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AUTHOR Tucker, Susan A.; Dempsey, John V.
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ABSTRACT

This report describes hypermedia as a non-linear interlinked representation of textual, graphic, visual and audio material, that enables students to connect large bodies of information while developing analytical skills necessary to think critically about this information. It is noted that the use of microcomputers for hypermedia instruction represents an instructionally innovative way for students to manage information. The paper focuses on the use of a semiotic checklist to evaluate instructional hypermedia using HyperCard. Five semiotic criteria are presented and discussed: (1) intertexuality/intermediality, which emphasizes the linking of text directly with the author, its reactors, and its audience; (2) decentering and recentering, which involves the user making his/her own interests the center of learning rather than the author's vision of the computer software; (3) mediating networking and navigating, in which learners control their own paths through the situated relations; (4) negotiating expert and novice boundaries, which emphasizes the necessity for instructional designers to account for the differences in expert and novice knowledge representations; and (5) boundaries of individual work, in which the boundaries of text are weakened by nonsequential reading and thinking. It is concluded that the increasing ease of access for users and the ease of development for non-programming as well as programming instructional designers requires systematic evidence on hypermedia's instructional dimensions. A criteria checklist is included. (47 references) (DB)

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by

Susan A. Tucker

and

John V. Dempsey

University of South Alabama

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Susan A. Tucker, University of South Alabama
John V. Dempsey, University of South Alabama

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ABSTRACT

In this paper, a semiotic checklist to evaluate hypermedia is presented. First, the authors examine the relation of hypermedia to contemporary semiotics, instructional design, and evaluation. Next, five criteria for instructional hypermedia are analyzed: achieving intertextuality, decentering and alternative representation, navigating networks, transcending novice and expert boundaries, boundaries of individual work. The final section includes the checklist.

Introductory Scenario

In preparation for a lecture on cognitive psychology, a professor reviews the assigned readings in the text. Scanning the pages, she sees the linkages between the concepts of automaticity and depth of processing. She perceives the evolutionary connections between early Gestaltists and contemporary information processing theory. Reading on, she is particularly amused by the remembrances of a conversation with her mentor, Jerome Bruner--something to the effect that "the purpose of education was not to produce self-confident fools". Furthermore, her previous acquaintance with Robert Gagne´ allows her to clarify the notion of "associated learning outcomes". Meanwhile, one of the most conscientious students in this survey class on educational psychology, prepares as well. What kind of text does he encounter? They are both reading the same material but the professor draws upon a rich field of relations and connections, whereas the neophyte student encounters a barren, disjointed text with most concepts lacking personal meaning

and significant dilemmas going unperceived. What if there were a way to help the student actively experience some of the connections obvious to the professor? Suppose he could immediately go to the opening lines of Gagne's Conditions of Learning or he could access whole passages from Bruner's Toward a Theory of Instruction, or he could touch another line and immediately view videos of cognitivist lesson plans. Imagine that he could touch still another line and obtain contextual timelines, interpretations, research studies and critiques made since cognitivism emerged. He can also annotate the text by creating notes, explanations, analogies and even adding his own glossary. With HyperMedia, all this is possible.

What is HyperMedia and Why should Semiotic Educators Care?

HyperMedia, non-linear interlinked representation of textual, graphic, visual and audio material, enables students to connect large bodies of information while developing analytical skills necessary to think critically about this information. As documented by Locatis et. al (1990), the history of hypermedia extends back to 1945 when Vannevar Bush, President Roosevelt's science advisor, called for a mechanically linked information retrieval machine (memex) to manage the post-war information explosion. By the 1960s, Nelson had adapted Bush's hypertext ideas to literary applications. He designed and developed a computer system to link text electronically and nonsequentially in order to trace the evolution of ideas and provide royalty payments. About the same time, Englebart created a system called NLS that could organize and retrieve information as well as handle electronic mail and teleconferencing. One of Nelson's collaborators created the first educational application in the 1970s. Known as FRESS, it was an experimental poetry course consisting of a single poem with links providing more detailed information. This electronic course had windows for adding notes, making annotations and mediating student-teacher conferences. In the early 1980s, hypermedia authoring software was being created on large computers (e.g., KMS Notecards, IBIS and Intermedia) and by the end of

the decade, micro-computer based authoring tools were appearing. The latest evolution of hypermedia makes it relatively easy for nontechnical authors to create linked bodies of materials that include text, static graphics, animated graphics, still and motion video, sound, and music.

Electronic hypermedia makes access to referenced material direct and immediate. The entire field of interconnections can be obvious and easy to navigate. From a user's perspective, hypermedia programs are knowledge bases in which every display is a navigational menu to other databases. Unlike paper-based texts, hypermedia facilitates relations and connections. This capacity changes the way texts exist and the way we experience them. It also changes the role of the author and reader, teacher and student, expert and novice.

Hypermedia usually refers to three forms: hypertext, hypermedia, and hypervisuals. While the concept of hypertext originated in 1945, today the more holistic notion of Hypermedia is conceptualized as an electronic approach to information management. Data is stored in networks of nodes connected by links. Nodes can contain text, graphics, audio, video, source code, and other data. Access to sound and visual data is often provided by peripheral storage devices (e.g., compact disc and videodisc). This multi-sensory data can be viewed via an interactive browser and manipulated through a structure editor. Browsers retrieve information within nodes, while structure editors allow altering node content and links (Smith & Weiss, 1988). Increasingly, browsers can be active participants in sophisticated hypermedia, evoking animations, adding their own notes, placing bookmarks in parts of the knowledge base they want to revisit. There are many consequences of this ideational networking, including the capacity for each learner to continually shift the focus of his investigation or to follow a particular association to its logical (or not so logical) conclusion.

Offering obvious potential to educators, it was not until very recently that the hardware and software could be easily accessed. While most hypermedia software still

uses large computers, microcomputer-based authoring tools are now emerging. Notable software include HyperCard and SuperCard for the Macintosh computer and Linkway, Hyperties, and Hyperpad for the IBM PCs and Guide as well as Plus for both machines. These tools enable hypermedia environments to be devised by teachers and subject area experts with relatively little programming experience.

The Purpose of this Paper and its Relation to Evaluation

While hypermedia suggests considerable possibilities for improving the quality of education, rampant speculation exists and many questions remain unanswered (Paivio, 1979; Salomon, 1979; Meringoff, 1980; Greenfield, 1984; Sinatra, 1986; Calvani, 1990). There are few guidelines for authoring hypermedia and those that do exist focus on hypertext (Kearsley, 1988; Locatis et. al., 1990, Landow, 1990). Furthermore, in spite of a plethora of emergent software, there is little systematic evidence concerning hypermedia's learning effects or the quality of instructional hypermedia. Nor do instructors find in-depth information about the effectiveness of specific facets of hypermedia courseware as it is actually used in purposeful instruction. For example, what is the impact of different symbolic systems (such as still versus motion images, written versus oral language) on the user/learner? What qualities should be used to judge both implicit and explicit links? Some other emerging questions concern:

- How can instruction incorporate diverse perspectives, so as not to be captured in a particular mindset (e.g., cognitive versus behavioral)?
- Much existing instruction limits genuine student generated questions and choices so how can this be accommodated in hypermedia?
- The power of active versus passive learning approaches has been well documented but how can hypermedia address this optimally?
- Typically, novice students have a shallow information base and what exists is not linked meaningfully. How can this preference for reductive thinking in learners be counteracted?
- What can be done to help learners access and actually make full use of diverse data sources such as introductory comments, footnotes, learner guides, glossaries, and other aides supplied expressly for them? More importantly, how can strategies for relating information in meaningful ways be transferred to students who lack these skills?

- How to address dualities of evaluating learning content such as: quantitative versus qualitative perspectives, description versus judgment, focus versus power, independence versus cooperation, proactive versus reactive, and self-initiated by the learner versus externally imposed.

The time has come to move beyond reiterations of general descriptions of applications and search for a deeper understanding of the multi-dimensional factors, tacit and overt, underlying instructional hypermedia. Several authors (e.g., Bednar et.al, in press; Cunningham, 1986; Driscoll, 1984; Driscoll & Flynn, 1989; Neuman, 1990; Tucker & Dempsey, 1990) have suggested the appropriateness of using constructivist, semiotic and naturalistic alternatives to the traditional empirical paradigm for conducting research and evaluation with interactive media. To date, semiotic investigations have focused on describing contexts of implementation rather than instructional dimensions of the media. This paper will focus on explicating a semiotic checklist to evaluate instructional hypermedia using the most popular and pervasive application, HyperCard (Atkinson, 1987). The overall assumption being that the application of semiotic criteria will yield agonistic data necessary to develop improved hypermedia design.

The Relationship of Instruction, Hypermedia and Semiotics

Literature is beginning to appear about hypermedia's educational significance (Calvani, 1990; Carr, 1988; Dougherty, 1990; Hooper, 1988; Jonassen, 1986; Marchionini, 1988; Landow, 1989). These claims are based on the notion that interlinked content in a hypermedia knowledge base is analogous to the semantic nets humans use to associate information in memory (Conklin, 1987; Jonassen, 1988). Jonassen contends that "because hypertext is a node-link system based on semantic structures, it can map fairly directly the structure of knowledge it is representing" (p. 14). Conklin further posits that hypermedia increases an author's cognitive load and infers that linking does not guarantee learning. Rather, the intrinsic qualities of hypermedia and its authoring software may make the technology more appropriate for teaching certain learners and certain skills. Shneiderman and Kearsley (1989) contend that hypermedia works best when users can

back up a node at a time, review paths and immediately reaccess any previous node; search for information with key words or indices; access central points from anywhere in the knowledge base; use maps and tables of contents to see overall structure; and get fish-eye views of neighboring nodes. Importantly, Landow (1989) challenges instructional hypertext and hypermedia designers and evaluators with ten rules which the present authors contend are critical for inclusion in any holistic data collection plan, semiotic checklists included. Reigeluth (1990) adds a final corollary:

> "We know relatively little about the kinds of relations that are most important in a sequence to maximize such goals as building stable cognitive structures, facilitating creative thought and allowing for maximal appropriate learner control. New approaches to sequencing will be particularly important for generic skills, understanding, and affective learning." (p. 7)

Semiotic writers in the vein of Derrida and Ong perceive both advantages and disadvantages about hypermedia. First, material is instantly centered and recentered in hypermedia in the sense that the user can make his or her own interests the organizing principle or center for learning. This capacity addresses Derrida's (1972) value of shifting perspective by decentering discussion. Hypermedia also fulfills Ong's (1982) notion of secondary orality by offering participatory mystique, communal sensitivity, present orientation, formula inclusion, and optimized analysis by its instantaneous nature. Even so, such freedom, which derives from hypermedia's fundamental lack of sequentiality, can disorient the user to the user to the point of being "lost in hyperspace" and lose the self-contained qualities of text.

Other semioticians such as Morgan (1985) suggest that intertextuality (and we raise the possibility of intratextuality as well) shifts attention from the triad constituted by **author-work-tradition** to another constituted by **text-discourse-culture**. In doing so, "intertextuality replaces the evolutionary model of literary history with a structural or synchronic model of literature as a sign system. The most salient effect of this strategic change is to free the literary text from psychological, sociological and historical

determinisms, opening it up to an apparently infinite play of relationships" (p1-2). In sum, Morgan captures a major implication of hypermedia's intertextuality: "the text opens up, freeing one to create and perceive interconnections" (Landow, 1989, p. 184).

Five Semiotic Criteria for Evaluating Instructional Hypermedia

This section presents semiotic criteria synthesized from the aforementioned relations. To be effective, a semiotic evaluation must be approached dualistically form the perspective of the learner and the teacher, the designer and the consumer, the novice and the expert. Given hypermedia's synthetic nature, it increasingly appears plausible that the evaluation model used must be equally synthetic. Traditional empirical models do not seem to accurately describe the instructional application of hypermedia's integral values (e.g., of having relative versus linear branching, multi-sensory versus verbal realities, variable control of sequencing and and content to suit the user level, flexible versus high structure, and accommodating both novices and experts). Thus, evaluation and its attendant data collection procedures should be holistic rather than distort the situation being evaluated with reductionistic interpretations. We are advocating the inclusion of a semiotically-based set of criteria wherein all syntheses are repeatedly open to dualistic perceptions. By recognizing that one's perceptions confirm, continue, enlarge and eventually correct one another, it is possible for the evaluator to synthetically enter into the perceptual systems of the those using the instructional hypermedia. Specifically, the incorporation of five semiotic values are seen as crucial for evaluating instructional hypermedia:

1. intertextuality/intermediality;
2. decentering and recentering;
3. mediating networking and navigating;
4. negotiating expert and novice boundaries;
5. boundaries of individual work

1. Intertextuality and Intermediality

Hypermedia has the capacity to emphasize intertextuality in a way that print based text cannot. In our field, professional journals offer an obvious example of *explict* intertextuality in nonelectronic form. The articles contained in these journals situate themselves within a field of relations, most of which the print medium keep out of sight and makes relatively difficult to follow because the references (or linked) materials are spatially distant from the original reference. Perhaps one of the attractions of professional conferences such as the one we are attending today is that it teases us with the hope of more *implicit* intertextuality by linking the text directly with the author and its reactors and its audience.

Consider the dimensions of a hypermedia screen world. Its reality establishes conventions about the appearance of objects and operations on them that are very different from traditional linear and behavioristically driven computer assisted instruction. Construction of understanding from diverse perspectives is encouraged. These perspectives are situated in real world contexts, which are believed to form links with knowledge embedded with it (Brown et.al, 1989; Resnick, 1987). For students to fully use hypermedia's multisensory dimensions, they will need to be able to understand non-linear linking processes and respond to the increasing speed possible. Multiple time dimensions are possible as well. Past and future can be captured very readily and easily linked to the present. In sum, the capacity of this tool will be greatly influenced by the degree of learner mindset about linearity, sequentiality and temporality.

Fundamental to hypermedia is its capacity to link content nonsequentially, allowing implicit and more natural forms of intertextuality to emerge. Building upon Reigeluth's (1990) notion of four major types of cognitive learning (i.e., memorizing information, understanding relations, applying skills and applying generic skills), it appears that hypermedia can incorporate all four. It also seems to be more effective as the instruction becomes more difficult, more affective, and richer relations are desired. Dede (1988)

warns that this richness can lead to "intellectual indigestion, loss of goal-directness and cognitive entropy" (p. 8). To date, what kind of information is "suitable" for hypermedia remains to be delineated but hopefully ongoing research and evaluation efforts will clarify this. Other intertextuality issues related to any evaluation paradigm of hypermedia include:

- what is the nature of the learner (prior knowledge, reflexive skills, expectations, motivation)?
- what is the instructional model used (e.g., eclectic or theory based)?
- what supports (e.g., focusing, hints and shaping) are provided for the user/learner ?
- what levels of information are included and what is the size and range of the knowledge base?
- how is information related (e.g., synchrony versus historical, diffuse versus focused, traditional work structures versus dynamic culture and discourse)?
- how is linear and nonlinear information linked?
- how is content granularity developed (e.g., how is relevant from irrelevant information filtered, chunking, degree of modularization)?
- how can hypermedia be structured to replicate content structures or knowledge structures?
- how is remediation versus enrichment information access provided?
- as instruction becomes richer, how does abstraction emerge (and is it backed by sufficient examples, practice, and alternative representations in different modalities)?

2. Decentering and Recentering

As stated earlier, information can be instantly centered and recentered in hypermedia in the sense that the user can make his or her own interests the center of learning rather than solely the author's vision of the courseware. Bodies of linked texts or multi-media that have no primary axis of organization, no center, can be infinitely decentered and recentered. In decentering, the process of shifting perspectives facilitates intellectual change (Derrida, 1972). But in order for a genuine shift to occur, the user must have a variety of good representations (in the form of nodes and networked nodes) to select as well as clear designations of how these representations are related. Good representations help make concepts clear and facilitate mapping to analogous subject matter. For example, the provision of alternative representations lets the learner move back and forth at will between two stacks with the same conceptual framework, in essence carrying out parallel searches.

The power of representations is influenced by both the learner and the designer. To be sure, the capacity to explore hypermedia environments is influenced by both the learner's and designer's understanding of the conceptual structure of the material being presented. Both need to be sensitive to the conventions used to connote at least three types of representations. Representations can be: 1) **hierarchical** where links between nodes center information according to a sequence of prerequisite information; 2) **relational** where epitomes and "bare bones" of subject matter are presented and the learner can freely associate between ideas, accessing elaborative details as required; and 3) **dialectical** in the sense that a Socratic style conversation, particularly guiding questions, between the user and the courseware is possible.

To access alternative representations or nodes, the relationships between nodes must be perceived by the user. This can be at an overt as well as a tacit level. The hypermedia software imposes a schema for knowledge representation to a certain extent. This is typically hierarchical in which a node at one level can access only nodes directly below or above it. Though it simplifies information access, hierarchical representation requires anticipating branch points before authoring and sometimes this is inappropriate for learning (Conklin, 1987). Other software like HyperCard generates relational and "referential links", allowing any node to be linked to another.

In summary, decentering and recentering appear to be valuable criteria for hypermedia evaluation. Specific questions which can guide evaluative studies include:

- how does the instructional model impose organization?
- how does the software impose organization: hierarchically and referentially?
- how are learner and teacher contexts defined and managed over time?
- what kind of representations are included in the courseware: hierarchical, relational and/or dialectical?
- what are the possibilities revealed by alternative sign systems?
- what objects are used in representations? how realistically are situations portrayed?
- what is the understanding of the conceptual structure of the information by learner and designer?
- what is the impact of different sequences of decentering and recentering?
- how do users assess different representations?
- how is decentering skill related to explicit organization and individual knowledge structures?

3. Navigating Networks: achieving cognitive search space

The process of making meaning from the myriad of information available on hypermedia courseware can take a variety of paths. The learning mode seems to be characterized by the degree of control the learner has in navigating through the situated relations (for example, free exploration versus drill and practice). In Calvani's (1990) relatively straightforward hyperCard stack, he developed the learner's exploration of meaning through the use of three buttons: first, opening a window with short contextual information; second, approaching or getting into an interior scene; and third, seeing a character's face and starting a dialog. The user is supported in her travel to meaning via accessing multiple levels of information to specialized documents, block notes where the learner can collect basic information from any window; and an online dictionary in which each text-base word is linked to an underlying dictionary which has been organized with different parts and specific internal sections and the possibility of a circular return to index field.

Hypermedia's capacity for virtually unlimited size and scope raise more questions than answers about cognition in general and cognitive search space in particular. How do learners perceive nodes as interacting? How do users form semantic networks or search the specific pathways and develop rules of interaction between local and global representations? How do nodes and network structures "compete" with one another? As Kreitzberg (1989) has queried, how much support should exist for "dynamic linking" (i.e., suppressing references to already viewed nodes and providing indexes, table of contents, or audit trails of user paths)? These are all very complex questions. These cognitive processes can be understood only within the context of meaning structures. Merleau-Ponty's (1962; 1963) phenomenological ideas concerning the dialectical relations between physical, vital, and human "orders" of behavior can help us develop a better framework for understanding such complexity.

For higher orders it is conceivable for the learner to move within a problem, even in violation of the designer's directions. This polemic of explict and implicit exploration seems to be a function of the content and how it is structured. Recent researchers have postulated that the presence of semantically constrained exploration facilitates hypothesis formation by cutting out meaningless or distracting options and making search space cognitively manageable (Hamburger & Lodgher, 1989). Similarly, making good hypotheses readily available should relieve the cognitive load on memory. Overall, it seems that while it is technically possible, we need to balance the amount of cognitive search space with learner attention capacity issues.

Navigating through hypermedia is not without its problems. Kerr (1986) noted "wayfinding" problems due to hypermedia's fragmented nature. The general consensus of the field to date is that the amount of navigational assistance needed is a function of: the size of the knowledge base, usefulness of navigational aides, and types of links allowed by the software. Locatis and his collaborators (1990) have summarized six ways to facilitate hypermedia navigation.

In summary, we need to go beyond semantics and question the semiotics of meaning on several levels:

- how is exploration conceived by the developers? what charting procedures exist?
- how do learners use their increasing power over the sequencing of material to gain meaning?
- to what extent are hypermedia users (and developers) bound by acculturation to book technology?
- when and how are links denoted meaningfully (at the start of a node or within it)? Of a related nature, should specific parts of the screen be reserved for links? When should links be imposed and when should they be learner defined?
- how many nodes can be displayed at one time without being confusing?
- how do learners avoid getting lost in "hyperspace"? how much support exists for "dynamic" linking? (e.g., mapping and audit trails)
- how can designers accommodate to both self-learners and those needing more external structure?
- when is it effective to insert critical questions, navigational guidance or hints to users?
- how can higher order thinking like hypothesis formation be prompted?
- how can various imagery and sounds/intonations be used to access emotions?
- when do sound and visual realities need to be separated for user load given different symbolic systems being used?

4. Boundaries between Experts and Novices

With hypermedia, the potential boundaries between author and learner, expert and novice can disappear when both have the same set of integrating tools that allow them to browse and add annotations and create original links. Linking does not guarantee learning but common wisdom asserts that more meaningful linking is done by experts (and presumably by developers). This brings up the issue of what methods should be used to structure hypermedia. To be sensitive to the power of hypermedia, developers must account for the differences in expert and novice knowledge representations (Alexander & Judy, 1988; Gagne´ & Glaser, 1987). In addition, developers must transcend mindsets about inductive and deductive methods (e.g., Jonassen, 1988) and include abductive approaches as well.

Novices tend to use more heuristic linking that moves away from quantitative detail. Most instructional hypermedia moves learners to more complex and less familiar systems, but attempts to maintain the functional comfort of the initial task. Some information domains may lend themselves to heuristics when there is relative freedom of ordering a move sequence and when there is a high degree of information independence. And heuristics many have benefits beyond the initial acquisition period in the case of building problem-solving skills (Landow, 1989). It is speculated that experts are probably more tolerant of arbitrary or abstract linkages. Little systematic research has been conducted regarding how the transition between novice and expert is facilitated in hypermedia. Furthermore, Resnick and Omanson (1987) caution that strong semantic understanding does not guarantee the ability to apply what is learned to realistic situations. Given the "real world" representations possible in hypermedia, it seems promising to explore the effectiveness of creating a series of transitional realities which push learners to test both their semantic understanding and their ability to use this understanding in "real world" contexts.

We support Spiro's (1988) argument that the complexity of the learning environment should be maintained and assistance given to students to understand the concept(s) buried in the multiple complex environments in which they are found in ordet to remain authenic. Simplicity deludes transfer. Instead, coach toward expert performance via modelling strategies such as cognitive apprenticeship (Collins, Brown & Newman, 1989) and exposure to alternative representations discussed under decentering.

Hypermedia enables users to construct their own knowledge representations *and* refine them over time. Yankelovich's (1985;1988) research has suggested that when they contribute to the learning system, student users accept more responsibility for material anyone can read. Other payoffs include self-initiated communities of learners. Learning to make connections through modelling and transfer seems to be very limited at first, but then emerges almost infinitely.

By way of summary, the emerging evaluation questions include:

- what methods for information retrieval are available?
- what methods are used for structuring hypermedia: deductive, inductive &/or abductive?
- what methods of browsing are available (e.g., single word/phrase search, Boolean logic, alphabetical index of node names, graphic maps of node relations)?
- how well does planning match execution of novice and expert access strategies?
- how representative are learning levels of development team? Additionally, to what degree are they captured in a prescriptive mindset?
- how effective is transition from novice to expert stages (i.e., when to use advisors such as online and offline instructional aides, use of adjunct and guiding questions, heuristics, modelling--and combinations thereof)?
- how smoothly can the learner move between two representations?
- to what degree are metacognitive or self-learning skills overtly taught?
- to what extent is heuristic guidance content specific in hypermedia contexts? when should information be suppressed?
- what are the motivational effects of learner control as they transition through the hypermedia environment?
- when is it beneficial for the learner to discover various paths on their own rather than via the minimal path?

5. boundaries of individual work

The links within and without an individual production become equivalent, bringing material closer and blurring boundaries. In essence, we can achieve intertextuality, intratextuality and extratextuality simultaneously. Hypermedia can speed up the process of

making connections between written ideas by providing the means of visualizing and hearing such transactions. According to Walter Ong (1982), computers have ushered in the age of secondary orality with its concomitant qualities of participatory mystic, fostering communal sensitivity, and concentrating on the present.

One major effect of nonsequential reading is to weaken the boundaries of the text, an effect that can be thought of as either correcting the artificial isolation of the texts from its contexts or as violating one of the chief qualities of the book (Landow, 1989) "Print .. situates utterance and thought on a surface disengaged from everything else, but it also goes further in suggesting self-containment (Ong, 1982, p. 132). Ong also points out that books, unlike their authors, cannot really be challenged. Hypermedia allows nonsequential reading and thinking, thereby weakening the boundaries of unquestioned text and replacing isolated thought on a written surface with integration and multidimensional challenges.

If hypermedia situates texts in a field of other texts, can any individual work that has been addressed by another still speak so forcefully? Landow (1989) raises the dilemma of facilitated dialog versus disembodiment. Other questions that emerge include:

- to what extent do metaphors emerge that help us conceptualize this complexity?
- to what extent are designers of hypermedia tacitly influenced by a print-based mentality?
- how does hypermedia influence an author's cognitive load (e.g., capacity to make decisions about links, content and transitions)?
- when does the author and the user perceive the significance of the link?
- how should links be denoted that have the same referent given hypermedia's capacity to indicate the relational strength of each node?
- what grammar can be established that portrays information non-linearly?

Conclusion

Hypermedia promises to help students meaningfully related or link large bodes of information while developing the analytical skills necessary to think reflexively about this information. With the increasing ease of access for users and ease of development for even non-programming designers comes many questions. To date there has been little systematic evidence concerning hypermedia's unique instructional dimensions. It is obvious that existing objectives-based evaluation models are insufficient to capture the

dynamic qualities of hypermedia and its attendant learning processes. This paper represents an initial effort to synthesize a more holistic approach to evaluating hypermedia which includes five semiotic considerations (Table 1). We are currently in the process of testing the viability of these criteria as part of a three year grant from Apple Computer to train teachers in developing instruction using hyperCard.

(insert Table 1 about here)

Table 1. Semiotic Criteria for Evaluating Instructional Hypermedia

1. Intertextuality and Intermediality

- what is the nature of the learner (prior knowledge, reflexive skills, expectations, motivation)?
- what is the instructional model used (e.g., eclectic or theory based)?
- what supports (e.g., focusing, hints and shaping) are provided for the user/learner ?
- what levels of information are included and what is the size and range of the knowledge base?
- how is information related (e.g., synchrony versus historical, diffuse versus focused, traditional work structures versus dynamic culture and discourse)?
- how is linear and nonlinear information linked?
- how is content granularity developed (e.g., how is relevant from irrelevant information filtered, chunking, degree of modularization)?
- how can hypermedia be structured to replicate content structures or knowledge structures?
- how is remediation versus enrichment information access provided?
- as instruction becomes richer, how does abstraction emerge (and is it backed by sufficient examples, practice, and alternative representations in different modalities)?

2. Decentering and Recentering

- how does the instructional model impose organization?
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3. Navigating Networks: Achieving Cognitive Search Space

- how is exploration conceived by the developers? what charting procedures exist?
- how do learners use their increasing power over the sequencing of material to gain meaning?
- to what extent are hypermedia users (and developers) bound by acculturation to book technology?
- when and how are links denoted meaningfully (at the start of a node or within it)? Of a related nature, should specific parts of the screen be reserved for links? When should links be imposed and when should they be learner defined?
- how many nodes can be displayed at one time without being confusing?
- how do learners avoid getting lost in "hyperspace"? how much support exists for "dynamic" linking? (e.g., mapping and audit trails)
- how can designers accommodate to both self-learners and those needing more external structure?
- when is it effective to insert critical questions, navigational guidance or hints to users?
- how can higher order thinking like hypothesis formation be prompted?
- how can various imagery and sounds/intonations be used to access emotions?
- when do sound and visual realities need to be separated for user load given different symbolic systems being used?

4. Boundaries between Experts and Novices

- what methods for information retrieval are available?
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- how representative are learning levels of development team? Additionally, to what degree are they captured in a mindset (e.g., prescriptive) ?
- how effective is transition from novice to expert stages (i.e., when to use advisors such as online and offline instructional aides, use of adjunct and guiding questions, heuristics, modelling--and combinations thereof)?
- how smoothly can the learner move between two representations?
- to what degree are metacognitive or self-learning skills overtly taught?
- to what extent is heuristic guidance content specific in hypermedia contexts? when should information be suppressed?
- what are the motivational effects of learner control as they transition through the hypermedia environment?
- when is it beneficial for the learner to discover various paths on their own rather than via the minimal path?

5. Boundaries of Individual Work

- to what extent do metaphors emerge that help us conceptualize this complexity?
- to what extent are designers of hypermedia tacitly influenced by a print-based mentality?
- how does hypermedia influence an author's cognitive load (e.g., capacity to make decisions about links, content and transitions)?
- when does the author and the user perceive the significance of the link?
- how should links be denoted that have the same referent given hypermedia's capacity to indicate the relational strength of each node?
- what grammar can be established that portrays information non-linearly?

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