Spatial Hypertext: An Alternative to Navigational and Semantic Links

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1 Introduction: The Emergence of Spatial Hypertext

Hypertext began as a vision of interconnected reference materials [Bush 1945] and literature [Robertson 1998]. These early visions were joined by working systems that supported link-based navigation among documents as well as branching points within (hyper)documents [Engelbart 1984]. As the use of hypertext systems became more widespread, researchers realized that readers could become confused or lost as they navigated large networks [Conklin 1987a]. Systems such as NoteCards [Halasz 1987] addressed this problem by displaying maps of the hypertext's network structure. The success of NoteCards's "browser cards" and other hypertext maps gave rise to systems in which the user's main interaction with the hypertext was through a network map rather than a document viewer. For example, systems such as gIBIS [Conklin 1988] and Aquanet [Marshall 1991] presented a visual network containing typed links and nodes where the types are visually distinguished within the map; the network could be edited and manipulated through this presentation.

The move from document-centered hypertext systems to map-based hypertext systems had some unforeseen but far-reaching implications: relationships between nodes could be expressed in more than one way. Maps showed interconnectedness explicitly, usually in the form of a directed graph. But also node proximity came into play; relationships among different nodes or documents could be indicated simply on the basis of their relative location. The use of these map-based hypertext systems to author new information spaces uncovered an interesting phenomenon. Users avoided the explicit linking mechanisms in favor of the more implicit expression of relationships through spatial proximity and visual attributes [Marshall 1992]. Further analysis showed that the use of these spatial and visual cues to imply relationships applied not only to map-based hypertext systems, but also to traditional hypertext systems and in the physical arrangement of paper and notecards [Marshall 1993].

New interface requirements arose from these observations of practice. Specifically, there was a need to support the expression of the implicit and transient relationships that develop between nodes [Marshall 1995]. With that

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requirement came the concomitant need to support manipulation, the movement of nodes and structures of nodes within the information space. Spatial hypertext systems like VIKI [Marshall 1994] emerged to support this new method of interacting with information. Commonly used visual attributes like color, shape, and border width can be readily changed to enable "information triage", the rapid interpretation and assimilation of new information [Marshall 1997a].

To better support the manipulation of transient perceptual structures, VIKI includes a spatial parser that recognizes patterns such as vertical and horizontal lists, stacks, and composites. Recognized structures provide easy access to the different levels of perceptual structure within a complicated information space and support the transition of these implicit structures into explicit hypertext [Shipman 1995].

2 Benefits of Spatial Hypertext

Given this historical perspective on spatial hypertext and a range of experiences with its use, what can we infer about the types of activities for which it will be useful? The most basic question is why is a spatial interface useful at all (compared to document-centered interfaces). Our experience indicates four major benefits: (1) it takes advantage of people's considerable visual recognition and intelligence; (2) it facilitates constructive ambiguity; (3) it supports emerging problem-solving strategies; and (4) it reduces overhead in communicating with others.

A spatial interface allows users to take advantage of their visual memory and pattern recognition. Remembering where one saw a document in a visual workspace is a process of recognizing the area in which a document was located at a progressively finer-grained level rather than having to remember the navigational path one took to get to the document. Visual recognition also enables the expression of relation variations -- people recognize visual patterns as being of the same or similar type even when they are not identical; this introduces a way to compose and share imperfect composites.

Another benefit of spatial hypertext is its facility for constructive ambiguity. Where a link in a document-centered hypertext either exists or does not in a particular presentation of the material, placement of a node close but not quite with others can imply some indecision or potential for a relation between the nodes. Allowing people to express ambiguity more easily enables them to perform tasks such as analysis or design where interpretations form as they work with the materials.

It is not only the case that the interpretation of individual documents changes over time in a spatial hypertext, but the visual language representing the interpretation changes as well. A study of users performing short-term interpretation tasks showed that visual languages emerge as users' understanding of the task and their method of approaching the task co-evolved [Marshall 1997a]. The use of a visual attribute to represent some abstract information about node content changed over time; for example, color might start off indicating the usefulness of a document but later be used to encode domain-specific characteristics of the content. Such changes indicate that users adapt their solution strategies as they gain more insight into their task. Aquanet and other systems with predefined types and relations make the overhead for making such changes in mid-task overwhelming and very unlikely to occur.

Many tasks require information to be shared among a group of collaborators. Hypertext's application to information sharing has been investigated by many systems including the Virtual Notebook System [Shipman 1989] and Sepia [Streitz 1992]. The initial study of spatial layouts of information implied a correlation between the number of people sharing an information space and the degree of visual structure apparent in the arrangement. When it was necessary for more people to understand the information space, they created a higher degree of perceptual structure and followed it more strictly. As with sharing information in a navigational hypertext or file system, users must agree on a basic framework in order to effectively communicate. In contrast with a navigational hypertext or file system, effective use of ambiguous and implicit relationships means the spatial hypertext does not require on users to agree on particular relationships or agree on their interpretation.

3 Impact of Spatial Hypertext

Hypertext research has evolved into a number of interrelated sub-areas of specialization. Spatial hypertext has contributed to a number of these lines of hypertext research: playing into the discussion of hypertext literary theory; framing the discussion of visualization and interaction techniques for hypertext information; challenging the open-hypermedia research community with a different model of hypertext; and motivating work on Web workspaces.

Theoretical discussions of hypertext have long explored the role of the reader. Spatial hypertext becomes intertwined with these discussions when theorists begin to take a closer look at how readers may interact with texts, taking a step beyond the reader-as-writer foundation. As an important example, Rosenberg has introduced the notion of the reader as gatherer [Rosenberg 1996]. In his vision of interaction, document-centered hypertexts invite "or" style traversal: a reader can choose to go to this document or that; by contrast, spatial hypertexts invite "and" interactions in which the reader can simultaneously apprehend many different nodes [Rosenberg 1997]. The representational malleability of spatial hypertext is also considered important; early critiques of the rhetoric of hypertext call for a need to reform the established structural rigidity of hypertext and move to a more exploratory one [Moulthrop 1991]. In fact, one element of Greco's call for a political praxis of hypertext involves the use of hypertext to explore interpretive frameworks and theories reflects the most basic goals of spatial hypertext [Greco 1996]. Kolb, a philosopher, further discusses the role of flexible representations of interpretation [Kolb 1997]. The properties of ambiguity and emergence are appealing to those who are interested in reframing existing texts.

Visualizations of hypertext networks have evolved since the original hypertext maps that inspired spatial hypertext. There are now visualizations involving algorithms that cluster nodes or infer a hierarchy to generate visual representations that are simpler and easier to use than the map of the entire link network [Durand 1998]. Additionally, visualizations have explored the use of three-dimensional representations for hypertext -- including the placement of text into virtual renditions of physical worlds or text-based spatial environments [Dieberger 1995]. Within VIKI, the constant shortage of screen real estate and the practice of performing multiple tasks simultaneously led to the development of a multi-focus fisheye view [Shipman 1999].

The goal of open-hypermedia research is to create a protocol that allows links to exist across different hypertext systems and information stored in one system to be displayed and manipulated in another. For systems that are based on a node and link model of hypertext the primary concerns involve versioning, permissions, and composites. Spatial hypertext, because of the lack of links or other explicit relationships between nodes, challenges the open-hypermedia research protocols to consider information structuring at a more abstract level [Nürnberg 1999]. Relationships implied in a spatial layout may need to be converted to a link in a document-centered hypertext system while links in such a system need to be converted into a generated layout in a spatial system. Additionally, the ambiguity of links and spatial composites in a spatial hypertext are difficult to express in a node-and-link based system.

The growth of the Web has led to a growing number of systems that provide "Web workspaces" in which users can collect, organize, and otherwise work with information. VIKI itself includes a number of interconnections with the Web including the ability to author presentations containing Web-based information [Shipman 1997]. Additionally, systems like Web Squirrel [Bernstein 1996], D-LITE [Cousins 1997], Web Forager [Card 1996] and Data Mountain [Robertson 1998] provide workspaces for analysis and interpretation similar to that of VIKI.

4 Future of Spatial Hypertext

Spatial hypertext emerged from the graphical presentation of traditional hypertexts as maps. The problems of understanding the context of the information currently being read and remembering how one got to a particular location are ever more a problem with the growth of the Web as a central public information resource. The benefits of a spatial representations and interfaces ensure continued research into spatial hypertext and Web workspaces. The current legal dispute about the bundling of Internet browsers and operating systems aside, the vision of the computer

as a information appliance will push new operating system interfaces to combine current OS desktop features with those of spatial hypertext.

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