoney.com, New York).

aim: to show the performance of a stock-market in a single visual snapshot by mapping the capitalization and changing stock price of more than 500 companies.

form: an information quilt using tiles to represent companies, with size, color and position encoding key attributes.

technique: interactive Java applet. Metaphor is based on a technique called treemaps.


further information: see <http://www.smartmoney.com>


<http://www.cs.umd.edu/hcil/treemaps/>
Map.net is a novel Web-search directory that employs perhaps the most comprehensive system of information spatialization currently available on the Web. The directory uses both 2-D multilevel information maps and 3-D fly-through cityscapes to spatialize over two million websites from the Open Directory (a well-known information directory available on the Internet). Map.net was launched in November 2000 and its underlying spatialization technology is called Visual Net. It is the brainchild of Tim Bray, who is not only an expert in hypertext and information navigation but also the co-creator of the XML standard. His company Antarcti.ca’s self-stated aim is to “transform networks into places” and it believes information spatialization is the best route to achieve this.

Map.net spatializes the two million or so websites in existence onto the land surface of the continent of Antarctica. They are grouped in a hierarchy of categories that are represented visually on the map display as nested rectangular tiles. The classification of websites into categories is achieved by the 30,000 or so volunteer editors at the Open Directory. The rectangular category tiles are color-coded and their size is in proportion to the number of websites they contain. For example, in the screenshot shown top-opposite we see the tiles for the Internet-related categories.

The legend to the left of the map lists the categories in order with their color coding. The small map of Antarctica in the top left-hand corner of the screen shows the location of this information map in relation to the rest of the Web mapped onto the land surface. Map.net’s 2-D information maps have many common features with ET-Map (see page 116–17) in terms of information representation, except that the categorization is derived by humans rather than through any automatic classification of websites. Also, the tile arrangement is not based on similarity of content but is simply laid out in alphabetical order from top-left to bottom-right in each image. The maps are fully interactive, allowing the user to move up and down the hierarchy of maps (effectively an informational zoom). Using the small control buttons around the edge of the map allows the user to pan around to see neighboring regions at the same scale. Clicking on a tile of interest will usually provide a more detailed map of just that category (see below).

Significantly, the actual position and characteristics of individual websites are shown on the maps as well. These are represented by the distinctive circular targets, and clicking on one will open the site in a new browser window. By default, the top-20 most visible websites in a particular map region are shown, but this parameter can be altered by the user. Visibility is an important metric computed by Map.net and is represented by an overall score to identify the “best” websites in the vast milieu of the Web. The visibility score is made up of four components and these are encoded graphically in the target symbols. The thickness of the outer black ring indicates how many outgoing hyperlinks the site has to other pages on the Web, while the thickness of the inner white ring is a measure of the site’s popularity based on the number of incoming hyperlinks from

**3.26: Map.net 2-D multilevel information maps**

*chief cartographer:* Tim Bray (Antarcti.ca).

*aim:* to provide a visual Internet search directory.

*form:* nested, rectangular, color-coded tiles and websites shown by red and white targets.

*technique:* Visual Net technology spatializes the Open Directory.


*Further information:* see <http://map.net>
the rest of the Web. The red circle at the center of the target symbol shows the relative size of the site in terms of the number of pages it has. Lastly, the small yellow arrows added to the outside of the symbol indicate that it has a “cool” rating from one of the editors at Open Directory.

This interactive, multilevel information map enables several million websites to be spatialized and browsed. As an example, the spatializations display a typical browsing sequence through three layers. As we navigate deeper into the information hierarchy, we see more detailed categories and the maps show much finer granularity of information. To begin, we have a general map of “Home” (bottom-left), one of the 16 top-level categories. The “Home” category is represented by the large aquamarine rectangle that fills the whole map window. It contains 17 subcategories, which are shown by the variously sized and colored rectangles. These are arranged in alphabetical order from the tiny “Apartment Living”, followed by the huge “Consumer Information”, right down to “Urban Living”. The most visible 40 websites, from a total of 32,024, are shown by the target symbols, with the majority of these coming from the “Kids” category.

Say we wanted to know more about cooking. At this scale, only three individual websites are shown, but clicking on the “Cooking” tile zooms in to reveal a more detailed map of this category (bottom-right). This is a more complex-looking map, with greater information granularity. Many more category tiles are shown, summarizing over 7,500 individual websites. If we are particularly interested in pizza, say, we can drill down further by clicking on the “Pizza” tile. This takes us to the most detailed available map, at the bottom of the hierarchy of categories (see map on p. 123). On this map all 32 pizza-related websites are shown. Most are just represented by a red dot with very narrow black or white rings, revealing that they are not well-linked or visible. None of them has been rated “cool”. Clicking on the background on this map, because there are no further levels, will load the 3-D fly-through cityscape view of this category.

Real-world geography and conventional cartography can be used to provide a spatialization of websites to aid navigation. These types of map are commonly known as “sensitive maps” or “clickable maps”, and one of the best examples is the UK Academic Map produced and maintained by Peter Burden of the University of Wolverhampton. The UK Academic Map from summer 2000 is shown on page 127. The original went online in July 1994 – ancient history for the Web! – and this is version 5.

In the early days of the Web in 1994 and 1995, sensitive maps like this one were a quite popular way of cataloging websites in a region or country (where another good example was the Virtual Tourist site). However, this approach did not scale well to keep pace with the tremendous growth in the number and type of websites. The UK Academic Map is one of the few examples that is still maintained and useful. Arguably, this is because it has specialized in cataloging a very limited segment of websites – those of UK academia – which is relatively static in size and Web address. The current version maps 204 different institutions (and other maps are provided showing colleges and research centers).

The map interface comprises a basic coastline of the UK onto which the university websites are plotted and labeled. The position of the symbols is as close as possible to the actual geographic location of the university. Differently colored and shaped symbols are used to denote different types of institution. Using the map as an information navigation tool is very easy: one simply locates the university of interest and clicks on its marker on the map to open that institution’s homepage. One can choose a particular access point into the university’s Web page, such as the prospectus or alumni page. For example, if one wanted to access the website of the University of Plymouth one would simply click on the red star symbol located on the city and its homepage would open. Or if one was interested in the students’ union at the University of Kent one would just select that topic from the list and then click on the star located at Canterbury and again the appropriate page would open. In this fashion, the map is said to be “clickable” or “sensitive” in that it
can sense the position of mouse clicks and respond. As such, even though this geographic directory of websites is inherently static, in that the map has to be manually updated, it offers limited interaction to the end user.

Clearly, there are some limitations with this kind of geographic map-based Web-directory approach, both in terms of graphical form and also at the conceptual level of information navigation. In graphical terms, data can quickly become cluttered as many websites tend to cluster in urban areas (see chapter 2). This is apparent with the high density of universities in Manchester and London making the designer’s job difficult in placing all the symbols and, particularly, their labels. In response, the map’s creators have been forced to abandon the geographic representation in these circumstances and simply present them as a long list on the right-hand side of the map, floating in the North Sea. For certain other universities that could not be fitted close to their geographic location, the authors have had to use long guiding lines to link the town to the symbol and label drawn on the edge of the map. In many ways these cartographic “fudges” are necessary in order to portray a volume of information that does not easily fit into the constrained bounds of geographic space. One obvious solution would be to break the UK up into smaller geographic units and have separate, small-scale maps for each. This would effectively provide greater expanse of “screen space” to represent the information and may increase legibility, but it would also impair the usability for information navigation. In particular, it would be much harder to browse, and the reader would lose the opportunity to see the “big picture”.

Another, more conceptual weakness of this type of navigation is that it is not appropriate for many kinds of resources on the Web. In our example of universities in the United Kingdom, it is generally suitable because these types of institution are strongly associated with a city or town; indeed, many are named after the place in which they are located. However, for many other types of information, a geographic location may not be an appropriate key for an index. Another important issue with using geography as the index is that a lot of people have a weak sense of geography in terms of finding cities or countries on a map. Using geography as the key may therefore make information navigation harder compared with, say, browsing through an alphabetic list. For example, if one wanted to find the University of Plymouth using the geographic directory and one did not know where the city of Plymouth was located in the UK, it would take a while to visually search the whole map.
3.27: Geographic map as Web directory – UK Academic Map

chief cartographer: Peter Burden (School of Computing and Information Technology, University of Wolverhampton, UK).

aim: a geographic index of all UK universities on a single map, to provide an easy way to access their websites.

form: a simple outline map of the UK with universities located by graphic markers, along with text labels of each institution’s name (see following page).

technique: simple HTML image map.

date: launched in July 1994; currently version 5 as at September 1998.

further information: see <http://www.scit.wlv.ac.uk/ukinfo/uk.map.html>
Spiral and STARRYNIGHT are interactive interfaces for browsing a large online archive of articles about net art at Rhizome. Both are clearly inspired by astronomy, employing the metaphor of stars floating in an infinite black void to represent individual articles. Rhizome is a not-for-profit online forum for the presentation and discussion of new media art. Its discussion list is edited and indexed into an archive of several thousand articles from the past several years. Each star in the STARRYNIGHT interface represents a single article in the archive. Each time an article gets selected (and read) the star gets a little bit brighter. Over time, then, the interface encodes the popularity of different articles. The position of the star in the interface is random, and new stars are added on a weekly basis.

Browsing STARRYNIGHT consists of passing the mouse cursor over the stars, which causes article keywords to “pop up”. Selecting a keyword of interest leads to the display of a constellation showing other similar stars (articles). Finally, clicking on a star causes the article to be opened in the browser. According to the site, “STARRYNIGHT is both a mirror and a map. On the one hand, it offers a reflection of the Rhizome community’s reading habits . . . On the other hand, it acts as a navigational interface by connecting similar stars/texts into constellations regardless of their brightness.”

Spiral uses many of the same metaphorical aspects as are employed in STARRYNIGHT except that it highlights the time dimension. Like STARRYNIGHT, Spiral is an interactive interface providing a view from “above” a Spiral galaxy of stars (bottom-left). The position of the stars along the spiral arm is chronological, so that the oldest stars are at the “center” of the galaxy. Using the slider on the right-hand side of the display, a user can smoothly rotate the spiral galaxy, thereby scrolling backward and forward through time. “Brushing” the mouse cursor over the stars reveals the summary details about the article. Clicking on a star of interest loads the full article into a semi-transparent pane on top of the spiral display (as can be seen bottom-right). Within the plane of the spiral, different strands of stars represent different broad categories of articles (such as events, reviews, theory). One can access the archive using conventional keyword searching and browsing.
Moment in time:
internet jamming
corey eiseman (corey@toegristle.com)
1999.Nov.7

Reading:
Digital H@ppy Hour-this Thursday
Mark Tribe (mark@thizome.org)
1999.Sep.14

From Mark Tribe (mark@thizome.org)
Subject: Digital H@ppy Hour-this Thursday

And now, as a live forum to foster a dialogue on
internet art and culture, as a means for
introducing this culture to a wider range of
people, and finally, as a service to have a place
sit up a couch and watch other people sweat
while they navigate the net on a huge projection
screen for you...

Digital H@ppy Hour
This fall, our Rhizome events will be held at The
walled garden, curated by James Elkins in
PhotographyGallery, 355 Bowery, 7th fl.

http://rhizome.org/space/exhibit/09/
“The view from within”: 3-D visualization and navigation of the Web

In the final section of this chapter, we consider mappings that extend methods to visualize and navigate the Web into three dimensions. Here, rather than seeking a “view from above”, the spatializations seek to place the user in the heart of the data: “the view from within”. In many ways, these spatializations are the closest in nature to those envisaged by William Gibson in his descriptions of cyberspace (see chapter 5).

As with other sections, we order the discussion along a scale continuum from the local to the global, with those concerned with the same scale then ordered from simple to complex.

Fork's intriguing 3-D network is very much at the boundary between a practical navigation tool and a work of art, being created by hand rather than by algorithm. Clearly, this divide is a fuzzy one, as we show in chapter 5. The creators envision Web navigation using a triangular orange graph gently floating and spinning in blank space. The 3-D network metaphor in many ways matches the nature of the organization and website being mapped - it being the various IT-related departments of the German airline Lufthansa, this part of the company being called the “Systems Network”. The intersections of the triangles in the graph form nodal points representing different departments. Users can freely interact with the graph, rotating it and zooming into nodes to reveal more details. Clicking on the labels takes one to the appropriate Web page.

3.29: 3-D navigation interface for Lufthansa Systems Network

aim: to show the structure of IT departments in the Systems Network group of Lufthansa and enable users to navigate their website.
form: 3-D triangular graph floating in space. The user can rotate the graph and zoom in to see more detail. Clicking on a title opens the relevant Web page.
technique: 3-D interactive graphics using Java.
further information: see <http://www.lhsysnet.com> and <http://www.fork.de>
further reading: Browser 2.0: The Internet Design Project by Patrick Burgoyne and Liz Faber (Lawrence King Publishing, London, 1999).
A world of words forever swirling and shifting is the vision of cyberspace presented by the Visual Thesaurus. It was created in 1998 by Plumb Design, an innovative New York-based design firm, in order to demonstrate the potential of its Thinkmap visualization technology. The company claims that this product is “an engaging experience in language and interface . . . an artistic exploration that is also a learning tool. Through its dynamic interface, the Visual Thesaurus alters our relationship with language, creating poetry through user action, dynamic typography and design.”

Visual Thesaurus provides an artistic interface to surf and explore the WordNet thesaurus of over 150,000 words, phrases and meanings, as well as the multitudes of associations and dependencies. (WordNet itself is a free-of-charge digital thesaurus database developed by the Cognitive Science Laboratory at Princeton University.) When Visual Thesaurus is initiated, the words are presented in a sterile white 3-D space. Clicking on words adds connected words, creating a complex and evolving linguistic mesh. The strength of linguistic relationships between words and phrases is indicated by distance and brightness in the display. Users can navigate through the thesaurus by clicking on words in the 3-D space or by entering them into the search box at the bottom of the display. Users can change how the thesaurus retrieves words, for example focussing on verbs or nouns.

Although interesting, it can be disorientating to use this product and in many ways it is more an experience than a lexical tool.

3.30: Visual Thesaurus

aim: to demonstrate the power of Thinkmap software for providing interactive displays of complex information. This demo visualizes a large thesaurus.
form: a continually swirling 3-D graph of words, with lines between them showing linguistic relationships.
technique: 3-D interactive graphics using a custom Java application.
further information: see <http://www.plumbdesign.com>
and <http://www.thinkmap.com>
HotSauce was an interesting and largely experimental three-dimensional fly-through interface for navigating information spaces such as websites or the files on a PC disk. It was developed – virtually as a one-man effort – by Ramanathan V. Guha in the mid-1990s while he was at Apple Research. The basic concept behind HotSauce can be expressed by the phrase “Why just browse when you can fly?”, the idea being that an immersive 3-D interface to spatialize information would aid navigation. The underlying format to structure data into hierarchies for specific spatialization was called Meta-Content Framework (MCF), also developed by Guha.

HotSauce worked as a browser plug-in, so that when you went to an MCF website you were dropped into a first-person perspective view of the information space, with pages floating as brightly colored asteroid-like blocks in an infinite black space. The view is somewhat like that from a “starship cockpit”, and you smoothly fly through the landscape with page blocks becoming larger as they are approached and then disappearing as they are “passed”. Web pages are represented by rectangular blocks that are labeled with the page title. Broader “topics” are indicated by round-cornered rectangles, and these provide organizing structure to the information space. Different hierarchical levels of the information space are denoted by different colors of the floating blocks, as well as their spatial depth in the 3-D display. It is easy to fly into and around the space using the mouse to guide the direction of flight and holding down buttons to go forward and backward. A page can be accessed by simply double-clicking on the relevant block.

The image top-left on p. 134 shows the default HotSauce view of the Apple website, circa 1997, with the main green “Apple Computer” topic at the front, which is then followed by major sections of the site represented by the bold red blocks. Further back still are yellow and then purple pages. The remaining screenshots try to capture the essence of the 3-D fly-through effect by showing a sequence for the Lightbulb Factory website.

Although smoothly zooming through HotSauce space is quite fun, it is surprisingly hard to find pages and fly toward them. Once immersed in the space and surrounded by blocks, it is easy to become disoriented. Despite the practical difficulties in actually using HotSauce for information browsing and retrieval, it remains an interesting experiment in mapping information. Unfortunately, Apple ended its development of HotSauce in 1997 and Guha moved on to other projects.

3.31: HotSauce information fly-through

chief cartographer: Ramanathan V. Guha (while working at Apple Research).
aim: to provide a way to browse information spaces with a 3-D interface.
form: fly-through interface, with Web pages represented as brightly colored rectangles floating in an infinite black space.
technique: small plug-in for Web browsers. Built on top of the Meta-Content Framework (MCF) for organizing and describing information spaces.
date: developed between June 1995 and April 1997 and publicly released toward the end of 1996. The screenshots here were taken in August 2000.
further information: R.V. Guha’s homepage at <http://www.guha.com>, while the HotSauce plug-in and documentation are still available from the Lightbulb Factory at <http://www.xspace.net/hotsauce/>
In 1996, researchers at Xerox Palo Alto Research Center developed a novel spatialization of the Web in order to provide users with a more effective tool to organize and browse online information. The system had two distinct components. The first was WebBook, a three-dimensional interactive book of HTML pages. WebBook allowed for rapid interaction with objects at a higher level of aggregation than pages. The second was Web Forager, an application that embeds the WebBook and other objects into a hierarchical 3-D workspace. The Xerox system applies very literal metaphors of familiar physical objects – the book, the desk and the bookcase – as a way of organizing large volumes of unordered Web pages.

In the conventional Web browser, the user sees only a single page at a time. With WebBook, large collections of pages can be browsed and quickly flicked through. Its creators argue: “We use the book metaphor not primarily because it is familiar, but because of the operational match to a corpus of interest and the efficient display characterization.”

Web Forager was an experiment in what its creators called “task-tunable information space” and it had three distinct levels of “attention”. The first level was for direct interaction, represented by the open book floating in a user’s line of sight. The second level is given by the books on the desk and floating in the air – called “immediate memory” because users can quickly explore these information sources. The third level is the bookcase, where information can be stored in an orderly fashion for later retrieval. All objects can be moved in the three-dimensional environment, for example touching the bookcase automatically “flies” the user to directly in front of it, so that a book can easily be accessed. The researchers conclude:

The Web Forager workspace is intended to create patches from the Web where a high density of relevant pages can be combined with rapid access . . . Through the invention of such techniques and analytical methods to help us understand them, it is hoped that the connectivity of the Web, which has been so successful, can be evolved into yet more useful forms.

3.32: WebBook and Web Forager 3-D information spaces

chief cartographers: Stuart Card, George Robertson and William York (User Interface Research Group, Xerox Palo Alto Research Center, USA).

aim: to provide users with a more efficient means to organize and browse the Web.

form: literal metaphors of a book to hold a collection of individual Web pages. The books are then organized in a 3-D space with a desk and bookcase.

technique: 3-D interactive graphics and animation.

date: 1996.

further information: see <http://www.parc.xerox.com/istl/projects/uir/>

The images here show the Harmony browser that a client has used to access an Internet hypermedia system called Hyperwave. Harmony provides an integrated 2-D graph map and 3-D landscape view of the structure of a hypermedia information space in addition to the conventional page view of the documents. Here, we detail the 3-D information landscape component developed by Keith Andrews and colleagues at the Graz University of Technology in Austria.

3.33: Harmony information landscape

*chief cartographer:* Keith Andrews (Graz University of Technology, Austria).

*aim:* to provide a 3-D interface to hypermedia data.

*form:* 3-D landscape with iconic representations.

*technique:* converts a hierarchical structure into a landscape.


*Further information:* Keith Andrews's homepage at <http://www2.iicm.edu/keith>


The Harmony Information Landscape provides a 3-D spatialization of an information space for users to browse resources (such as documents, files, images, etc.) which are represented by blocks and icons laid out across an infinite flat plain. Collections of resources (the Hyperwave equivalent of a website) are represented by flat slabs onto which the actual resources are placed as iconic glyphs, such as a book to represent a text file and an old-fashioned movie camera to identify a video clip (see top-left). The spatial arrangement of the blocks encodes the hierarchical structure of the Hyperwave information space. The user is able to fly over the landscape and choose objects of interest, which are then displayed in the conventional browser window. As the user browses, new collections are added dynamically to the landscape. In this way, the hyperwave site can be browsed and navigated as a 3-D landscape.
VR-VIBE represents the application of Collaborative Virtual Environment (CVE) technologies for information searching and retrieval, creating a 3-D cooperative system that can be simultaneously shared by several users. (Internet virtual worlds, such as AlphaWorld, are commercial examples of CVE, and we consider them in detail in chapter 4.) The screenshot opposite shows a pyramid of blocks, each representing a document in the bibliography. Matching documents from keyword queries are displayed as simple blocks floating in patterns above a flat landscape covered with a regular yellow grid. Keywords, represented as octahedra, are positioned across the space and the document blocks are displayed in relation to strength of attraction to each keyword. As such, keywords act as virtual magnets pulling documents toward them with differing strengths depending on their significance to the search. The images here display screenshots of a VR-VIBE session where over 1,500 documents are spatialized according to five keyword “magnets”. The size and color of a document block encodes the relevance score of that document to the overall query, so large, brighter blocks that are visually the most prominent are the best matches to the whole query.

Crucially, this data space is a shared virtual environment. Other users present in the space are represented by simple shapes that look like sticks with eyes. This shared aspect raises interesting possibilities for collaborative searching and exploration of a large information space. Users are able to dynamically interact with the VR-VIBE data space in a number of ways. For example, a user could fly in close to examine part of the document space in detail and then quickly fly above to get an overall view of the configuration. Users can change the parameters of the search query by adding, deleting and moving the keyword “magnets”. So the user can select a keyword glyph and move it by dragging it, and then the spatial arrangement of the documents will dynamically adjust. It is also possible to dynamically change the thresholds of the query using a 3-D scrollbar to limit the number of matching documents. Finally, documents of interest can be selected, and these can be fetched and displayed in a conventional Web browser.

3.34: VR-VIBE, an example of a populated information terrain

chief cartographers: Steve Benford and colleagues (Communications Research Group at the University of Nottingham, UK).
aim: to visualize and interact with relational databases.
form: a 3-D landscape of floating blocks.
technique: calculates strength of attraction to keywords.
date: 1995.
further information: see <http://www.crg.cs.nott.ac.uk/>
The images here show three sets of “semantic constellations” created by Chaomei Chen, in the Department of Information Systems and Computing at Brunel University, United Kingdom. The model is designed to help users browse through a complex collection of electronic documents, is created via VRML, and is used within a standard desktop VR environment. The images are example spatializations of an information space containing large collections of documents (academic conference proceedings). In the latter case, every paper in the collection is shown as a sphere in the semantic space, a metaphorical constellation of documents. The VRML display reveals how these papers are semantically connected in this semantic space.

As with HyperSpace, an arc-node 3-D graph is employed, with spheres representing the individual papers and the arcs connecting them based on how related their content is. The spheres are color-coded by year. Unlike HyperSpace, the arcs are not explicit “hard-coded” hyperlink connections; instead, in the constellation they are based on a computed measure of semantic similarity between the papers. So the papers that discuss the same or related topics will be semantically linked in the spatialization. The more closely two papers are related in terms of their content, the nearer they are in the semantic space. The semantic linkages are spatially arranged and connected into what is known as a “PathFinder” network. Pointing to a particular sphere causes the paper title to be displayed in a pop-up window and clicking on a sphere will display the paper abstract in a linked window in a Web browser. This allows an examination of the detail of a particular paper in one window and yet the ability to keep open the entire semantic space in another.

3.35: Domain visualization

chief cartographer: Chaomei Chen (Department of Information Systems and Computing at Brunel University, UK).

aim: to provide an interactive 3-D environment to explore large and complex collections of digital documents such as conference proceedings.

form: 3-D graph floating in space representing the document collection, with each sphere being a single document and the connections between them showing the semantic linkages. The vertical stacked bars projecting from the spheres show the volume of citations for successive time periods.

technique: sophisticated algorithms to analyze the semantic and citation. 3-D environment produced using VRML.

date: 1999.

further information: see <http://www.brunel.ac.uk/~cssrccc2/>
In 1995, Tim Bray spatialized large sections of the Web in order to answer four key questions, namely: How big is it? How wide is it? Where is the center? How interconnected is it? In order to answer these questions, Bray used a large search-engine index to calculate the key metrics on the structure of the known Web in 1995 (then a mere 11 million pages spread across 90,000 sites). These questions are still very relevant to academic researchers and commercial developers today. Much of the research into understanding Web morphology focusses on the analysis of the human-built hyperlink structures, the aim being to improve current Web searching tools and develop new searching algorithms to find elusive information sources that lie “hidden” in the ever-growing expanse of the Web.

Examining the hyperlink structures of the Web, Bray found that interlinking between sites was surprisingly sparse. Most links were local, within a site, and a few key sites (e.g., Yahoo!) acted as superconnectors tying sites together. He derived two intuitive measures of the character of a website, based on hyperlinks; these measures were “visibility” and “luminosity”. Visibility is a measure of incoming hyperlinks – the number of external Web sites that have a link to a particular site. In 1995, the most visible website was that of the University of Illinois, Urbana-Champaign (UIUC), the home of the Mosaic browser. The vast majority of sites had very low visibility and nearly 5 percent had no incoming links at all. Measuring the reverse, the number of outgoing links, determines a site’s luminosity. The most luminous sites carry a disproportionate amount of navigational workload. In 1995, Yahoo! was the most luminous site – and it probably still is today.

Bray used visibility and luminosity to map the key landmarks of the Web in 1995, highlighting the largest, most visible and most connected websites. The result is an information landscape dotted with 3-D models, which he termed “ziggurats” (the word for ancient stepped pyramidal temples). Each ziggurat visualized the degree of luminosity and visibility of a single site, along with the size of the site and its primary domain (government, education, commercial, etc.). The basic graphical properties of the ziggurat – its size, shape and color – were used to encode these four dimensions. The overall height represented visibility, the width of the pole represented the size of the site, in terms of number of pages, the size of the globe atop the ziggurat indicated the site’s luminosity, and color-coding displayed the primary domain (green for university, blue for commercial, red for government agencies). The ziggurats were also labeled with the domain name of the site for identification. The spatial layout of the ziggurats across the plane were based on the strength of the hyperlink ties between them. The model is constructed in VRML and can be “flown around”. The images opposite display fields of ziggurats at the very core of the Web in 1995. Further from this core there would be many thousands of other ziggurats, but most would be minuscule in relation to those at the heart. Bray developed many of these ideas for the Map.net visual search directory.

3.36 Web space as a landscape of ziggurats

chief cartographer: Tim Bray (whilst working at OpenText, USA).
aim: to visualize the structure of the whole Web.
form: ziggurat structures representing the characteristics of individual websites, arranged on a flat infinite plane.
technique: VRML-generated landscape.
date: 1995/6.
further information: see <http://www.textuality.com>
This spatialization is the three-dimensional equivalent of Map.net (detailed on page 122) and is a direct descendant of Bray’s ziggurats (previous page). Instead of viewing an informational landscape as if from above, the 3-D version allows the user to walk across the landscape, navigating through buildings that represent particular websites. Although this restricts the field of view to a limited territory, each individual website can be scrutinized in more detail.

Movement through the landscape is controlled by the cursor keys or the mouse, and the speed of movement can be altered; furthermore, it is possible to jump across the territory or teleport to new locations. Moving the mouse cursor over a building or area reveals an information box detailing the site name, a site description, and country of origin. The style, shape and size of the buildings encode information about the site’s visibility and luminosity. Houses rank low on the visibility scale (top-opposite), office buildings are middle ranked (bottom-opposite), and skyscrapers have high visibility (below). Brown skyscrapers are designated “cool” by Open Directory editors. The size of the site is represented by roof size on a house, and height for offices and skyscrapers.

3.37: Visualizing Web space as a 3-D cityscape

chief cartographer: Tim Bray (Antarctica).  
aim: to provide a visual search engine.  
form: 3-D cityscape, where each building represents an individual website. The shape and size of each building encodes characteristics such as the visibility of the website.  
technique: 3-D interactive fly-through graphics.  
further information: see <http://map.net>
A very literal information landscape is the 3-D Trading Floor (3DTF) of the New York Stock Exchange, unveiled in March 1999. In 3DTF, information flows and real-time data are spatialized in a 3-D virtual environment modeled on a physical architectural space. Shown opposite are two striking views of the 3DTF environment.

The information environment is used as a real-time decision-support system for operators who manage the stock exchange, keeping vital networks and computer systems running as well as monitoring the actual information flows of the market performance. Users can be immersed in the interactive environment. Various real-time data streams on business systems – including stock performance of individual companies and user-defined aggregations – as well as not only the underlying networks and computer servers but also news broadcasts can all be spatialized. Particular failures, incidents and unusual activity can be highlighted and examined in detail.

3DTF is used by operators in a purpose-designed command center, nicknamed “The Ramp”, in the heart of the actual stock exchange. It is displayed on a bank of large flat-screen panels. It is not accessible over the Internet. To power such a large and complex spatialization that is running with real-time data streams requires considerable computer resources, employing six expensive graphical supercomputers from SGI.

At present, 3DTF is somewhat of an experiment and it remains to be seen how valuable and useable the spatialization is in real-time management of the information space. There are plans to develop 3DTF further, with extended interaction and users represented by icons, as well as providing wider and remote access to the environment.
UBUBU seeks to provide a new desktop to Web browsers, using three-dimensional planets. The surfaces of the planets are populated with icons, such as skyscrapers and flower-pots, that provide visual bookmarks to Web pages, files and applications. UBUBU’s planets are highly detailed and 3-D-rendered, floating in clear blue space. With this imagery, you can have the world as your desktop and the planets can be seamlessly rotated with the mouse. They are designed to make using a computer more fun by providing a more eye-catching desktop compared with more conventional interfaces.

The software comprises the (free) UBUBU Universe, which allows you to download a “solar system” of distinctive planets from a range freely available on the company's website. There are three classes of planets: topic planets, special-edition planets and community planets (submitted by users). Many of the planets and the default bookmark icons are sponsored by various corporations, such as SciFi channel, WWF wrestling, Warner Bros., etc. Shown here is the “Earth” topic planet (top-opposite) along with “Romance and Revenge” (bottom-left). The other planet (bottom-right) is a corporate special edition sponsored by the Hollywood film, *X-Men*, with the surface covered with photographs of the film’s characters and the icons linking to related websites of the movie and cartoon.

Although the planets are customizable and users can delete the default icons and links, the whole effect has a strong marketing bias, with much of the effort being to get branding and advertising messages onto people’s computer desktops. UBUBU earns revenue by users clicking on icons to go to a sponsor's website. It takes quite a bit of manual effort to reconfigure your own planet and override the corporate feel.

UBUBU’s website claims that its software is “turning cyberspace into real space – and it’s yours”. However, the planets, whilst appearing to be effective spatializations, have little spatial consistency, with no relational quality between an icon's position and its neighbors. Indeed, on the default planets the icons are just scattered randomly. In this sense the planets are really just acting as eye-candy.

3.39: UBUBU

chief cartographer: Bryan Backus (UBUBU, pronounced “you be you be you”).

aim: to make computers and the Web more fun by providing visual desktop with shortcuts and bookmarks.

form: 3-D planets covered with icons that provide bookmarks.

technique: custom-programed browser interface to the Web.

date: launched in April 2000.

further information: see <http://www.ububu.com/>