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ABSTRACT

Many writers suggest the use of metaphors in creating hypermedia and multimedia products. However, it is unclear how to choose an appropriate metaphor and how to avoid an inappropriate metaphor that will cause confusion and conceptual difficulties for users. A metaphor compares one thing to another without directly stating the comparison, suggesting the likeness of terms not literally applicable to each other. Visual metaphors of pictures and illustrations are found in hypermedia and multimedia products. They can be seen as underlying (primary) metaphors and auxiliary (secondary) metaphors. The work of A. Paivio can be used to identify appropriate auxiliary metaphors that stimulate images and semantic expressions related to those stimulated by the underlying metaphors. An example of the book as metaphor illustrates the "properties, operations, phrases, images, and types" (POPIT) approach to the metaphor and the selection of auxiliary metaphors. A map provides another such example, with rich auxiliary metaphors possible. Selecting appropriate metaphors is complex and difficult and requires study of how users react. (Contains 32 references.) (SLD)

Title:

Designing Hypermedia is Hell: Metaphor's Role in Instructional Design

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Many writers suggest that one should employ metaphors in creating hypermedia/ multimedia products. For example, Erickson (1990) suggested that "metaphors function as natural models, allowing us to take our knowledge of familiar, concrete objects and experiences and use it to give structure to more abstract concepts" (p. 66). Rosendahl-Kreitman (1990) suggested that "metaphors, if they are appropriate, are quickly understood" and thus help to reduce the extent to which users need to learn to use the system completely from scratch (p. 1.7). Erickson (1990, p. 72) accounted for this "reduced learning curve" by suggesting that a metaphor, once adopted, brings with it "additional bits of structure that may be useful later on," a suggestion that finds support in the work of Allinson and Hammond (1989), Mitsch and Dubberly (1990) and Thimbleby (1984). Despite these proposed benefits, Semper (1990), Rosendahl-Kreitman (1990), and Vertelney, Arent, and Lieberman (1990), among others, have warned that inappropriate metaphors can cause confusion, misunderstanding, and both navigational and conceptual difficulties for users.

What is unclear, however, is how one can identify an "appropriate" metaphor. What are the key properties of a metaphor and how exactly does one operate? What makes one metaphor more appropriate than another? Is more than one metaphor appropriate for a given product? Can we use multiple metaphors in a product? If so, how do we determine if they interact in ways that contribute to the effectiveness of the product? This paper seeks to address these questions. It begins by examining what a metaphor is and how it operates. Next, it divides metaphors into two classifications and offers an approach for analyzing and selecting metaphors. Several metaphors are then analyzed and methods for evaluating the effectiveness of the selected metaphors proposed. The paper closes by considering whether employing metaphors is worth the effort.

WHAT A METAPHOR IS AND HOW IT OPERATES

Lakoff and Johnson (1980) defined the essence of metaphor as "understanding and experiencing one kind of thing in terms of another" (p. 5). A metaphor compares one thing to another without directly stating the comparison and "the likeness is suggested by terms not literally applicable to each other" (Walsh & Walsh, 1972, p. 165). Mac Cormac (1985) described metaphor in terms of mental processes. He suggested that metaphor is "the creative cognitive process of activating widely separated areas of long-term memory and of combining normally unassociated concepts" (p.147).

How exactly does the process of comparison occur? What brings together Mac Cormac's "widely separated areas" and "normally unassociated concepts"? Mac Cormac argued that "these concepts are juxtaposed in a meaningful manner because at least some of the semantic features of each concept are similar to one another" (p. 147). Mountford (1990) agreed, suggesting that metaphors, through comparison, convey "both superficial and deep similarities between familiar and novel situations" (p. 25). The interaction of similarities and differences, therefore, is the key to the effectiveness of a metaphor.

This seems closely allied with Black's (1979) division of the metaphor into two components, the primary subject and the secondary subject. Black argued that metaphors work by projecting upon the primary subject 'associated implications' drawn from the characteristics and uses of the secondary subject. According to Searle (1979), once we identify something as a metaphor, we examine the secondary subject to identify its properties or values and then look for applicability to the primary subject. The impact of a metaphor arises from the interplay of these components (Kittay, 1987). Kittay suggested

further that there is tension between the two components of a metaphor because Black's `associated implications' may or may not seem appropriate to the primary subject.

This tension seems the foundation of Miller's (1979) three-step process in understanding metaphor: recognition, reconstruction, and interpretation. In the recognition step, we perceive the metaphor to be a statement of relation or comparison and not a statement of fact. In reconstruction, we start to rebuild the primary subject in terms of the properties of the secondary subject and to interpret how the reconstructed primary has changed in terms of properties and operations. According to Miller, we cannot separate reconstruction and interpretation because many possible reconstructions exist, some of which fit the context and the user's intent and some do not. Interpretation and reconstruction interact to help us identify and discard inappropriate reconstructions and retain and refine reconstructions that seem suited to the context but still have non-applicable properties. Thus, as Searle (1979) argued, we limit the number of applicable properties to those which we judge most appropriate. Lakoff and Johnson (1980) and Mountford (1990), among others, stressed the importance of this recursive refinement process and suggested that this interactive process plays a major role in reshaping an individual's understanding of the metaphor.

Kittay (1987) categorized properties of the secondary subject as having either affinity or contrast. Properties of the secondary subject that are appropriate to intent and context display affinity, while properties that do not appear to match intent and context display contrast. A property of the secondary subject that exhibits contrast is not automatically excluded, however. Instead, such contrast leads the individual to change his or her "frame of mind"; that is, to modify expectations and interpretations as part of the recursive refinement process. According to Kittay, multiple contrast sets exist and each provides a set of contrasting properties to consider. One might view these contrast sets as a semantic field of interconnected and associated words and concepts. This description of how a metaphor operates seems evocative of Erickson's (1990) definition of a metaphor as "an invisible web of terms and associations that underlies the way we speak and think about a concept" (p. 66).

Paivio (1971) considered metaphor in light of what he termed referential meaning and associative meaning. Referential meaning describes a relation between an image and a verbal label. In this relation, the verbal label and the image evoke one another clearly. They are matched exactly, one to the other. Associative meaning alludes to groupings of associations involving words, images, or both (pp. 84-85). According to Paivio, the semantic system and the imaginal system operate both separately and cooperatively. As the properties of primary and secondary subjects are considered in the recursive refinement process, spread of activation occurs in both systems. Both he and Kosslyn (1983) argued that much of our cognitive "knowledge' is actually dual coded. It exists in related forms in both the semantic and imaginal systems. Metaphor, according to Paivio (1979), may be a particularly effective way of stimulating interaction between the semantic and imaginal systems. Paivio (1986) used the term referential processing to refer to the stimulation of one system by a stimulus in the other system. Associative processing, on the other hand, is the process by which a stimulus subsequently stimulates other items within the same system. The two processes constitute the spread of activation within and across the two systems. These interconnections between systems "are not assumed to be one-to-one but, rather one-to-many, in both directions" (Paivio, 1979, p. 63).

Images may be more easily modified in the refinement process than are semantic items (Ambron, 1990; Bugelski, 1971). That is, the spread of activation within and across systems may enable one image to evoke another in a constantly changing pattern of

relations and comparisons. de Bono (1967) labeled this property of imaginal modification "fluidity and plasticity" (p. 83) and suggested that one could modify images and their related properties more quickly than one could make similar modifications in verbal labels or expressions. According to Gibbs (1992), our mental schemata reflect metaphorical structures based on common cultural and linguistic experiences. We recognize, without formal thought, that a particular metaphor reflects these metaphorical structures, and our unconscious recognition stimulates us to focus on related associations within those structures.

THE RELATIONSHIP BETWEEN METAPHOR AND GRAPHICAL USER INTERFACE

If, as authors cited above have contended, a metaphor helps users -- particularly novice users -- understand how a hypermedia/multimedia product works, then how is the metaphor implemented? It is clear how writers of books and speakers employ metaphors. They can write, "He was a bear of a man," or state that "politicians are vultures feeding on lost herds of inattentive voters." Although computer programs are not necessarily written or spoken expressions, they are capable of using metaphors in the content they deliver. Hypermedia/multimedia's more likely use of metaphor, however, is as visual metaphor. The vehicle by which they convey visual metaphors is most frequently the interface. Today's interfaces are often graphical. That is, they employ pictures and illustrations that make the screen and interface appear to be something other than a blank screen on which text or illustrations appear. Graphical user interfaces (GUIs) often employ icons (little graphical images or pictures) to represents options and actions. They also often employ a general screen appearance that may resemble something other than a computer screen. These visual metaphors, then, represent the use of metaphor in hypermedia/multimedia products.

TWO CLASSES OF METAPHORS

For purposes of discussion, let us divide metaphors used in hypermedia/multimedia products into two classes: underlying (or primary) metaphors and auxiliary (or secondary) metaphors. An underlying metaphor is the principal or first metaphor employed, while an auxiliary metaphor is a subsequent metaphor employed by the product. Some hypermedia/multimedia products may employ only underlying metaphors, while other may employ one or more auxiliary metaphors in addition to an underlying metaphor. The trick, it would seem, is to select auxiliary metaphors that are consonant with the underlying metaphor. In the words of Kittay (1987), we need to look for auxiliary metaphors that exhibit a fairly high measure of affinity and do not exhibit excessively contrasting properties. How is this determined, however?

If we use Paivio's work as a basis, we may look for a combination of associative and referential processing. That is, we could look for auxiliary metaphors that stimulate images and semantic expressions related to those stimulated by the underlying metaphors they are intended to accompany. One may think of the underlying metaphor as establishing the general context into which the auxiliary metaphor must fit. Properties, operations, phrases, images, and types associated with the underlying metaphor may provide the imaginal and semantic links to related metaphors that might serve as auxiliary metaphors. Thus, one might begin by selecting an underlying metaphor and then begin systematically to identify related properties, operations, phrases, images, and types (POPIT). Once these were identified, in addition to helping to determine the key features and functions of the graphical user interface (GUI) based on that underlying visual metaphor, they might also

suggest promising auxiliary metaphors.

APPLYING THE POPIT APPROACH

What does this approach offer us? Let's examine two frequently used underlying metaphors. Applying the process and generating ideas in each of the five areas is not necessarily a linear process. An idea generated in one of the five areas may stimulate ideas in other areas. This tendency to `hop around mentally' is typical of brainstorming activities (Osborn, 1963) and perhaps offers some empirical evidence of Paivio's earlier discussed theses on the spread of activation.

The Book

Many hypermedia programs employ the book metaphor. That is, one thinks of the product as a book and each screen becomes a page. The GUI might well, therefore, portray the screen as a book, perhaps with binding on one side and pages of text on the other or with a page of text on the left side of the screen and a page of text on the right side and the binding down the middle of the screen . In fact, the book metaphor is the one employed by Asymetrix's ToolBookTM hypermedia/multimedia authoring tool to help authors understand how to build a product. Similarly, the graphics needed to implement the book metaphor are supplied by Apple with their authoring tool, HyperCardTM, although Apple actually uses index card (underlying) and stack of cards (auxiliary) metaphors in the accompanying literature.

First, let's consider the properties of a book. A book has a front and back cover. It is bound. It is printed on paper. A book has pages. Pages may contain text, illustrations, photographs, or a combination of the three. Pages are numbered. Pages may be organized into chapters. The table of contents comes after the title page but before the main body o text. The index comes after the main body of text. A book has an author or authors. It may have an illustrator. Books have publishers. Books are sometimes published in later editions.

Second, what operations does one perform in using a book? One picks up a book. We may take it from a bookcase or shelf and we may return it to that shelf or bookcase when finished. One opens a book. We may scan a page or we may read it. If there are illustrations or photographs, we may examine those. We can reread difficult passages. One turns pages forward and backwards. One may use a table of contents to determine what is to follow and an index to help locate references to any particular phrase, term, or name. One can look ahead in a book or look back to re-examine something read earlier. One can stop reading whenever one wishes. One can mark one's place with a bookmark. The text in a book may be read silently or aloud. If one owns the book, one can mark in it. One can copy material from a book, either by hand or using a copy machine. Some people moisten their fingertips before turning a page.

Third, let's note that phrases (or terms) associated with books and reading include: binding, pagination, tome, read aloud, read silently, turn pages, mark your place, open, close, begin reading, thumb through or page ahead, quit reading, fold the corner of the page down, underline, highlight, write marginal notes, margins, and read with your finger.

Fourth: Images associated with books include favorable ones like leather bound books, illustrations, onion skin paper, and the smell of new paper in new books; unfavorable ones

like dog-eared or smudged pages, the smell of mildew or mold in old books, and trails from hungry silverfish; and neutral ones like hard covers, soft covers, hefty books and paperback pocket books.

Lastly, let's identify types of books. Reference works include dictionaries, encyclopedias, atlases, thesauruses, almanacs, and the like. Recreational books include the paperback pocket book, the mystery, science fiction books, fiction and non-fiction books, comic books, magazines, and others. Scholarly books include textbooks, the Bible, Torah, Koran, law books, and other similar works.

How do these five areas affect how we implement the book as the underlying metaphor? The book metaphor carries with it organization and sequence and a variety of implied assumptions about how one uses a book, and thus, any product `like a book.' As suggested earlier, we would expect the product to use pages and we would expect to be able to "turn" pages -- that is, to move forward or backward by pages. We might well expect pages to be numbered and organized into chapters. We might expect to see a table of contents and to be able to use an index to locate particular material. Since books contain primarily words, illustrations, and photographs, we would expect to see these in a product using a book as the visual metaphor for its GUI. We might well expect to open and close the book. We would hope to be able to stop whenever we wished and to use a bookmark to mark our place. Many readers might like to be able to mark in their books. If so, the product would need to permit underlining or highlighting. If it wished to allow the user to write marginal notes, logically, it must first have margins. To avoid a "smudged" look, any underlining, highlighting, or marginal notes would need to appear in a fashion that did not reduce the readability of the page. If the product were to echo associated phrases, perhaps the last page one read before stopping would have its page corner "folded down" until one started reading again, at which time the page corner would "unfold," thus avoiding the problem of dog-eared pages. Similarly, might the product permit thumbing through or paging ahead?

What auxiliary metaphors might accompany the book metaphor? One auxiliary metaphor might be the tab. Some books -- usually reference works (taking our cue from types) -- have tabbed sections. These tabs permit the user to move quickly to important or frequently used sections of the book. In many books, tabs are cut into the pages and are rounded to accommodate the tip of the human finger. Other times, the tabs project beyond the edge of the page so that they act as dividers separating the sections of a book. A product using the tab metaphor would be expected to present the user with similar appearances and properties.

This suggests a second auxiliary metaphor (this one derived from phrases): the finger/thumb metaphor. Perhaps the product could employ images of a finger in some way as a pointer, a place marker, or an indicator. Perhaps the product could use the image of a thumb in some way to indicate the ability to thumb through or thumb ahead. The auxiliary metaphor here is one of making the interface in some way parallel the use of fingers and thumbs in reading.

A third auxiliary metaphor, this time based on operations, might be the copy machine. Might the product in some way facilitate copying, using images that mirror the way books are actually copied? Could the operation resemble the process by which one uses a copier, including such features as variable number of copies, enlargement and reduction copying, collated copies, and two-sided copying for bound copies? Would the book be opened faced down on top of the copier? Would copies come out one side of the copier?

The identified types of books offer another suggestion. Perhaps a fourth auxiliary metaphor might be the overlay metaphor. In encyclopedias one may find a set of transparent overlays bound into the book. These overlays enable the reader to "build" an image out of several layers or to "uncover" lower or internal levels by removing layers. The most frequently encountered example of such a constructed image is probably the `visible' human body: One layer shows the skeleton; one shows the internal organs; and one shows the skin. We would expect the layers to "flip" in the direction of the binding. In most cases, for books written in English, we would expect to uncover by lifting from right to left and to build by placing transparent overlay pages from the left on top of similar pages on the right. If the binding were at the top, we would expect to build by lowering overlays from the top and to uncover by lifting pages from the bottom. A product employing the overlay metaphor would be expected to have some pages that permitted the user to build and uncover images in keeping with this metaphor.

A fifth auxiliary metaphor -- also drawn from types -- might be the pronunciation key. Dictionaries and similar reference books often include a printed pronunciation key. This is a set of letters and phonetic representations that are intended to help the user figure out how to pronounce a word properly. A product implementing this auxiliary metaphor might provide the user with the ability to hear the word pronounced. This is clearly the first auxiliary metaphor that goes beyond the normal capabilities of the object or device to which the GUI is being compared. Books do not normally speak to their readers. For the present, however, let's accept this implementation as valid. We will consider in the next section of this paper whether this is a legitimate addition or a violation of the underlying metaphor.

A sixth auxiliary metaphor based on operations is the shelf/bookcase metaphor. If a hypermedia/multimedia product is a book, then it can be part of a shelf of books, perhaps organized by topic, time period, or some other common trait. If related books reside on the same shelf, then perhaps a bookcase houses shelves of related volumes. Perhaps one could draw books from different shelves as needed. Perhaps, as is the case in research libraries, users could "read" the shelves for interesting books, confident that they are "in the right section" because related books are shelved together. Among other functions, this auxiliary metaphor might be used to help organize related products in the same line.

The Map

Another visual metaphor for a hypermedia/multimedia product's interface might be the map . Thus, using the map metaphor, the screen becomes a map of a place.

Properties of maps: Maps generally focus on contiguous areas or locations. Maps have legends that explain the symbols they use. They have locations that are spatially related to one another. Maps may represent various properties of the places they represent. Individual maps often fold. Maps are often hard to refold. Many maps fold out to be large. Maps are often complete on one side of the page. Some maps, particularly those in atlases or book form, will have notes at the edges of individual maps to inform the user of where that map connects with a related map. Maps often use very small print. Many maps use color to help users distinguish features and relations. Maps, particularly those that depict routes, usually provide an index of street or location names. Route maps often supply tables of distance or travel time as aids to users. Some maps include enlarged views (insets) of important areas, such as cities.

Map operations include unfolding and refolding, reading the legend, getting the map oriented in terms of what you're looking for, marking your route, and noting interesting locations along a route.

Phrases include getting one's bearings, figuring out which way is up, reading the map, finding the best route, plotting a course, getting the lay of the land, calculating distances or times, no one could refold this thing, men never use maps or stop to ask directions when lost, `x' marks the spot, you are here, and putting your finger right on it.

Among the images that come to mind are maps covering table tops; the difficulty of reading a map in a constricted space like a car, the difficulty of reading the small print; the difficulty of refolding a map without creating an awkward bundle; and the colorful and pleasing appearance of well produced maps.

Types of maps include topographical and geophysical maps, geosocial and geopolitical maps, directional or route maps, maps that depict demographics -- characteristics of the people who live in the places depicted -- and maps that describe properties of the region represented, such as economic maps. Maps may be presented individually or as a set (atlas).

What are the implications of our POPIT analysis? We would expect any hypermedia/multimedia product that used a map as its underlying metaphor to use the map to depict spatially related locations. It should include a legend to explain any symbols involved and should indicate which way is up (phrases). Color might serve to help define relationships. Products using the map metaphor might offer indexes to street or place names or tables of distance or time.

From operations: An accompanying auxiliary metaphor here might be the inset. A product that implemented the inset metaphor might be expected to include enlarged views on screen. Another option here, drawn from properties and images, might be to think about how users obtain enlargements when none is provided: the magnifying glass. Perhaps the magnifying glass metaphor could serve as an alternative auxiliary metaphor to the inset. The product would then make available to the user a magnifying glass that, when passed over the surface of the map, revealed greater detail. In a typical mouse- directed GUI, one might expect to see the traditional pointed arrow mouse pointer replaced by a magnifying glass. The images on the map would then become enlarged as the user moved the mouse and its correlated magnifying glass over the surface of the map on the screen. In the case of the magnifying glass, as in the case of the pronunciation key, we have shifted slightly from the original device (the inset). We have not changed the intention. What we have changed, however, is how that intention is accomplished.

From properties: Since individual maps fold and unfold, products could use the folded map auxiliary metaphor to make it possible to have access to many maps from the same screen. Maps could be unfolded and refolded. Noting the difficulty many people have in refolding maps and the sense of frustration that act can produce (see properties, phrases, and images above), the product could attempt to automate the process in a visually -- and perhaps auditorially -- satisfying way.

From types: A collection of products based on the map underlying metaphor might be clustered together using the auxiliary metaphor of atlas. Like the shelf/bookcase

metaphor, the atlas metaphor makes it possible to organize an entire line of products in a way that makes clear to the user their relationships to one another. Taking a cue from properties, these relationships might be clarified further by notations on the edges of maps stating which other maps connect to those edges.

EVALUATING METAPHORIC INTERACTION: COMPLEMENTARY OR CONFOUNDING

We have attempted above to derive a network of related or associated elements that help to define and describe an underlying metaphor. We have then used those elements to help us identify how we would expect a hypermedia/multimedia product employing that underlying metaphor to operate. In addition, we have examined a number of possible auxiliary metaphors one might use in a product based on a specific underlying metaphor. In Kittay's (1987) terms, we have attempted to use an analysis of these elements to help us identify implementations of the metaphors that exhibit high degrees of affinity and acceptable levels of contrast. Stated in simpler terms, our goal is to implement visual metaphors that operate in ways that are consonant with the experiences of our users in working with the object or device to which we are comparing our product's interface (our underlying metaphor). Thus, a product based on the book metaphor should (1) bear some visual resemblance to a book and (2) operate in ways very similar to (consonant with) how a `real' book operates. Similarly, auxiliary metaphors should complement -- add to, enhance, help make complete -- the underlying metaphor. When contrast occurs, it should be of a type that encourages users to reinterpret and reconstruct (Miller, 1979) their understanding how the interface operates. If users finds that the contrast is too great, however, one might expect them to reject the comparison. When this occurs, we may term the interaction between the underlying and auxiliary metaphors as confounding. The
interaction between underlying and auxiliary metaphors is, therefore, either complementary or confounding.

Since our earlier examples have all attempted to be complementary implementations, this seems a logical time to examine some implementations that seem confounding. Consider a product having as its underlying metaphor the book. An auxiliary metaphor of a videotape player seems clearly confounding. A book may not contain a videotape player. When users are faced with such an auxiliary metaphor they are required to reconstruct the environment radically, envisioning a book that is unlike any that the user has ever seen. Users seem unlikely to make such radical reconstructions. Instead, what they will probably do is to decide that some parts of the product act `something like a book' and others act like other things. When users come to this conclusion, the benefits of the underlying metaphor are greatly reduced. The dynamic tension inherent in the metaphor (Kittay, 1987) is removed; the user no longer feels compelled to interpret and reconstruct to make the metaphor fit.

Consider a product that employs an underlying metaphor of the map. While the earlier discussed auxiliary metaphor of folding seems complementary, an auxiliary metaphor of a toolbox seems confounding. We would not expect maps to contain toolboxes. No reconstruction that the user may perform can create a map capable of offering boxes of tools. Instead, the user will most likely decide that some parts of the interface operate `like a map' and other parts operate in some completely different way.

Earlier in this paper we considered two auxiliary metaphors that seemed perilously close to confounding. The first, the pronunciation key, offered users a chance to hear a word pronounced when they clicked on it. The second, the magnifying glass, offered users the chance to pass a magnifying glass over a portion of the screen in order to see an

enlargement of what appeared on the screen. Why are these two metaphors not confounding? Let's examine them.

It is worth noting that there are published books -- mostly for children -- that do offer the reader the chance to hear recorded sound played back. In fact, one can buy greeting cards that play tunes or messages and picture frames that, in the words of their marketers, "allow your loved ones to hear your recorded message each time they touch your picture." Thus, users may well be able to reconstruct their interpretation of the product as a book that -- like those children's books and the greeting cards -- is capable of allowing them to hear a recorded sound. Another reason that this metaphor may work is that readers using a printed pronunciation key in a book usually attempt to use that guide to pronounce the word aloud as they read it. Users may, therefore, be accustomed to hearing the pronunciation as they read the key. While the product's implementation changes the source of that aural stimulus, it does not seem excessively dissonant with users' own experiences (Brown, 1988).

It is also well within most users' experiences to use a magnifying glass to read printed materials that are small. In addition, when reading a map, one might well lay the magnifying glass down on the map outside the area one was currently examining and then lift it and pass it over any area one wished to see enlarged. Thus, although maps do not contain or offer magnifying glasses, the use of the one with the other can easily be reconciled, and the user can reconstruct the metaphorical comparison in consonant ways that enhance the interaction.

How then do we handle our need to include such functions as video segments and tools in hypermedia/multimedia products? One way would be to select as underlying metaphors ones that permit us to include a wider range of auxiliary metaphors. While a book cannot offer a videotape player, many settings could offer such a device. For example, it would not be unreasonable to find a videotape player in an entertainment center or production studio. It also would not be unusual to find books in such settings. By selecting a broader underlying metaphor, one can include more auxiliary metaphors. A second way to include needed functions might be to consider ways in which the subject of the underlying metaphor might offer similar functions. For example, an electronic journal might be handled in the form of marginal notes or notes written on a separate pad while reading. A third possible solution might be to think of the metaphor less in terms of places and things and more in terms of events or chains of events. That is, one could use a metaphor that involves a sequence of events, like traveling, where location and function change in predictable ways that invite the use of multiple auxiliary metaphors. Thus, in traveling, one might get tickets or make reservations, board the method of transportation (embark), travel on board -- with whatever events occur thereon, arrive at one's destination disembark), have experiences at the new location, re-board transportation, travel back, and disembark at the original location. Since the concept of traveling is predictable and yet varied, traveling may prove a useful underlying metaphor. Traveling on a plane offers its own set own events that differ from the events available on a cruise or in a car. It is not difficult to think of other similar sequential metaphors. One that come quickly to mind include chronology (particularly in terms of birth to death), production (perhaps from raw material to finished product), and construction (for instance, foundation to roof) or its inverse, demolition.

METAPHORS RECONSIDERED

By now, it should be clear why this paper's title compares the process of selecting appropriate metaphors to the damnation of the underworld. The process is neither

uncomplicated nor free of risk. It is difficult to decide how much or how little metaphor to use. While an interface devoid of metaphor may require more effort from its users because it does not permit them to use other, non-computer experiences to assist in understanding and predicting the actions of the interface, an interface encumbered with too many metaphors may overwhelm users, leaving them confused, irritated, and worse off than in a many chunks of information one can handle and Furukawa's (1970) research on cognitive load, designers may wish to choose one underlying metaphor and no more than five to eight auxiliary metaphors. The more closely these auxiliary metaphors are related to the underlying metaphor, the less additional cognitive load their presence should place on the user (Andre & Phye, 1986; Oren, 1990). That is, the less difficult it should be for the user to recognize how they relate to the underlying metaphor and to one another and the easier it should be for the user to incorporate them into a unified interpretation of the interface.

Not everyone supports the use of metaphor in hypermedia/multimedia products. For example, Nelson (1990) argued that dependence on the use of metaphors for all aspects of a multimedia system could kill a product. Extensive use of metaphor is undesirable, according to Nelson, because the relationship between the product and the object or device to which it is being compared is usually tenuous at best and, once a metaphor is implemented, everything has to become a part of it. He suggested instead that designers identify "well-thought-out unifying ideas, embodied in richer graphic expressions that are not chained to silly comparisons" (p. 237).

While anyone who has had the opportunity to observe a large enough sample of hypermedia/multimedia products can attest to the existence of numerous examples of just such misuse and overuse of metaphor, this fact may be more reflective of inadequate analysis of the metaphors employed and lack of attention to the relationship between underlying and auxiliary metaphors than of the weaknesses of metaphorical thinking itself. Nelson's argument that we should use `richer graphic expressions' seems reasonable, but those graphic expressions are themselves rooted in metaphorical thinking. Few things on a computer screen are what they appear to be, particularly in a GUI. As Langer (1958) noted, a label is not what it describes, nor, as Magritte pointed out, is a picture that which it represents. Recognizing this, an earlier work proposed a model for considering the properties of the graphics used as icons (Cates, 1993). It seems unlikely that we can -- or should -- avoid metaphors in hypermedia/multimedia products. As Lakoff and Johnson (1980) suggested, metaphorical thinking is so pervasive in our society that we cannot avoid it. If dual coding plays a major role in the operation of our cognitive processes (Paivio, 1986), users cannot easily separate the image from the related verbal label, nor can they isolate themselves from the associated spread of activation that occurs naturally when they are exposed to either verbal labels or images.

Laurel (1990) suggested that, "People transform their interfaces. Interfaces also transform their users" (p. 91). As designers, we face two choices: (1) We can ignore the spread of activation in the users of our products and pretend that interfaces are not affected by this spread of activation, or (2) We can do our very best to analyze metaphors, predict the likely types of activations, and consider the ways in which users interact with our interfaces. The latter choice seems the only reasonable one. Making this choice calls for a commitment, however. In order to produce the most effective interfaces, we will need to analyze our metaphors carefully before we decide to include them in our products and we will need to collect and analyze data on how users interact generally with our products and specifically with the metaphors those products contain.

REFERENCES

Allinson, L., & Hammond, N. (1989) A learning support environment: The hitch-hiker's guide. In R. McAleese(Ed.), Hypertext: Theory into practice (pp. 62-74). Norwood, NJ: Ablex.

Ambron, S. (1990). Multimedia composition: Is it similar to writing, painting, and composing music? In S. Ambronand K. Hooper (Eds.), Learning with interactive multimedia: Developing and using multimedia tools in education (pp. 70-84). Redmond, WA: Microsoft.

Andre, T., & Phye, G. (1986). Cognition, learning, and education. In G. Phye and T. Andre (Eds.), Cognitive classroom learning: Understanding, thinking, and problem solving (pp. 1-19). San Diego, CA: Academic.

Black, M. (1979). More about metaphor. In A. Ortony (Ed.), Metaphor and thought (pp. 19-43). Cambridge,England: Cambridge University Press.

Brown, C. (1988). Human-computer interface design. Norwood, NJ: Ablex.

Bugelski, B. R. (1971). The definition of the image. In S. J. Segal (Ed.), Imagery: Current cognitive approaches(pp. 49-68). New York: Academic.

Cates, W. M. (1993). Making the most of imagery: Theoretical issues in selecting metaphorical images. A paperpresented at the annual meeting of the American Educational Research Association, Atlanta, GA, April1993.

de Bono, E. (1967). The use of lateral thinking. London: Cape.

Erickson, T. (1990). Working with interface metaphors. In B. Laurel (Ed.), The art of human computer interface design (pp. 65-73). Reading, MA: Addison-Wesley.

Furukawa, J. (1970). Chunking method of determining size of step in programmed instruction. Journal of Educational Psychology, 61, 247-254.

Gibbs, R., Jr. (1992). Categorization and metaphor understanding. Psychological Reviews, 99, 572-577.

Kittay, E. F. (1987). Metaphor: Its cognitive force and linguistic structure. Oxford: Clarendon.

Kosslyn, S. (1983). Ghosts in the mind's machine: Creating and using images in the brain. New York: Norton.

Lakoff, G., & Johnson, M. (1980). Metaphors we live by. Chicago: University of Chicago Press.

Langer, S. (1958). Language and creative thought. In C. M. Babcock (Ed.), Ideas in process. New York: Harper and Brothers.

Laurel, B. (1990). Users and contexts: Introduction. In B. Laurel (Ed.), The art of human computer interface design (pp. 91-93). Reading, MA: Addison-Wesley.

Mac Cormac, E. (1985). A cognitive theory of metaphor. Cambridge, MA: MIT Press.

Miller, G. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. The Psychological Review, 63, 81-97.

Miller, G. (1979). Images and models, similes and metaphors. In A. Ortony (Ed.), Metaphor and thought (pp. 202- 250). Cambridge, England: Cambridge University Press.

Mitsch, D., & Dubberly, H. (1990). Muddy media, or The myth of the intuitive. In Multimedia [user] interface design (pp. 2.1 - 2.17). Santa Clara, CA: Multimedia Computing Corporation.

Mountford, S. J. (1990). Tools and techniques for creative design. In B. Laurel (Ed.), The art of human computer interface design (pp. 17-30). Reading, MA: Addison-Wesley.

Nelson, T. (1990). The right way to think about software design. In B. Laurel (Ed.), The art of human computer interface design (pp. 235-243). Reading, MA: Addison-Wesley.

Oren, T. (1990). Designing a new medium. In B. Laurel (Ed.), The art of human computer interface design (pp. 467-479). Reading, MA: Addison-Wesley.

Osborn, A. F. (1963). Applied imagination (3rd ed.). New York: Scribner.

Paivio, A. (1971). Imagery and verbal processes. New York: Holt, Rinehart, & Winston.

Paivio, A. (1979). Psychological processes in comprehension of metaphor. In A. Ortony (Ed.), Metaphor and

Paivio, A. (1986). Mental representations: A dual encoding approach. New York: Oxford University Press.

Rosendahl-Kreitman, K. (1990). The challenge of interface design: Creating a quality experience for the user. In Multimedia [user] interface design (pp. 1.3 - 1.23). Santa Clara, CA: Multimedia Computing Corporation.

Searle, J. (1979). Metaphor. In A. Ortony (Ed.), Metaphor and thought (pp. 92-123). Cambridge, England: Cambridge University Press.

Semper, R. (1990). HyperCard and education: Reflections on the hyperboom. In S. Ambron and K. Hooper (Eds.), Learning with interactive multimedia: Developing and using multimedia tools in education (pp. 52-67). Redmond, WA: Microsoft.

Thimbleby, H. (1984). User interface design: Generative user engineering principles. In A. Monk (Ed.),Fundamentals of human-computer interaction (pp. 165-180). London: Academic.

Vertelney, L., Arent, M., & Lieberman, H. (1990). Two disciplines in search of an interface: Reflections on the design process. In B. Laurel (Ed.), The art of human computer interface design (pp. 45-55). Reading,MA: Addison-Wesley.

Walsh, J. M., & Walsh, A. K. (1972). Plain English handbook: A complete guide to good English (6th rev. ed.). Cincinnati, OH: McCormick-Mathers.