

Association and argument: Hypertext in and around the writing process

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While hypertext is often claimed to be a tool that especially aids associative thinking, intellectual “work” involves more than association. So, questions arise about the usefulness of hypertext tools in the more disciplined aspects of scholarly and argumentative writing. Examining the phases of scholarly writing reveals that different hypertext tools can aid different phases of intellectual work in ways other than associative thinking. Spatial hypertext is relevant at all phases, while page-and-link hypertext is more appropriate to some phases than others.

1. Introduction

Hypertext, we have often been told, provides a technology of writing and reading that fits the associative way that the human mind works.¹ Yet, neither the mind nor hypertext is simply associative, and hypertext can assist thought and writing in multiple ways.

2. Three pioneers

In his prophetic essay, “As We May Think”, Vannevar Bush argued that the memex, his proposed data storage and linking device, would better fit the way the mind works. Bush was concerned with information organization; he compared associative thinking to hierarchical data structures, not to linear prose writing. He envisions a revolution in data organization and access more than a change in our mode of writing.

When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by tracing it down from subclass to subclass. . . . one has to have rules as to which path will locate it, and

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¹ In popular discussions, hypertext has come to be associated with the notion of associative thought.

Some people are appalled by the lack of linear logic in hypertext, and the way this makes traditional rhetorical argument very difficult, but is that type of argument a relic of the past? Was it better suited to a society that was characterized by different needs and interests and a different understanding of the world? (Anlitz 1998)

For other examples, see Lepers (1993), Brown (1999), and Gosse *et al.* (2002).

the rules are cumbersome. Having found one item, moreover, one has to emerge from the system and re-enter on a new path. The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. . . . the speed of action, the intricacy of trails . . . [are] awe-inspiring beyond all else in nature. (Bush 1945, section 6)

When Bush describes new kinds of writing, he describes a network of crossing information trails. Bush's examples show that while he wants freer associations, he envisions the process of association as disciplined by the particular goals for each knowledge task.

Wholly new forms of encyclopedias will appear, ready-made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified. The lawyer has at his touch the associated opinions and decisions of his whole experience, and of the experience of friends and authorities. . . . The historian, with a vast chronological account of a people, parallels it with a skip trail which stops only at the salient items, and can follow at any time contemporary trails which lead him all over civilization at a particular epoch. There is a new profession of trail blazers, those who find delight in the task of establishing useful trails through the enormous mass of the common record. The inheritance from the master becomes, not only his additions to the world's record, but for his disciples the entire scaffolding by which they were erected. (Bush 1945, section 8)

Bush does not describe the memex as providing assistance to a writer beyond improving access to information. Memex trails would be a new class of intellectual product, but they would not replace traditional essays and books. Trails would provide suggestions and connections but would not in themselves argue for conclusions. An association on a trail does not make a specific claim except that a connection exists. If the links on the trail were labeled with different types, then the trail could begin to assert specific kinds and directions of connection, but a series of such connections would still not have the intricate interrelations and subordinations found in the propositions of an argument. A collection of linked items might furnish evidence, but until it was focused and directed by claims and argument, it could not enter the back and forth of intellectual and scholarly interchange.

Ted Nelson has long been an energetic proponent of a freer associative mode of thinking and writing. Speaking of the early source of his ideas, he said

I particularly minded having to take thoughts which were not intrinsically sequential and somehow put them in a row because print as it appears on the paper, or in handwriting, is sequential. There was always something wrong with that because you were trying to take these thoughts which had a structure, shall we say, a spatial structure all their own, and put them into linear form. . . . you had to take these two additional steps of deconstructing some thoughts into linear sequence, and then reconstructing them. Why couldn't that all be bypassed by having a nonsequential structure of thought which you presented directly? (Nelson 1992)

Nelson wants new kinds of intellectual products that present not sequences of argument but nets of association. Priority and foundation are replaced by coherence and connection:

A structure of thought is not itself sequential. It is an interwoven system of ideas. . . . None of the ideas necessarily comes first; and breaking up these ideas into a presentational sequence is an arbitrary and complex process. It is also a destructive process, since in taking apart the whole system of connection to present it sequentially, we can hardly avoid breaking—that is, leaving out—some of the connections that are a part of the whole. (Nelson 1992)

The result, he says, is closer to literature than science.

To me literature is the great ideal here, not some engineer's notion of information retrieval. . . . So the issue is what will be the extension of literature into the great realm of interactive, multi-dimensional, many-threaded presentational forms. (Whitehead and Nelson 2002)

Nelson wants to enrich thinking and discussion through easy intertextual reference and reuse. He has more to say about relating items in the docuverse than about the process of composing a single document, because he distrusts the idea of a single bounded document. But the same issue arises as with Bush's trails: a net of connections is not yet an argument for a set of claims. If the goal for hypertext writing were to assemble everything possibly relevant, to spark and record creative associations, then the more associations the better. Put in anything that might enlarge insight and enrich the net; it may be useful. Evaluation is subordinated to collection and linkage. The resulting net of associations, which Nelson wanted to be both rich and disciplined, will be a resource, but not yet an argument. Nelson's machinery of transclusion would enable the writer to easily weave together references and linked materials into argumentative writing.² His own print publications are printed multi-media, full of quotations and images laid out using adjacency to suggest propositions that bolster claims made in straightforward prose sentences. There is more structure than one of Bush's trails but less explicit argument than a scholarly essay.

The world of scholarly and argumentative prose demands precision and narrow focus. If hypertext were only about assembling associations, it would

² In his vision of the Xanadu "system for the supply and presentation of material" Nelson proposed "two basic relationships: what we would call the link, which is an unchanging connection between objects, or parts which are different, and the transclusion, which is a maintained connection between parts which are the same" (Whitehead and Nelson 2002). Transclusion places a reference to a source into a text's code, which is displayed as if the transcluded item were part of the document, when in fact it is called from the source. Nelson envisioned this as, among other things, a micropayment scheme for dealing with intellectual property issues. Current page-and-link systems do not support transclusion, though see the gIBIS-descended Compendium tool as a link-mapping example of transclusion at both node and link-map levels.

not be so helpful for scholarly and argumentative composition.³ But hypertext is more than association; it can be used for argument, reflection, and evaluation. Intellectual work is a play between association and structure, and that play is more disciplined in some of its phases than in others. The process of scholarly and argumentative writing has more phases than association, and hypertext is differently relevant to each phase.

Douglas Engelbart has had much to say about the process of writing. His NLS system was devised to assist with more than networks of associations. Engelbart wanted to augment a whole hierarchy of skills. “If we then ask ourselves where . . . intelligence is embodied, we are forced to concede that it is elusively distributed throughout a hierarchy of functional processes” (Engelbart 1962). Engelbart’s ideal user would let the computer “do some of his symbol-manipulating processes for him so that he can use more powerful concepts and concept-manipulation techniques”.⁴ Engelbart emphasizes that improvements in the efficiency and speed of low-level actions enable improvements on higher levels. So, he has been concerned with interfaces and with having the computer aid in smaller organizational and linking tasks, then building up to more complex tasks. “The impressive new tricks all are based upon lots of changes in the little things you do”. With a word-processing program we can add text, cut and paste, move paragraphs around, and so on. Lower-level efficiencies can enhance the higher-level activities of composition and revision. Engelbart’s system was designed to assist more than low-level activities. In Engelbart’s famous filmed demonstration that introduced so many innovations, it is text that is manipulated, but

³ Stephen Robertson discusses the relevance of associative thought to scholarly method in history:

This website has been designed to present history hypertextually. . . . Traditionally this is seen as facilitating “associative thinking”. . . . Therefore, we find many attempts to produce interconnected, nonlinear narratives to facilitate this thought process. It is the suggestion here that the “associative thought” model may not translate well to historical inquiry. It is worth noting that history, to the extent that it can be defined as a discipline at all, must be defined as a way of thinking, as a methodology for analysis. Certainly there is much variety in historical modes of thinking, and its precise terms are almost impossible to define, yet it would appear to be a distinct possibility that “associative thinking” could mark a clear deviation from the strict processes of analytical thought that would appear to constitute historical thought. (Robertson 2002)

⁴ Emphasizing how the affordances of tools can change processes, Engelbart asked what would have happened if our ability to record and manipulate symbols had depended on a writing instrument the size and weight of a brick:

The effort in doing calculations and writing down extensive and carefully reasoned argument would dampen individual experimentation with sophisticated new concepts, to lower the rate of learning and the rate of useful output, and perhaps to discourage a good many people from even working at extending understanding. (Engelbart 1962)

the textual objects stand for progressively more complex intellectual products. Engelbart sees tremendous advantages arising from

the simple capability of being able to establish arbitrary linkages between different substructures, and of directing the computer subsequently to display a set of linked substructures with any relative positioning we might designate among the different substructures. You can designate as many different kinds of links as you wish, so that you can specify different display or manipulative treatment for the different types. (Engelbart 1962)

Engelbart's NLS/Augment system had such capabilities, but no present hypertext tool is as flexible, though software developers are trying.⁵

3. Hypertext tools

The three pioneers cited above-presented large-scale visions, but a different future arrived. The pioneers dreamed of a universal hypertext system working with centralized link servers and a networked data store. The private desktop computer and the multiplication of software development sites brought fragmentation where the pioneers had hoped for unity. There are no standardized hypertext tools or link servers, and data transfer from one system to another has been difficult. The systems often embody visions of hypertext that depart from what the pioneers foresaw. The most widespread system, HTML, embeds links inside documents instead of storing them on external link servers, so that many of the features dreamed of by the pioneers are not easily realized. Also, the ASCII terminal was replaced by display technologies that permit direct spatial manipulation of graphical data objects, and this allowed a kind of spatial hypertext that makes connections without demanding the precise relations and defined links that were important to the early visions.

On the other hand, there is the Internet, the growth of web services, and the spread of XML. Data conversion between hypertext systems will become easier, and the infrastructure can allow centralized data stores and link servers. Even so, I suggest that the fragmentation of hypertext will likely

⁵ The NLS/Augment system was deployed at a variety of government bureaus and corporations, but his full vision, like Nelson's, has been frustrated by corporate thoughtlessness, confusions about "office automation", and a lack of funding. At the ACM Hypertext Conference 2004, Engelbart protested that hypertext research was still not properly pursuing his ideals for the augmentation of intellectual skills. His complaint seems to me only partly justified, for while there has been no centralized and hierarchically arranged suite of tools such as he envisioned, there has been gradual but continuing development of tools that augment various cognitive tasks for scholars, scientists, and poets. The resulting fragmentation and variety is a key difference between our situation and that envisioned by all three pioneers.

continue, since different tools answer to the differing needs of authors and to the internal complexities of the process of writing.⁶

In this essay, I am concerned about how hypertext can aid scholarly and argumentative writing. Such writing is typically controlled by an accepted methodology and makes references to ongoing debates from a series of books and essays. It argues for claims. This contrasts with personal expressive essays and purely descriptive works, as well as with literary writings. It would seem not to have a role for associative thinking in hypertext, but in fact there is such a role, and hypertext can do even more.

I am using the term “hypertext” for nonlinear or network writing that cannot be straightforwardly presented in print. The most familiar examples are encountered in a web browser, but hypertext can be presented in environments other than single-window configurations. Hypertext is an event, a mode of access and reading, an experience of nonlinear linking and juxtaposition, no matter what data structures the content resides in. Hypertext is reading an item (a piece of text, an image, a page) within a larger field of explicit connection than linear text can present.⁷

I want to distinguish four kinds of hypertext: page-and-link, stretchtext, link mapping, and spatial hypertext. A hypertext tool may include more than one of these. They are differently relevant to different phases of scholarly work.

- *Page-and-link* hypertext is familiar from the web: A piece of text or an image appearing in a window contains embedded links that lead to other pieces or images. The others usually appear by replacing the original, but they may appear in separate windows so that several items are simultaneously available.
- *Stretchtext* presents a piece of text that when queried expands to offer more detail. An abstract might morph into a summary, then into a shortened version, then into a full article. Stretchtext can be presented in

⁶ Parallel to the development of general hypertext tools, there have been efforts to develop specialized systems tailored to represent argument structure, such as Aquanet (see Marshall *et al.* 1991), gIBIS, Compendium, Notes (see Neuwirth *et al.* 1987), ClaiMaker, Araucaria and DebateMapper. Their theory and history are presented in Buckingham Shum (2003).

⁷ Hypertext can signal explicit connections by colored links, spatial relations, or special symbols. Texts also possess implicit connections suggested by the meanings of words and syntactic relations. These multiply beyond the ability of any set of explicit links. Joyce’s *Ulysses* is richer in linear prose than a hypertext version would be, since the hypertext would have to make explicit and overemphasize a selection from the many implicit connections suggested in the text.

page-and-link fashion, or with its own visual effects that show new material being added into the old.⁸

- *Link mapping* provides a spatialized overview of linked networks, most often in the form of boxes linked by arrows. This is seen occasionally on the web, but more often in specialized software. Often users can alter the maps to bring out different features of the link network.⁹
- *Spatial hypertext* also constructs visual displays, but instead of showing link structures, it relies on our ability to assign meaning to spatial positions and relations. In a link map, moving boxes with arrows around does not change the link network, only its current presentation. But moving graphical items around in a spatial hypertext display does change the items' basic relations and meanings.¹⁰ Spatial hypertext allows structures that are tentative, vaguely defined, and incomplete, which networks of precisely defined links do not express so well.¹¹

In assisting writing, hypertext mixes the textual with the spatial and visual.¹² This can happen through a single tool that does both, or through cooperating single-purpose tools. Many hypertext systems include multiple modes of presentation and manipulation to fit authors' differing cognitive and

⁸ Zellweger *et al.* (1998) demonstrate the purest form of stretchtext, where text flows aside to allow an expansion of a phrase or sentence to appear. Guide, described in Brown (1987), uses buttons that are replaced by new material (see also DeBra *et al.* 1999, concerning MetaDoc). HTML can perform stretchtext either by replacing one page with a longer one, or by using CSS to hide and reveal portions of a page.

⁹ A kind of spatial mapping appeared in Engelbart's NLS/Augment system where text objects could be repositioned on the screen and linked by lines. Mapping was prominent in NoteCards (Halasz 1988) and gIBIS (Conklin and Begeman 1988; the most recent version of gIBIS is available as Compendium). Link mapping was important in Intermedia (Garrett *et al.* 1986, Kahn *et al.* 1995, Landow 1997) and became central to Storyspace, whose sibling Tinderbox combines link mapping with spatial hypertext features. There has been active research toward developing tools that can add link mapping to the web. See, for example, Chen (1997), Mukherjea and Hara (1997), and Durand and Kahn (1998), and Toyoda and Kitsuregawa (2001).

¹⁰ See Marshall and Shipman (1997), Shipman and Marshall (1999), and Shipman *et al.* (2001). The most elaborated spatial hypertext system is VKB (Visual Knowledge Builder); see Shipman *et al.* (2002).

¹¹ A spatial hypertext system may also provide for creating links among spatially distant items, but this is not its major virtue. Page-and-link hypertext can approximate the flexibility and tentativeness of spatial hypertext by using and revising multiple types of links. But the result is visually clumsy, and a precise link labeled as "tentative" is not the same as the "maybe it's sort of related maybe not" of a spatial positioning. Spatial hypertext can be added to page-and-link and link mapping hypertext tools. Tinderbox has perhaps the most complete integration: a net of links appears in a manipulable link map, but there are also non-link spatial colorings and areas that can be employed to overlay other kinds of structure and relation onto the link map.

¹² The interplay of text and visual space creates challenges for those working to make hypertext useful for the visually disadvantaged.

compositional styles,¹³ but it is not obvious that one do-it-all tool will ever dominate the field. In styled text word processing, data formats have been proprietary, so getting different tools to interact with the same text has been difficult. On the other hand, because of open data formats for ASCII programming code and for texts and images for the web, these are often prepared using many interacting tools, selected according to the authors' cognitive needs and work patterns. As hypertext tools gradually standardize on XML data storage, there may emerge a single large dominant system after the model of Microsoft Word (and the visions of Nelson and Engelbart), but it is more likely that authors will continue to use a variety of tools that answer to the differing needs of authors and to the internal complexities of the process of writing.

I am investigating the contribution hypertext tools might make to the process of writing scholarly and argumentative prose, whether the final product will appear in print or on the screen, with or without images. How does hypertext help in the process of developing the order and connection of ideas in claims and arguments? Based on my own and others' writing experiences, I am suggesting a vision for the future that may help shape the further development of tools to assist scholarly writing.

We teach ourselves and our students to obtain an overview of the literature in a field, select appropriate items to analyze and understand in depth, evaluate what they find, and create their own contributions. So, we might distinguish four phases of scholarly writing: survey, analysis, evaluation, and creation. These phases do not have to be sequential; they interpenetrate, and they aid one another. Nonetheless, they involve different skills and can be discussed separately. What it means to work efficiently and fluently varies in each phase. So, too, will the role hypertext might play, and the appropriate hypertext tools.

4. Survey

The assembly of materials to survey can profit from associative thought and investigation that is not limited to any given set of categories or hierarchies. But if a survey is to be useful, it needs more than breadth; it needs to produce an organized overview as well as lists of surprising associations. Hypertext can aid intellectual surveys by making it easy to add associations and surprising links, but also in ways not limited to associative thinking. Link

¹³ Systems aimed at writing often provide multiple different views of the developing linear or hypertextual documents, such as SEPIA (Structure Elicitation and Processing of Ideas for Authoring; see Streitz *et al.* 1992), KMS (Knowledge Management System; see Akscyn *et al.* 1988), Storyspace, Tinderbox, and the ART suite of tools. For a review of writing support systems, see Smith *et al.* (1987), Sharples (1992), Buckingham Shum and Hammond (1994), and Sharples and van der Geest (1996).

mapping and spatial hypertext can improve overview, focus, and the organization of survey results.¹⁴

The most pressing issues in an intellectual survey are comprehensiveness and the efficient use of time and attention. These often conflict, and the increasing torrent of new items has made the survey more difficult. The standard control on the amount to survey had been to establish trusted gatekeepers. Peer review for quality journals and qualified publishers reduced the cognitive load on the surveyor. Now, gatekeepers control a smaller fraction of the terrain to be surveyed. The explosion in the number and cost of journals makes them less available, and the economic straits of university presses reduce the number of monographs. Self-publication on the web becomes easier, whether in electronic exchanges of preprints or in linked informal modes of communication such as blogs and wikis.

So, intellectual workers are deluged. Hypertext's support for associative thinking helps widen the field of view, but that by itself does little for organization and filtering. Links may gather references, but a hundred links are just a list that needs organization. Hypertext can help here not only by links but also by spatial hypertext's overviews and loose categorizations.

A further step would be to invoke automatic filtering and arranging. Google's Page Rank algorithm is a step in this direction, and an important change from the older Yahoo-style hierarchical index. Google Desktop Search and its cousins appearing in Apple and Microsoft operating systems suggest that for the individual knowledge worker, even the amount of data stored "at home" is now too large for hierarchical file structures to remain cognitively useful, just as Bush predicted. The current paradigm for both net and desktop is a powerful search applied to data that may be in unorganized heaps or in complex structures, but the structure is largely ignored in the search results. This brings the freedom to use information regardless of what hierarchies or classifications it might be located within, but it lessens the usefulness of the metadata those structures can provide. While such searches can find multiple items, they produce long lists that do not give the searcher a structured overview.¹⁵

Spatial hypertext can aid by keeping the survey as a whole in view while also structuring it loosely. This will eventually be aided by searching and gathering algorithms combined with spatial parsers that can amplify organization that is implicit in users' tentative collocations of items.¹⁶

Organized views would also be aided by more metadata about the specific relations of one item to others, produced either through algorithmic text

¹⁴ See Marshall and Shipman (1997) for a discussion of information triage.

¹⁵ There are tools such as Devon Agent that try to structure web search engine results. On the Web, see the Web search engine Clusty and the blogging indices that try to keep keywords and linked families in view (Blogdex, Daypop, Technorati, and others).

¹⁶ The spatial parser in VKB helps refine the user's practices, as does the related WARP system, described in Francisco-Revilla and Shipman (2000). Tinderbox agents can perform user specified (but not automatically adaptive) actions that affect both link structure and spatial presentation of a hypertext.

analysis, citation tracing, or author-provided meta-data as in the ClaiMaker system. So, hypertext, with its ability to present large amounts of material through multiple representations of relations, connections, and metadata, can help the survey phase of intellectual work by adding organization and overview to associative thinking.

5. Analysis and understanding

When we turn from surveying a field to the individual encounter with selected texts and arguments, the role for hypertext changes. If links combined with spatial hypertext would seem the choice for survey, stretchtext enables graded access to individual items.¹⁷ As the scholar decides how much attention to devote to an item, increasingly fuller versions should be available. Google gives you a narrow choice: either a few words or the whole article. Intermediate stages are needed. Author-created abstracts are useful but not always present. The algorithmic creation of summaries is not yet trustworthy for detailed intellectual work.¹⁸ A refinement might be the automatic extraction of a few key paragraphs that had been marked for that role by the author. Another helpful aid would be a standard style for presenting abbreviated survey versions, so that it was not necessary to decipher new presentation conventions for each item. The full paper might then employ whatever novel interface the author deemed appropriate.

Few scholarly items are originally composed as native hypertexts, so hypertext tools are likely to organize and link mostly items that are close to conventional printed papers. These may be Web-adapted with links for navigating among sections and to other items, but most of them could be printed out. (As for native scholarly hypertexts, I will offer them the last word later on.)

Yet, linear scholarly prose is not one kind of writing. The scholar must work through many different kinds of texts, whether presented on the screen or in print. In my field, philosophy, the reader must learn to navigate and understand many historical genres and half a dozen contemporary styles of writing academic articles. In each case, the reader is exploring a world and a style of thinking. In that exploration, what does it mean to encounter

¹⁷ The growth in the number and popularity of simple tools that can hide the more detailed levels of outlines shows that writers value graded access to complex document structure. Outliners provide what in hypertext terms are composite nodes representing whole sections of a document, but hypertext programs also provide richer interrelations than hierarchical outlines.

¹⁸ Amazon.com now provides for some books a list of distinctive terms and phrases automatically extracted from the book's text and listed as "statistically improbable phrases" that are presumed to reflect unique concepts presented in the book, a common approach to document differentiation in information retrieval research. However, one suspects that this approach would not be effective in differentiating scholarly articles within a given field, which make different points while manipulating the same vocabulary as related articles. An approach to adding layers of human-encoded metadata is required at present to extract and formalize argumentation (e.g. Buckingham Shum *et al.* 2005).

concepts and ideas? It means more than a quick survey can provide; it means seeing the ideas in operation, tracing claims and their inferential links and evidential bases. It means keeping a great deal of material in mind while organizing a vision that is both detailed and general. Hypertext can help with that dual task. While the survey phase calls for wide-scale and effective groupings of many items, the analysis phase needs complexly detailed connections among a smaller number of components. Analysing an argument requires a concentration that is in many ways the opposite of associative freedom.

Encountering arguments and conceptual structures, I might take a yellow pad and make a graph diagram of the key assertions in the article as I read, connecting them by arrows.¹⁹ Or I might use 3 × 5 cards sorted into piles that I place in significant juxtapositions on my desk. What can hypertext do that I cannot do with my yellow pad and cards? The same issues of complexity and quantity that moved the survey phase away from lists and hierarchical structures come into play when dealing with complex individual items. Hypertext can keep active more complex link structures than a page or card can show. Hypertext tools can provide an unusually free space for gathering notes and insights, for tentative outlines, for managing snippets and clippings, and for adding annotations to digital versions of a linear text. The aim here is not to produce an overview survey of the field, nor to write a new contribution, but to help the researcher encounter an item in detail and understand its claims and arguments.

Scholarly works seldom lay out their arguments in abrupt step-by-step form, since there are rhetorical needs to add context, clarifications, and motivations. Hypertext tools can provide ways to paraphrase complex arguments into stricter form, while maintaining links to the actual text.²⁰ Precise linking can separate issues and make argument structure clear. Thus, for the analytic phase of intellectual work, the best tools would seem to be ones that combine the multiple presentations of stretchtext, the precision of page-and-link structures, and flexible link maps. Link mapping with boxes and arrows is more helpful in this phase than the less defined relations of spatial hypertext.²¹ To help the writer, the tools should allow easy revision of current structures and be able to present the results in multiple ways, so that the scholar can view and manipulate the developing presentation of concepts

¹⁹ Buckingham Shum (2003) points out that researchers seeking to represent on paper concepts and arguments have from the beginning used box-and-arrow notations.

²⁰ See Kolb (1997a, b) for examples.

²¹ Mancini (2000) and Mancini and Buckingham Shum (2001) explore other visual ways of expressing specific argumentative and rhetorical connections.

and propositions.²² They might switch rapidly from a focus on one connection to a global view of the whole argument, linking to outside material when relevant. Associative thinking does not play so large a role in this analytical phase of intellectual work.

The result is a hypertext summary and analysis of the item being studied. This reading aid can then assert its own independence. Coming to understand an article or book by developing hypertext notes about it constructs a new artifact that acquires its own special value beyond the limits of the work being analyzed. In his 1962 essay, Engelbart imagined a future user saying that once he had produced a hypertext analysis and representation of the ideas and arguments in a scholarly text, he did not go back to the original:

I found, when I learned to work with the structures and manipulation processes such as we have outlined, that I got rather impatient if I had to go back to dealing with the serial-statement structuring in books and journals. . . . it is like trying to project n-dimensional forms (the concept structures, which we have seen can be related with many many nonintersecting links) onto a one-dimensional form (the serial string of symbols), where the human memory and visualization has to hold and picture the links and relationships. I guess that's a natural feeling, though. One gets impatient any time he is forced into a restricted or primitive mode of operation—except perhaps for recreational purposes. (Engelbart 1962)

6. Evaluation

Along with analysis comes judgment. Analysis and evaluation are not fully separate, since discerning the significant evaluative questions to ask about a proposition or an argument is part of coming to understand it. I am distinguishing these moments because while analysis of argument structure is the phase of intellectual work that is least like an associative network, evaluation requires imaginative and associative thinking. An argument is not a free association; it aims at connections that have a certain necessity. But testing the necessity of an argumentative connection demands that we compare it with alternatives that are seldom present in the text. There may be unstated presuppositions that could be otherwise; there may be other ways the terms could be defined, or could relate to one other, or there may be different consequences drawn from the argument, or connections to outside materials that would question the quality of the argument or the validity of its premises. Discerning these requires imagination and associative thinking as

²² “The [links] whose establishment and use within the files [Bush] describes at some length provide a beautiful example of a new capability in symbol structuring that derives from new artifact-process capability, and that provides new ways to develop and portray concept structures” (Engelbart 1962). Engelbart’s classic filmed demonstration shows how text objects can be manipulated spatially to express relations and implications. Engelbart seems to use “concept structure” to designate both sets of classifications and sets of propositions; this can conflate two kinds of linguistic entities and their different kinds of relations, but their spatial representations might well be similar.

well as precise focus. Evaluation of an argument requires producing alternatives and enlarging the space of vision.

Page-and-link hypertext should be able to help the close examination of argumentative connections, while also linking them to unexpected associations and alternatives. This could be done better if hypertext systems were to treat links themselves as first-class items that could be linked to and commented upon. Evaluation also needs ways to make visible and examine an argument's connections to a wider universe of texts, and to a non-argumentative context of practices, conventions, and daily issues. Linear prose cannot bring these surroundings into the document, but page-and-link, and spatial hypertext, can surround precise structure with a more loosely structured environment of texts and references. It would be useful for this purpose to employ an "open hypermedia" system that allows the user to link to specific portions of foreign documents or images produced by non-hypertext means. That requires that link structures are kept separate from documents, which is how the pioneers envisioned hypertext systems. HTML and the web were helped to spread quickly because links were embedded in each document. No link servers are required, but it is not possible to link to or from the details of non-HTML documents. Instead, the web offers large downloaded files, so the precision of linking is lost. Open hypermedia systems and link server systems have been proposed, but none so far have been able to overcome the web's inertia.²³ This may change in the future, but the result is likely to be a series of different link server systems.

7. Creation

Creation is a different play of freedom and structure. When they compose their own contributions, authors reach for whatever tools they have found convenient and inspirational. Hand-written outlines and word processing are commonly combined. While we cannot say that hypertext tools are necessary for composition, they may be helpful, especially with growing complexities in content and context. In this phase, most of all, the details of the interface become important.

There is a stage of gathering ideas and resources, brainstorming, and defining the task, which hypertexts can assist by being open and flexible in many dimensions. As the structure matures, hypertexts could provide tight focus while maintaining an overview. While a new text is being written, there are moments of evaluation as well, so hypertext tools that allow one to analyze what one has written could be useful in the ways mentioned earlier. Providing a variety of visual presentations, hypertext tools can be designed to

²³ See, for instance, the program *Microcosm*, discussed in Davis *et al.* (1992) and Carr *et al.* (1996).

help writers to go beyond an outline into an exercise of design as a mode of critical inquiry.²⁴

Page-and-link hypertexts provide an endlessly expandable pad to write on that can maintain links among its parts. Spatial hypertext offers writers freedom to create tentative arrangements rather than definite links. For example, the spatial ART Writing System Programs (2005) use a two-dimensional space to organize linear documents or media presentations; individuals use the spatial display in ways that give varied meaning to spatial relations.²⁵

The resulting two-dimensional positioning of objects allows designers to perform reflection-on-action. We found that subjects used a variety of visual properties of two-dimensional positioning as a representation. Some put elements that need further attention in the bottom right corner of the ElementSpace. Some subjects made a set of completed elements be the same size and carefully aligned them. One user had two elements overlapping each other with a verbal protocol saying that she felt that they should be related to each other but could not describe how they are related (therefore they were overlapped and not aligned). Another user made some elements much larger than others so that it would “call for attention” later in the task. Subjects used different distances between two vertically positioned elements to represent different types of relations of the two elements. Some subjects placed two elements that were almost completely horizontally aligned but with a slight height difference so that they “looked” horizontally aligned but are not from the system’s point of view. (Yamamoto *et al.* 2002: 2)

Using spatial hypertext can be like arranging cards on a desk, but the cards are flexible, easily editable, and the desktop indefinitely large. The writer might have the equivalent of the piles of note cards, distinguished and related by intersecting qualities of color and shape as well as by location on the screen. The hypertext piles are more capacious and linked than paper piles, and can contain nested sub-piles. The VKB system allows the creation of complex collections of groupings. It and other spatial hypertexts allow the writer to vary the visual appearance of items to express complex and

²⁴ It would be useful to study how hypertext tools compare to outliners and to programs for organizing clippings and snippets of text. Some hypertext tools, such as Storyspace and Tinderbox, can function as outliners, but this is a subset of their abilities. Goranson (2005) continues a detailed discussion of the features and uses of outlining programs. There are also clipping organizing programs such as Devon Think, Hog Bay Notebook, NoteLens, and the clipping facilities added to OmniOutliner and Tinderbox. See Neuberg (2005) for a discussion of such tools. There are also programs, such as the editor Ulysses, that manipulate buffers and multiple files, using concepts from Emacs and programming editors but presenting them in ways more clear to creative writers.

²⁵ See Nakakoji *et al.* (1998), Yamamoto *et al.* (1999, 2002), and Yamamoto (2001).

intersecting qualities and visual relations that go beyond spatial positioning. VKB can also replay the development of a document.²⁶

The advantages of spatial hypertext come with interface difficulties. Due to limits of screen size, only a portion of a large array can be seen without scrolling. An interface that can zoom continuously from global to close-in views would help.²⁷ Also, in spatial representations, text objects may be designated only by titles, with the text appearing in another pane or window. This decreases the sense of direct spatial manipulation of text. The ART writing tools put text in a separate pane but also have text visible in the boxes manipulated in the spatial view. The user decides on the size of each box and thus the amount of text visible. VKB provides a pop-up preview of content when the mouse is positioned over an item in the spatial array. An earlier version of Storyspace allowed some text to appear in the map boxes, but the boxes were small. Here, too, the writer would be helped by a zooming interface that allowed more or less text to appear in the boxes.

However it is constructed, a hypertext document that aids the production of scholarly writing will itself be valuable beyond the confines of its initial project. The linked “collection of statements, sketches, computations, literature sources, and source extracts that is associated” becomes a resource for future work. “It became apparent that the final issuance from my work, the memo itself, would represent but one facet of a complex symbol structure that would grow as the work progressed” (Engelbart 1962). As it grows, the hypertext is more than an assembly of materials because its link and spatial structures provide a record of thought and a stimulating context for future thought.

In summary, at every phase of scholarly writing, there is a different play between association and argument.²⁸ We can conclude from the mapping between writing phases and tools that different types of hypertext become relevant as each phase demands both focus and overview but in different proportions. Stretchtext is most helpful for a graded approach to individual items. Page-and-link hypertext comes to the fore in analysis and evaluation, and works best when combined with link mapping of argumentative structures. Spatial hypertext provides freedom and new abilities for every

²⁶ If a writer wants to recall a past state of a document, in order to understand its present state, or to examine alternative developments, in most systems the writer will need to have saved past versions of the file under different names. VKB’s “timeline slider” offers an internal, automatic, and elegant method of reviewing the development of a document.

²⁷ Continuous zooming has been implemented in single-purpose tools from Windsor Interfaces and from the University of Maryland Human–Computer Interaction Lab, and the persistent value of stepwise zooming in link-mapping mode is consistent with its provision in hypertext tools from the early NoteCards and Storyspace systems, through to the more recent VKB, WARP, Compendium, and Tinderbox.

²⁸ I have discussed elsewhere how hypertext might be of service to argumentative analysis, critique, and writing. See Kolb (1996, 1997a, b, 2000a, 2002). For other discussions, see Carter (2000), Dalgaard (2001), and Buckingham Shum (2003).

phase of intellectual work, especially for organizing surveys and for the early stages of text creation.

So, well-designed hypertext tools should in principle be able to improve the scholarly writing process. Because they introduce new abilities, they may at first be difficult to use, but, as with some word processors, the tool can eventually recede so that the writer is dealing directly with text and ideas. Getting to this point is a challenge to designers and programmers.²⁹

8. Native hypertexts

Because I have been discussing contributions hypertext might make to scholarly and intellectual work as it is now, I have not dealt with scholarly works composed natively as hypertexts. There are not many of these yet, and they are likely to evolve in surprising ways. But even if there were many of them, we would still need the hypertext tools described above to survey, analyze, and evaluate the native hypertexts, just as with more familiar scholarly items. If a survey reveals some items that are native hypertexts, we would want, again, degrees of access, overviews of their relation to other (mostly non-hypertext) works in the field, and aids for their internal analysis and evaluation. The tools we would use might differ from those used to compose and present the native hypertexts.

But whatever their number, native scholarly hypertexts re-emphasize the importance of associative thinking. When we begin to write native hypertext, the play of association and structure alters (Kolb 2004). Native hypertexts question boundaries. Even on the web today, the edges of a single work are not always clear, and links and overviews can question the boundaries of fields. While I have portrayed hypertext as an obedient servant for the scholar, in fact it has subversive tendencies (Kolb 2000b). The link is promiscuous and it does not have to obey the rules. Spatial hypertext can break as well as make boundaries. Hypertext can show a text—or a scholarly field—to be located in a larger context than its internal rules can manage. This may question or supplement the field or the text's self-definition and its assignment of tasks. We do not need hypertext to do this, but hypertext's abilities at juxtaposition and its native ignorance of borders makes it useful in ways that may surprise

²⁹ “Our approach is to make computer systems ‘invisible’; users must be able to feel that they are interacting with ‘representations’ not with ‘computers’ in using such systems” (Nakakoji *et al.* 2000, 1). This may be an argument for simpler cooperative single purpose tools. On the other hand:

Both Adobe Photoshop and the Emacs text editor are tools that require significant effort to learn effectively. And yet, those people that do put in that effort often love those tools, sometimes fanatically, and use them in countless ways for years. . . . Part of the reason . . . is that once an expert has mastered them, they can focus on the task at hand without interruption. This is due in my opinion to their general efficiency, powerful macro capabilities that allow automation of repetitive tasks, and to the robustness and predictability of the software. (Bederson 2004, 3).

us authors. This will be even truer when algorithmic linking becomes effective in dealing with the flood of texts and information. The inevitable imperfections of such algorithms may lead to cognitive novelty. Since they are not able to perfectly imitate the interests and selections of the disciplinarily trained human, the algorithms may offer surprising connections and juxtapositions that suggest new views and definitions. The hypertext does not just mimic the disciplinary rules; it occasions thought.

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