Visual Representation in Instructional Multimedia: A Conceptual Framework

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A Thesis

In the Department

Of

Education

Presented in Partial Fulfillment of the Requirements
For the Degree of Master of Arts (Educational Technology) at
Concordia University
Montreal, Quebec, Canada

March 2004

Your file Votre référence
ISBN: 0-612-91099-7
Our file Notre référence
ISBN: 0-612-91099-7

ABSTRACT

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Instructional designers make use of visuals in the design of multimedia-based instruction. Literature pertaining to this area spans many different disciplinary boundaries, and as such, lacks much coherence. In order to organize and synthesize insights from the literature, a conceptual framework is needed, in particular one that pinpoints essential concepts from these disparate sources and contextualizes them within a perspective that is relevant and useful to instructional design practice. This thesis aims at developing such a framework based both on the literature and a brief case study, and presenting it as a means of analyzing the various levels of visual representational involved in instructional interface design.

Acknowledgements

I would like to thank the following: my Mother for immeasurable love & support, and for "extending my zone of proximal development" by giving me a copy of Arnheim's 'Visual Thinking" years before I was able to understand it. My whole family for being "the best-est family ever". My teachers at F.A.C.E. school for early introduction to a holistic approach to learning & discovery. Dr. Steven Shaw for helping me to navigate the wacky growth of ideas. David Wells for support and encouragement all the way through the program—thank you for your faith in me. Dr. Dennis Dicks, for coming through in a pinch, and Dr. Gary Boyd, as well as Dr. Richard Schmidt for additional support. Gordon Bradley for volunteering (yes, volunteering) to read drafts, and showing genuine interest in the subject matter. And to Dr. Austin Furrington for keeping my stacks of articles warm and furry.

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"Design concerns itself with the meanings

artifacts can acquire by their users." – Klaus Krippendorf (1995)

Part I.

1.1 Executive Summary

Instructional design aims at structuring content in a systematic and purposeful way in order to enhance and optimize learning. This includes selecting and structuring all aspects of the content so that it is appropriate and meaningful to the learner. Instructional designers use their knowledge of language to create texts meaningful to the target learner, but in what ways do they inform themselves about how to select and use visuals appropriately in multimedia-based learning?

In multimedia-based instruction, visuals are used to represent information and convey meaning to the learner. In a computer-based environment that which is represented via the graphical user interface is "all there is" (Laurel, 1993) to convey the structure and function of the system to the user. Therefore, the visuals used within instructional multimedia are a central way in which meaning is communicated to learners, both as instructional tools and as navigational cues.

This paper draws on an instructional design project in which I participated, as a mini case study, to illustrate various issues that arise within the design of a

computer-based learning environment—specifically those related to the design of visuals.

Through participating in this design project, I became aware of how the subject of visuals in instructional multimedia lies at the crossroads of various disciplinary boundaries: graphic design, interface design, aesthetics, and instructional design. Approaching the project as an instructional designer, I decided it would be beneficial to search for theories and research that could inform the design issues arising from the project. The preliminary literature searches found that while information exists on this topic, most of it is cursory, piecemeal, or severely outdated. As well, a large number of the relevant articles found were from fields outside of instructional design, and therefore do not discuss their insights in the context of instructional settings.

This paper identifies a gap in current instructional design literature. It posits that this gap is partly because literature on this topic is scattered across various disciplines, as well as that traditional experimental research methodologies are at odds with the ill-structured domain of visual communication. It suggests a framework with which to analyze the various levels of representation communicated in images. The focus is on examining the essential conceptual issues related to visuals in multimedia instruction, rather than issues of efficiency and delivery methods. The main approach is to analyze the different ways that visual symbol systems operate within multimedia instruction.

The literature reviewed is drawn from the various disciplines of instructional design, human-computer interaction (HCI), Communication studies, information design, and cognitive science. It also examines past literature in instructional design to assess if concepts from older media (such as print) might be applicable to multimedia based learning. The aim is to synthesize terminology and concepts drawn from the literature and to use them to clarify and illuminate the issues that arise from case study.

The mini case study is drawn from a development project which I participated in as an instructional designer. It is used as a way of illustrating central issues and grounding the literature review in current instructional design practice. It is also revisited later in the paper as a way of accessing the usefulness of the framework as a method of illuminating issues in instructional design practice. It is presented in the form of narrative-style participant-observer notes. It is not the focus of this paper and should not be regarded as a full-scale case study.

The final framework integrates central concepts drawn from both the mini case study and the literature. The result is a series of concept maps that illustrate the various concepts and the interrelations among them, as well as reference the literature bases that inform them. Written descriptions accompany these, drawing together the insights gained from the literature, as well as the related concepts. Where possible, visual examples in the form of screen shots or drawings are used to clarify the concepts.

I hope that this framework provides a useful guide for both practitioners and students of instructional design to the main issues, concepts, and terminology involved in the use of visuals in instructional multimedia design. It may also serve to clarify some of the issues involved in researching the use of visuals in instruction and may therefore spur further research.

1.2 Introduction

Multimedia based learning systems make heavy use of visuals to communicate meaning to the learner. Visuals are used as illustrations, to organize information, as navigation systems, and for aesthetic purposes, among other reasons. Instructional designers are taught how to purposefully select appropriate content, write appropriate text, and structure learning in an appropriate way. There is, however a lack of literature that synthesizes the skills and knowledge needed for instructional designers to select appropriate visuals for multimedia based instruction. More specifically, it is unclear what main issues and concepts are involved in this task.

Language is a symbol system (Ball & Smith, 1992) based on conventions that have been established over time and are ever shifting and changing. Ferdinand de (1959) describes language as having a "langue" and a "parole", the former being the overarching concept of the language itself—i.e. the English language—and the latter being the actual way in which the language is used in daily life.

Visuals such as photographs, illustrations, icons, etc., are another form of symbolic communication. Some research (Braden, 1996) has proposed that visuals should be studied in much the same way as we currently study language—that people should become "visually literate". Others (Cassidy & Knowlton, 1983) have suggested that this view of visual communication as analogous to written or verbal language is problematic in that there is no

formalized symbol system—no "langue"—for visual communication. Additionally, the meaning we derive from visuals is entirely dependent on our experience, cultural background and what we are taught.

If part of instructional design involves structuring instructional content in a logical, meaningful and appropriate way, how then can instructional designers approach designing the visual elements of instruction? Tools exist to guide language-based instruction—we have access to dictionaries, thesauruses, glossaries and references for grammar—but it is unclear what resources we have to help us with deciphering the "langue" of visual communication.

Current methods of instructional multimedia design include teams of experts from many different domains, each with a specific role within the production process. Instructional designers provide the blueprint for the nature and structure of the content, which is then passed to the production team to be realized. The visual aspects of instructional multimedia design are often considered the domain of graphic designers, and are often neglected within the considerations of the instructional designers. The reasons for this are unclear. It could be that images are still considered to serve mainly aesthetic purposes, and are therefore assumed to be part of the realm of art and graphic design. It might also be due to a lack of knowledge or recognition of the communicative properties of visual elements and their role in instruction. It could also be, as this paper suggests, due in part to the lack of coherence and consistency within the literature related to this subject.

The brief case study examined within this paper chronicles a number of different issues that arose within an instructional design project regarding the design of visuals for multimedia instruction. These issues ranged from questions of determining the appropriateness of illustrations, to designing instructionally sound principles for interface design metaphors. These issues crossed the boundaries of the disciplines of instructional design, graphic design, and interface design; they also touched on issues such as the transfer of information from one medium to another, and the profile of the target learners. Within the context of the project, such issues were dealt with on a case by case basis, and resolved through in-depth discussions within design team meetings. While some of the issues encountered in the case study example could be considered unique to the particulars of the project, it is clear that some issues that arose can be used as illustrations of over-arching concepts involved in representing information through the use of visuals in instructional multimedia design.

In order to understand the various manifestations of visuals within the context of multimedia instruction, we must first be familiar with the basic characteristics of visuals themselves. Once this has been examined, we can search for themes within their use in instructional multimedia in order to distinguish between the various contexts in which they appear. The aim of this paper is to help give coherence to existing literature sources through the creation of a framework of central concepts—principally those related to theories of representation.

The hope is that this framework provides illumination and explanation for the main principles operating within this subject area as well as some of those encountered in the case study, and that it will give instructional designers some insight into how best to deal with them. Specifically, it is hoped that it will provide the necessary conceptual basis for instructional designers to be able to untangle the presently murky realm of how images convey information in interactive learning contexts.

1.3 Problem statement: Context of the problem

Background literature review

While the inclusion of visuals in learning has been said to date back as far as 1472 (Olson, 1974), literature on the subject has fallen in and out of prominence. The topic was quite popular in the 1970s, and consequently there exists a large body of literature from that period relating to the use, analysis, and interpretation of visuals in instruction. However, given the state of technology at the time, most of the literature deals with visuals in print-based instruction (some studies touch on film-based instruction). Although the design of multimedia based learning involves some issues that are unique to computer-based design, there is still quite a lot of older literature that can be applied to aspects of multimedia-based instruction.

Apart from the momentary surge in the 1970s—and some scattered maverick articles—in recent years the field of instructional design has remained quite barren in its attempts at dealing with visuals in instruction. Classic instructional design (ID) texts such as Smith's and Ragan's (1999) make mention of the need to design visuals purposefully, but offer only cursory guidelines. Consequently, student instructional designers can remain unexposed to basic concepts related to the use of visuals.

One explanation for the "paucity" (Kanuka and Szabo, 1999) of literature on this topic might be the various methodological and theoretical problems involved in researching visual communication, particularly within a learning

context. The section that follows examines these problems, as well as provides an overview of possible alternative approaches.

Visual Communication: An interdisciplinary investigation

The first factor relates to a characteristic of visual research in general, namely, that it is an interdisciplinary topic. Investigating how we represent things visually is not a new a concept. In his dialogue, *The Republic* (written sometime between 387 and 367 BC), Plato outlined his theory of representation (or *mimesis)*. He made a distinction between the *form* of something, e.g. the abstract concept of a bed; a *particular* of it, e.g. a specific bed; and a *representation* of it, e.g. a painting of a bed.

Since the time of the ancient Greek philosophers, the study of visual communication has splintered into many different fields of study, and is now an interdisciplinary endeavour spread across the arts, art history and design; anthropology and cultural studies, media and film studies; psychology and cognitive science, architecture, education, linguistics, and philosophy (Moriarty, 1997). Therefore people interested in researching visuals as a whole are presented with the challenges of conducting interdisciplinary research; namely the task of negotiating a varying assembly of concepts, terminology, research methods and ideologies.

The interdisciplinarity of research in visual communication presents practitioners of instructional design with a confusing problem: how to determine

which aspects of these fields are relevant to instructional design, and how to apply these theories and findings to "real life" design issues.

Added to this, is the fact that if we aim at investigating visuals in multimedia instruction, we are in fact touching on three different possible bodies of literature. In order to develop a clear idea of the diverse bodies of literature that can inform the design of visuals in instructional multimedia, we first need to look at the broader categories of which it is a part. A simple way of partitioning these groupings would be to look at the components of it: "visuals", "instructional", and "multimedia". We could then look at literature that addresses each of these areas of focus, as well as any literature that deals with where they overlap. This is represented in a Venn diagram in Fig 1. below.

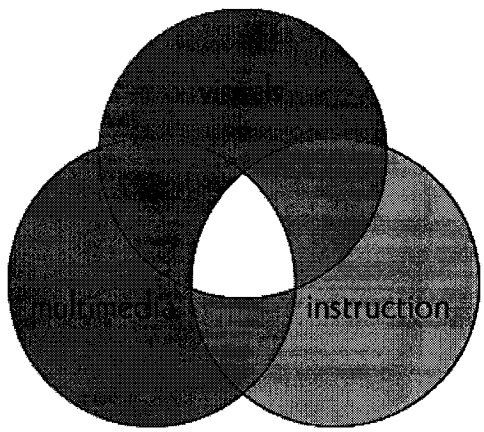

Fig 1. Diagram of overlapping bodies of literature.

For the purposes of this literature review, I will treat "instruction" and "multimedia" as being combined under the heading of "educational technology". Later on in this paper they will be looked at more closely as individual areas, each containing various distinct sub-categories, (e.g. multimedia literature deals

with interface design issues, whereas instructional design literature deals with learning theories).

This fusion of otherwise traditionally distinct domains also brings with it a melding of terminologies, concepts and theories, which could be potentially confusing for novice instructional designers.

The role of visuals: art or instructional design?

Another aspect of visuals in instructional multimedia that potentially creates confusion for instructional designers is the lack of clarity regarding the role that visuals play in learning. Visual aspects of multimedia-based instruction, such as the graphic user interface (GUI) are often described as the "look and feel" of a particular website or CD-ROM. Descriptions like this are misleading as they point to only part of the role of a graphical user interface: aesthetics. While all visual elements of Computer-based Learning Environments (CBLEs) contribute in some way to the affective experience of the learner, viewing them as merely 'pretty pictures' belies an ignorance of the communicative attributes of images. Learners and instructional designers alike may not consciously infer meaning from visual elements in instruction, but that does not mean that no meaning is being communicated.

In her book about human-computer interaction, Brenda Laurel (1993) points out that the non-verbal elements of a computer environment often communicate "in the place of words, [and] ...may be said to function as language when they are the principle medium for the expression of thought" (p. 57).

Alesandrini (1987) underlines the need for further attention to the use of graphics in instruction, stating that graphics are often "underused or misused" in computer-assisted instruction (CAI). She goes on to cite examples of CAI in which graphics were used, even when they were irrelevant to the course's content.

Kanuka and Szabo (1999), as well, cite examples of studies that have found significant gains from using visuals in learning, but they go on to warn that the mere inclusion of a visual element is not a guarantee that learning outcomes will be improved. They quote Steinberg's (1991) assertion that: "Designed without an understanding of how people gain meaning from them, displays can have no effect or can even interfere with learning" (p.144).

There are no clear-cut answers as to how people will interpret visuals, for this reason there are no clear-cut answers as to how to design visuals for learning. The field of graphic design relies on a designer's 'artistic sense', as well as knowledge passed on through apprenticeship. Empirical studies within cognitive science and educational technologies often take the approach of creating 'recipes' for design. However, neither of these approaches seem entirely appropriate for instructional designers who neither have the time to acquire a graphic design degree, nor to wade through journals worth of contradictory research reports.

It is easy for us as instructional technologists, or even as users, to criticize a bad design decision after production has ended. This however, is not the most productive or effective approach to good instructional software design.

An important distinction that needs to be recognized here is that the parameters of visual representation within a design project—the message being communicated through the visuals—is not just a matter for graphic designers to take care of, it is also part of the overall instructional message that is communicated, and is therefore also the concern of the instructional designer. As Laurel (1993) points out:

> Graphic designers undoubtedly have had to wrestle with...bias, design being seen not as a task of representation but one of mere decoration. Decoration is suspect because it may get in the way of the serious work to be done. ... The fact of the matter is that graphics are an indispensable part of the representation itself...(p.22)

The aim of this paper is to start the process of building a repertoire of concepts and terminology within the instructional design field that will better equip us to thoroughly and clearly think through the issues involved in the design of visuals for instructional multimedia.

Media comparison research and research-based design

A last possible factor in the shortage of information about the use of visuals in multimedia instruction may be related to research methodology. In general, instructional design research has approached the study of visuals empirically—either as a subset of instructional media research or as a cognitive science issue. (I use the word "instructional" here to specify that I mean media research conducted within the field of educational technology, rather than the communication studies tradition.) Although these two approaches have

generated some interesting questions, and have helped identify some of the specific factors involved in learning through visuals, there have been problems with these kinds of approaches in terms of applying them in practice.

Media comparison research

In instructional settings, media can be used to illustrate, emphasize, and explain that which is being taught (Smith & Ragan 1999). Exactly how media fulfill these functions seems to remain unclear to researchers (Salomon, 1978). The problem of how to analyze and describe the ways in which people learn through media has been the subject of many debates.

In the 1980s, researchers in the field of instructional design discussed the problems involved with media comparison studies. Notably, Clark (1983) launched an attack on McLuhan's (1964) famous media studies slogan "the medium is the message", asserting that the medium is merely a method of delivery for the message; a vehicle which has no more effect on the message than a delivery truck has on the groceries it carries. Clark's main criticism, however, was that research into media-related issues in instruction was fundamentally flawed in its approach and that it could therefore not determine any reliable conclusions. This point has been debated extensively in major educational technology journals over the past twenty years (Kozma, 1991, 1994; Ullmer, 1994; Clark 1994; Jonassen, Campbell & Davidson, 1994; Morrison, 1994; Cobb, 1997).

Clark's staunch position created a ripple in media research in educational technology, and seemingly rendered the topic taboo for some researchers. More

than a decade after the debate began, Cobb (1997) suggested that the field of educational technology seemed ready to just drop the subject.

While Clark's criticism brings to light many important points regarding media research; it cannot be taken as an endpoint to investigations into media in instruction. A lack of useful research results will not stop teachers and instructional designers from using visuals in instruction. The problem then, remains how to go about describing the way that media interact with learning.

Research-based design

Research into the role of visuals in learning has been going on for the greater part of the last century. Anglin, Towers and Levie (1996) cite research dating as far back as the late 1920s which explores the use of visuals in instruction. A large surge in research in the 70s and 80s (Jonassen, 1982; Houghton & Willows, 1987; Levie, 1987; Levin, Anglin & Carney, 1987; Pressley, 1977; Brody, 1982a) investigated the use of illustrations, text layout, and structuring of content within instructional texts.

In general, these studies aimed at uncovering the cognitive bases of visual perception. While these studies are helpful in understanding the 'hardwired' ways in which we perceive images, they do little to account for the highly subjective and context-dependent ways in which people interpret meaning from images.

Based on these empirical studies, some researchers have attempted to piece together "checklists" or "guidelines" of optimal layouts for instructional materials. Some of these have attempted to quantify, and therefore legitimize, basic graphic design principles (Downs & Clark, 1996; Park & Hannafin, 1993).

Others have produced layout recommendations based on the principles of perception & cognitive science (Fleming & Levie, 1993; Ware, 2000). Recent studies provide research-based guidelines for the design of web-based instruction (Skaalid, 1999; Ivory et al, 2001).

While these approaches have done a good job at drawing attention to the importance of visual design within instruction, their prescriptive, recipe-like approach has failed to provide instructional designers with a holistic picture of the role that visuals play in instruction. It also neglects to acknowledge the creative aspect of instructional design; an oversight that could be compared to teaching cooking using the principles of chemistry.

Szabo and Kanuka (1999) outlined problems that arose from summarizing research on screen design, claiming that many summaries do not include any new research findings, and that they are often confounded by the fact that they have been conducted on paper, rather than on actual computer monitors.

Surely empirically based checklists are not the only way we can inform ourselves about design decisions. Design of appropriate visuals is a highly context-dependent activity requiring knowledge of the learners, as well as knowledge of how images communicate meaning. In this sense, visual design fits quite clearly with Spiro et al's (1991) description of ill-structured domains:

> Each case or example of knowledge application typically involves the simultaneous interactive involvement of multiple, wide-application conceptual structures... each of which is individually complex...and the pattern of conceptual incidence and interaction varies substantially across cases nominally of the same type. (p. 25)

Viewed this way it would seem logical that instructional designers should be exposed to various examples and counter-examples of visual design issues in order to develop advanced expertise. A simple example of this is demonstrating how one image can be interpreted as representing different things for different learners, (for example: a red light in the West means "stop", but red in the east is good luck).

Cochran et al (1980) point to the inherent problems of using a "physicalistic paradigm" for investigating visual issues in learning. In their discussion of visual literacy research they state that classical experimental research designs are "severely strained" because the relationships being explored in visual literacy are cultural and non-causal.

If the design of visuals in instructional multimedia is an ill-structured domain, it would be useful for instructional designers to learn "an appreciation...of the varieties of meaning 'shades' associated with the diversity of uses" (Spiro, et al 1991). A different way of approaching the problem would be to approach the topic as a group of conceptual issues, rather than an empirical question in need of response. In this sense, literature would have to be identified to serve as the theoretical basis for such an inquiry.

New approaches: visuals in multimedia instruction

If media research has done little more than show us that under "some conditions" certain visuals can be useful to "some learners" in "some areas"

(Salomon, 1978), then instructional designers must find new ways to guide themselves in making sound decisions regarding the use of visuals.

Parallel to Clark's debate, other research has attempted to look at media research from a different perspective. One suggestion is that the offending research was based on the incorrect premise that "media are... unitary invariant 'entities'" (Salomon, 1978). Instead, it is suggested that media "are composed of different, distinctive elements, each of which is a possible source of variance for some outcome domains but not for others" (p.39).

Although he recognizes Clark's criticisms, Salomon (1978, 1979) suggests that the focus of research should be shifted from delivery methods to looking at the individual attributes or "components" of each medium, and more specifically, the symbol systems that operate within them. He states that the future of media research lies in its ability to interact with other disciplines.

An analogy to help illuminate the difference between examining the effects of a medium and the components at work *within* each medium is the following. In describing the problems with the media research he criticizes, Clark makes the analogy that a given medium is like a delivery truck—it has no more effect on the resulting message than a truck has on the food it delivers. We can continue this analogy by saying that media comparison studies look at the container, but fail to examine the contents of that container. Each medium is like a box, and each individual 'text' produced in that medium is like a different meal. Each meal is made up of different sorts of food; one might contain chicken, carrots, and broccoli. Another might contain one similar food—e.g. the carrots—yet instead of

chicken, this one may contain beef. If a nutritionist were to try to analyze the effects of each meal on a person's health, they would want to obtain as much detailed information as possible. Clearly analyzing the box it came in would not be substantial enough; they would need to know what types of food the meal contained, as well as the quality of the foods. From there, they could analyze the nutrients and properties of each food. They would also possibly examine how each of these foods interacts with each other. This deeper level of analysis is akin to what Salomon is proposing in his assertion that we focus on symbol systems and their components, rather than the medium.

This kind of an approach is closely related to an analysis approach used by theorists in communication studies: semiotics. Semiotics can be broadly defined as "the study of signs" (Chandler, 2002); it involves looking at how we use symbols to communicate, through either verbal or non-verbal means. It has its roots in linguistics, but more specifically in structural analysis.

The main core of this paper is based around the assumptions and methods of symbols systems theory and semiotics. This is a useful method of analysis with which to get at the heart of the issues involved in designing visuals for instructional multimedia. Over the years much research within educational technology (Driscoll, 1989, 1994; Cunningham, 1992; Suhor, 1984), has pointed to the usefulness of semiotics as a method of analyzing instructional media, as well as a means of approaching education in general.

Within the domain of instructional film, Worth (1981) developed a "semiotic of film". He identified a need for a common language for research in film, stating

that his aim was to develop "a semiotic" of film as a way of "untangling" existing film theory, clarifying concepts and developing a language to talk about film. Outside of educational technology, Andersen (1990, 2000) has used semiotics as a means of analysis for interface design.

Although semiotic theory is not traditionally part of instructional design theory, it is not entirely new or foreign to the field. Since the inception of semiotics in the 1960s, instructional design theorists have pointed to the usefulness of both it and closely related post-modern theory within the field. In an essay about semiotics and post-modern theory, Hlynka (1991b) suggests that instructional design theory would benefit by broadening its scope "[incorporating] concepts derived from literary and aesthetic theory, including reader response theory, semiotics, and post-structuralist analysis into the design of instructional program and products" (p.30). Similarly, back in the 70s, Hoban's (1974) view of the 'future of theory and research in educational communication' was that in order to progress it would need to "[broaden] its concepts and concerns", as well as include "deeper conceptual analyses of our technology" (p.35).

More recently, Solomon (2002) has argued for a re-discovery of post-modern perspectives. He cites examples from the past where research made use of such methodologies, particularly Knowlton's (1964; 1966) creation of a conceptual scheme for the audiovisual field. The scheme aimed at "clarifying terms and constructing shared meaning among members of the audiovisual community": developing a "meta-language for talking about pictures" (p.16).

It is hoped that this paper will provide the basis for the development of such a tool to guide instructional designers in discussing and designing visuals for instructional multimedia.

1.4 Rationale

If we are to understand the ways that visuals can be used to communicate in multimedia based instruction, then we must search various literature bases in order to draw out the key concepts. This paper synthesizes concepts from various fields and disciplines, in order to create a conceptual framework to aid instructional designers in addressing the issues involved in designing visuals for instructional multimedia. In this sense, it takes an interdisciplinary approach to the issues at hand.

The body of literature on interdisciplinary research describes the ways in which aspects of a given discipline can be shared across disciplines as a form of 'cross-pollination'. Lattuca (2001), quoting the Center for Educational Research and Innovation, describes interdisciplinarity as "[an] interaction among two or more different disciplines... [that] may range from simple communication of ideas to the mutual integration of organizing concepts, methodology, procedures, epistemology, terminology, data, and organization of research..." (p.18). More specifically, Klein (2000) describes how concepts and theories can be shared across disciplinary boundaries, explaining that they are "robust enough to maintain unity across fields" (p.12).

Given the interdisciplinary nature of both visual communication and the field of instructional design, a number of articles have attempted to examine and draw together the disparate sources and concepts that feed them. Previous research has attempted to clarify the nebulous conceptual structures of

instructional design (Jonassen, 1989), visual literacy (Braden & Baca, 1990), and visual communication in general (Moriarty, 1997). The common approach has been to generate lists of essential concepts and then to "map the field" by creating concept maps of the interrelations of concepts.

The notion of separating out concepts from their original sources and compiling them into a more comprehensive whole was used by Posner and Strike (1976) in their creation of a categorization scheme for content sequencing. They described their goal as trying to "explicate a plausible set of concepts useful for theory, research, development, and evaluation", suggesting that the concepts could then be used as a "framework for discussing alternatives and implications" (p.666).

Similarly, Wiesenberg and Baine (1994) used the approach of fusing two major models to form a model for "the systematic design of instructional pictures". Their approach was to integrate Gagne's methods for the design of instructional text and Goldsmith's model for the evaluation of educational illustrations. This resulted in an instructional design model for pictorial elements in print-based instruction. Other similar attempts usually use one discipline or theoretical approach, to provide insight into a specific issue. For example, Reilly and Roach (1986) discuss the boundaries between interface design and graphic design. Deboard and Lee (2001) look at the overlap between interface design and information design. Sims (1999) explores how human-computer interaction principles can be used in an instruction setting.

While numerous articles exist that attempt to draw links between various fields, few articles aim at creating a holistic picture of the issues and concepts involved in the design of visuals for instructional multimedia. The article that comes closest to meeting this description is Oliverira and Baranauskas's (2000) "Semiotics as a basis for educational software design". In it, they map out the beginnings of what could be a very useful linkage drawn between semiotic analysis and educational software design. Out of all the articles I have surveyed so far, this example is the closest that instructional design theory has come to what Krippendorf (1995) phrased as "...[concerning] itself with the meanings artifacts can acquire by their users".

While few and far between, these papers provide the foundation work for generating a more complete picture of visuals in multimedia instruction. They do, however, tend to focus on combining only two elements at a time and therefore lack a truly holistic approach.

In his article "Toward Integration: Education, Instructional Technology and Semiotics", Cassidy (1982) proposes that the field of instructional technology is in need of a new perspective, one which "encourages integration of existing data and guides future research" (p.86). He suggests the incorporation of insights from other disciplines, stating that "it is particularly important that we scrutinize the literature closely, select what is appropriate, and synthesize the results" (p.76). This paper attempts to do just that.

1.5 Approach

Description

This paper takes an interdisciplinary, literature-based approach to analyzing concepts related to visuals in instructional multimedia. It also aims at grounding the concepts found in the literature with examples taken from the field of instructional design. There are various ways of approaching a synthesis of literature. After considering various methodologies for accomplishing this, I decided to use a model from the health sciences.

The field of nursing is situated mid-way between practice and theory. There is a need to connect what happens in the field with current nursing theory. Schwartz-Barcott and Kim (1986; 1993) describe how nursing theories were considered by some to be too abstract and vague to be applied in the field. Their suggestion was that the focus be shifted away from the plethora of competing theories in order to focus on the individual concepts that made up the theory. The reasoning was that if the concepts could be analyzed and refined, they could be used as components to be applied to specific situations in clinical nursing contexts. The identification of this need within the field spurred the creation of the hybrid model of concept development: a method of concept analysis.

Concept analysis

Concept analysis is a way of bringing together information from written and unwritten sources, with the aim of finding conceptual patterns and uncovering an over-arching conceptual structure. Researchers (Morse, 1995; Hupcey, Morse, Lenz, & Tason, 1996; Morse, Hupcey, Mitcham, & Lenz, 1996; Morse, Mitcham, Hupcey, & Tason, 1996;) within the field of nursing have used concept analysis as a method of finding patterns across literature.

The methodology of concept analysis is a practice rooted in philosophical inquiry and has been outlined by theorists such as Wilson (1963). He states that part of the concern of conceptual analysis is with "actual and possible uses of words". He points out that not all words have 'real meanings' that exist outside of the context in which they are used. The aim then is to "analyze the concepts and map out these uses and applications." (p.10) (This can be seen as existing in consort with the ideas of post-modernism and semiotics; e.g. Solomon's reference to Knowlton's "clarifying terms and constructing shared meaning" as being a post-modern approach to research.) The particulars of his approach are discussed in detail in the methodology section that follows.

Grounded in practice

The added component provided by the hybrid model of concept development is an explicit reference to current practices within the field.

Schwartz-Barcott and Kim (1993) outline the four criteria for a hybrid concept analysis as the following:

1) The concepts explored should be related to practice, and ideally drawn from personal experience within the field.
2) The literature review should be broadly based and cross-disciplinary in order to capture multiple usages, overlaps, and contradictions of concepts.
3) The focus should be on definition.
4) The literature review should be integrated with data from the field.

It is my view that the issues identified by Schwartz-Barcott and Kim within nursing are parallel to those encountered within the design of instructional design, particularly the design of instructional multimedia.

Barnard (1991) describes the phenomenon of theories of human computer interaction (HCI) becoming "fossilized" to the point where few of them have any direct impact on design. Andersen (1990) has criticized laboratory experiments in HCI for being divorced from everyday life, asserting that they rarely yield practical advice to designers.

Instructional design is an applied field—one that needs to strike a fine balance between theory and practice. In this sense, it is like the field of nursing; a theory's perceived relevance is heavily dependent on its applicability to practice.

Research Model

The hybrid model of concept development incorporates information from both the field and literature. These sources are used in conjunction with each

other to create a holistic picture of the concepts being investigated. It consists of three phases: 1) the theoretical phase, 2) the fieldwork phase, and 3) the final analytical phase. Phases 1 and 2 are meant to overlap so that there is an iterative dynamic between them. This is to ensure that the literature review can serve "as an ongoing basis for comparison" with information collected from the field.

For the purposes of this paper, I have created an adaptation of the diagram provided by Schwartz-Barcott and Kim (1993). It has been adapted to account for the fact that my analytical phase will result in the creation of a framework, (see Appendix 1).

The stages of the literature review, case study and framework development are described in the following paragraphs, in the order outlined in Appendix 1: "Approach to literature review, case study and framework development". The intention is to show the iterative dynamic between the literature review and case study in the development of the framework, rather than to be redundant.

Informal literature review

This stage marks the beginnings of considering the topic in general and preliminary exposure to related literature.

Informal case study observations

This stage occurred before the project was formally undertaken, on what would become the site of the case study. It consisted of informal observations.

Pre-Framework

This is also a pre-stage, consisting of any initial thoughts about how the concepts interrelated with one another.

Literature Searches

The literature search consists of three parts:

1) An initial literature search

2) The literature review itself

3) A revised literature search

The goal of the first part is to identify the main search terms, as well as the domains and corresponding literature bases that might inform the topic, (e.g. the domain of computer science, and the literature on human-computer interaction). This information, as well as the search terms found in the field notes, is then used to guide part two of the literature review.

Once the search terms and literature bases are identified, part two of the literature search begins. This will be discussed in detail in the methodology section.

Framework – Stage 1

The concepts found in the literature review are used to create Stage 1 of the framework. The goal is to create a framework including the various issues and concepts related to designing visuals for multimedia-based instruction.

Case Study

Although the focus of this investigation is on concepts drawn from the literature, I felt it would be beneficial to ground and focus the literature search with information drawn from instructional design practice. An abbreviated case study is therefore used. Its purpose is to help pinpoint the types of issues that arise within instructional design practice regarding the design of visuals. A sampling of the issues that arise is collected via participant-observer notes taken during design and development meetings on the case study site. The participant-observer notes are then organized according to these issues so that they can later be reviewed in relation to the literature.

Framework – Stage 2

The concepts found within the literature are used to form the component parts of the framework. The goal is to form a synthesized model of the process and issues involved in both the production and reception of visuals in instructional multimedia.

Framework - Stage 3: Synthesis

This phase focuses on creating a unified picture of the research and concepts that relate to the design of visuals for instructional multimedia. It consists of conceptually ordering the main concepts found in both the literature and the case study and arranging in relation to one another to form a coherent whole.

Evaluation 1 and 2

The final step is to validate the framework. This is done by revisiting the issues raised in the case study and analyzing them with the aid of the concepts and structure provided by the framework.

1.6 Methodology

Case Study

The purpose of the case study in this project is to ground the literature synthesis in current instructional design practice. Observation notes will be presented in a narrative form in order to illustrate the various issues to be examined. It is meant to be exploratory, rather than a full-fledged investigation into instructional design practice. Given the above caveat, it is nonetheless relevant to present the basic methodological considerations that will underpin it.

Background

The case study was conducted on the site of an instructional software development project that was undertaken in Concordia's Department of Education, (for this paper, it will be called the Reading CAT). The project was made up of a large team of researchers working to produce a computer-based learning environment (CBLE) to improve children's reading success as an integrated part of the client's Reading program. I was involved in this project as a junior instructional designer from September 2001 to December 2003.

Field notes methodology

Schwartz-Barcott and Kim (1993), describe the steps in the fieldwork phase as a "modification of classic participant observation" (p.115) although they note that it differs slightly in terms of scope, focus, and time frame. The steps

they outline are an adaptation of Schatzman and Strauss' (1973) methods for field research. They are as follows: Setting the stage, Negotiating entry, Selecting cases and, Collecting and analyzing the data. I will discuss how each of these will be addressed in the paragraphs that follow.

Setting the stage

I was part of two teams within the project: the design and development team and a special research team investigating issues related to the interface between computers and skill-focused writing. My work with both of these teams included weekly meetings to discuss issues related to the instructional design behind the software. The impetus behind using this site as a source of information came from my initial informal observations in these meetings. I noticed that over the course of our discussions we encountered various problems related to representation of information visually in a computer environment. This issue was particularly prominent in the context of this project because the target learners/users of the software were young, pre-literate children. This meant that a lot of information, which might for a literate user be communicated through text, be communicated visually.

For these reasons, I felt that the Reading CAT project was an appropriate site for my abbreviated case study. As I had already been with the project for a substantial period of time, I felt confident it met the three criteria stated by Schwartz-Barcott and Kim (1993) for population and setting:

a) The likelihood of frequent observations of the phenomenon under study

b) The appropriateness of participant observation as a method of gathering data

c) The likelihood that the researcher will be able to create and sustain a participant-observation role in the setting. (p.114)

Negotiating entry

In the preliminary stages of my research, I discussed my project informally with the members of the research teams in which I was participating. They expressed support for my research and said that they did not feel it would be intrusive, as I would merely be making notes about issues related specifically to visuals. Later, once I had received ethics approval, I obtained written informed consent from each member of the team regarding my research.

Selecting cases

This step involves determining the unit of analysis. This model of concept development does not require a large number of cases to observe, especially if the main features of the concept are apparent. In the event that a concept is unclear, it is suggested that Wilson's (1963) method of concept clarification be used, (i.e. the identification of model, contrary, borderline and related cases).

Collecting and analyzing the data

The hybrid model of concept development outlines methods for recording and organizing field observations. These methods are mainly intended for research including multiple sources of empirical field data. In the abbreviated form in which I am using the observation notes, these methods are not applicable.

Literature search

Search criteria

The main aim of the literature search was to locate articles that could provide strong conceptual models for the use of visuals in the design of computer-based learning environments.

Preliminary searches were conducted, in order to determine which domains would be useful as sources of literature. A final list was created of the main domains determined to be likely to contribute to a holistic picture of the uses of visual in computer-based learning environments. Searches were conducted both online and in the library database.

In searching for the main articles to be used, preference was given to refereed journal articles, particularly those found via sources such as ERIC or via branching from other articles. Articles from sources other than refereed journals were be included based on the following criteria:

- Equivalent articles were not available in refereed journals

- They were articles by prominent researchers that were only available online.

- They were referenced in articles or bibliographies compiled by prominent researchers. (e.g. IVLA Visual Literacy Bibliography http://www.ivla.org/news/rdocs/vlbib/, and Sonesson's bibliography of visual semiotics: http://www.fl.ulaval.ca/hst/visio/biblio.htm)

As one of the goals of this literature synthesis was to examine the applicability of past research to current issues, no preferential distinction was made between older and newer articles. Where possible, branching was used to trace back references of secondary sources to uncover the primary literature on the topic.

Both empirical and theoretical articles were included, although the emphasis was put on significant conceptual contributions.

Books that were found to provide relevant information, as well as bibliographic sources for further branching were also included selectively. Experts such as professors in the departments of Education, Fine Arts, and Communication studies were consulted on an informal basis to provide suggestions for further readings and resources.

Content criteria

The relevance of article content was weighed in the following way in descending order of priority:

- Articles that address the issues directly and all-inclusively
- Articles that propose partially-inclusive conceptual models of the issue
- Articles that propose inter-disciplinary approaches to the topic, therefore trying to synthesize literature from two or more domains.
- Articles which address component aspects of the issue
- Older articles dealing with the instructional use of images in a non-computer medium, e.g. print-based or film.

Preference was given to articles that attempted to provide a framework for the analysis and/or design of visuals in instruction. Within these criteria, further preference was given to articles that directly addressed this issue in relation to the design of instructional multimedia. Another form of article specifically sought after were articles attempting to integrate findings from the various key domains; e.g. an article about educational applications of semiotic theory.

Relevant articles that were found were entered into a database and catalogued according to key words, as well as the domain of which they are a part (e.g. semiotics). After this was completed, the database was reviewed in order to weed out irrelevant and/or less important articles. The final step was to review all database entries, in reference to the article texts and prioritize them according to the above content criteria.

Search terms

In general, terms in the search term list fell into one of three categories:

1) Key terms related to the topic

2) Various synonyms for key terms related to the topic

3) Homonyms for key terms (i.e. terms that seem related to the topic but are not)

In order to account for synonyms I created a search list that included both the most often used instances of a given term, as well as the multiple instances and variations of it across disciplines. Homonyms were kept track of, to avoid generating search results that included unrelated topics, e.g., scientific visualization. A list of search terms was created and revised over time in order to keep track of which terms yielded successful search results and which produced divergent results, (see Appendix 2).

Conceptual analysis

Articles were reviewed to look for concepts that could inform the issues identified in the case study. These concepts were synthesized in order to form Stage 2 of the framework (See Appendix 1). As suggested by Schwartz-Barcott and Kim (1993), the conceptual analysis methods of Wilson (1963) were used as a reference in the process of teasing apart concepts and terminology. In brief, this method consists of selecting a model case and then seeking to define the boundaries of it by presenting contrary, related, borderline, and invented cases.

In the field of nursing, the models and contrary (etc.) cases are illustrated through the inclusion of narrative examples from the field observations. In the context of this project, the cases are illustrated through a combination of narrative, as well as visual examples. Concept maps are also used to illustrate the possible inter-relationships among concepts.

Notes regarding Language

As this paper is primarily focused on exploring concepts within instructional design practice & discourse, it is appropriate that the use of language throughout it be addressed.

Decisions have been made about the use of terminology throughout this paper in the interest of consistency and clarity. The problem of terminology both within and across various fields is part of what is being examined within this paper. While no one term is inherently superior to another, it is helpful to limit the variety use of terms used in order to get past the jargon and deal with the ideas at hand.

I have tried my best to avoid using heavy jargon, especially from fields such as semiotics and computer science (e.g. "neo-positivism", "widgets", "syncategorematic"). Where appropriate, I have tried to use terms drawn from the literature. Obstacles to this occurred when various authors have either used different terms for similar things (synonyms), or the same term for slightly different things (homonyms). In these cases, I have done one of two things: I have either decided on the use of one author and their set of terms (in which

case I specify the reference), or I have created my own 'code' or composite term to use as an umbrella term.

If I have used terms from one author, I have tried to use their terms in conjunction with each other, at least within the main domain in which their work is situated, e.g. Salomon's terms for aspects of symbol systems are used because his writing provides the most complete description of that topic.

One of the problems existing in the literature is the overuse of synonyms. In order to address this, I have tried to limit the use of multiple terms to mean the same thing. To simplify things, I have therefore created "compiled terms". These are terms that I have chosen to designate groups of synonyms and used throughout the paper in a unified way. The specific cases where I have done this are listed below.

Conversely, in reviewing the literature, I noticed that many terms related to visual concepts in general were used as if they were interchangeable (homonyms), while upon closer examination, it was clear that they had distinct meanings and therefore should be used as such. This tendency to use visually related terms imprecisely might be related to the loose way in which they are used in the vernacular. This is further examined in the body of the paper.

Compiled terms:

'Instructional multimedia'

The field of educational technology, and its subset instructional design, employ many different terms to describe the use of computers (either via CD-ROM or the World Wide Web) as a means of delivering instruction. Terms

currently popular include: computer-based learning environments (CBLEs), computer-assisted tutors (CATs), open learning environments (OLEs), computer-based training (CBT), computer-assisted instruction (CAI), distance learning (DE) Older terms include: Intelligent tutoring systems (ITS), Programmed instruction, microworlds.

Some of these terms carry an ideological connotation, e.g. ITS are generally assumed to be based on cognitive learning principles, while CBLEs are associated with Constructivist theories. In the interest of avoiding references to specific learning theories, I have decided to use the term "instructional multimedia". By this, I mean any website or CD-ROM purposely designed for teaching someone something. The word "instructional" is used in the sense that I am assuming the system has been designed according to general instructional design principles with the aim of being educational. The word "multimedia" is meant to denote that the system is computer-based, either in web or CD-ROM format, and that it includes the use of visuals and possibly sound and video.

'Visuals'

There is currently no term accepted as a standard or catchall way of describing the visual components on a monitor. Each component could variously be described as a picture, a photograph, an illustration, an icon, or a button. There are also more technical terms such as GIF and JPEG. For the purposes of this paper, I use "visuals" as a term to describe all static visual components of multimedia, excluding text, video clips, and animation.

I exclude text because I do not intend to deal with issues such as font design or impact beyond a brief mention of the use of it as highlighting or visual cueing. Nor do I intend to embark on an analysis of the various uses of motion graphics (animation or video), since I feel that an attempt to classify various forms of video would be a project unto itself and is better left to film theorists.

'Learner/user/audience'

Within the diverse bodies of literature this investigation draws on, various terms are used to denote the hypothetical person who interacts with that which has been designed. The term used for this 'person' (normally, simply a computer 'user' where purpose is unspecified) varies depending on the primary use the 'person' is deriving from the computer session. Within literature, dealing with learning and instruction, the term "learner" is used; in computer-related literature, the term most often used is "user"; and finally, in media and communication studies focused literature, the term "audience" is used. For the purposes of this investigation, which is focused on instructional design, the term 'learner' is mainly used—although all three terms above are evoked through its use.

What is not included: graphs, diagrams, charts, 3D graphics, film/video clips, animation, text placement (simple text), highlighting. (This is explained in further detail in the chapter that deals with definitions of pictures.)

1.7 Framework Development

The trajectory of this thesis' development has not been clear-cut. Although I started out with a specific area of interest, how best to go about exploring it did not become clear to me until almost halfway through the project. Even after a suitable methodological approach had been decided upon, quite a lot more effort was needed to go through the thought process resulting in a solid structure for the final framework. The following section traces the process of framework development from start to finish; outlining both the methodologies undertaken and the rationale that provided the impetus behind each of them.

Background—Interdisciplinary focus:

The study of visual communication is interdisciplinary and draws from so many sources it would be next to impossible to address it comprehensively. The proposition of writing a thesis that aims at summarizing literature on visual communications might therefore seem a little over-ambitious. Recognizing this, a possible approach might have been to focus on the interdisciplinarity itself. Various researchers (Moriarty, 1995, 1997; Braden & Baca, 1990) have already taken up this task, some hoping to establish visual communication as a field of study in its own right.

While this topic is quite interesting, it is beyond the scope of the current investigation and is therefore not the goal of this thesis. Additionally, through following the thought process of this paper's development, I realized a central

point: in investigating a topic, it is interesting to draw information from various sources, and to note the cross-fertilization of ideas that can occur across sometimes disparate fields of study. These types of phenomena, however, rarely give true insight into the information itself. Fields of study, while based on basic divisions of knowledge, are a manufactured construction. There is no reason, for instance, why a student of music should not have access to physics courses related to the physical properties of sound—the division is based mainly on tradition.

For the purposes of this thesis, I take the position that information is information, regardless of its origin. What is of interest to any investigator or learner is the context in which the information is presented, namely if it is relevant to those who can make use of it. It is based on the rationale that I have chosen to structure this paper around the context in which I hope it will be used: instructional design practice.

Introduction to development process

In general, framework development proceeded in the way outlined in the "Approach" section, based on the model presented in Appendix 1, to be described below.

While I have done my best to describe to process undertaken in framework development, it must be noted that once the literature review was mainly completed, and the case study notes compiled, much of the work that

followed was of an iterative, rather than procedural nature. The description of the framework development process which follows is, at best, an outline of "key events" within a considerably less structured process.

The main catalysts behind shifts in the framework were, in fact, usually a result of my own thoughts in observing and noting the interactions between the various concepts encountered in the literature and case study. Key articles I had read previously often took on new and different meanings when reflected in the light of reading of other sources. This phenomenon was, in fact, the identical dynamic I had hoped would result from this project; in particular from the 'cross-fertilization' that occurs in an examination of literature that spans disciplines and publishing dates.

Above all else it has been my own evolving understanding of the concepts and the relations between them which has been the driving force behind the framework's development. In a metaphorical sense, I have taken on the role of a detective: collecting elements from various sources, hoping that through the careful process of deduction I will be able to piece together the relationships between them in order to uncover the whole picture.

It is also in order to acknowledge the possible biases involved in such an endeavour. If time and resources had permitted, it might have been an interesting exercise to introduce a procedure akin to "inter-rater reliability". Regrettably, given the scope of my thesis, the implementation of such a procedure would have required that a second, and possibly third 'rater' be already familiar with the subject matter, as well as willing to carry out their own literature reviews, case

study observations and framework development. Realistically this would not have proven a viable option, particularly in the absence of a provision for huge sums of monetary compensation.

Outside of issues of personal bias, I would like to re-emphasize the bias that has intentionally been incorporated into this investigation; namely, an instructional design and multimedia design perspective. The rationale behind this is it would serve to narrow the scope of an otherwise unruly subject area, making it more comprehensible to those within the field of instructional design.

Stages of Development

The first three stages of the framework development process are the informal, unformed beginnings of my thesis. They can be described as the exploratory phase of development. As the framework itself is a structured arrangement of *concepts*, it is fitting to give a brief account of the shapeless stirrings of my own initial interest, and the beginnings of my understanding of the topic.

Informal literature review

This stage consisted of my initial interest in the topic of visual communication, as well as sub topics such as visual perception, interface design, etc., since I have been collecting literature out of personal interest for some time. This stage also includes the exploratory literature searches I conducted, in order

to get a clear idea of what literature existed on the subject, and which subject matter domains touched upon it, i.e., becoming familiar with the literature available on the topic in general; e.g. visuals in learning, interface design, symbolism in images. It was at this stage that I started to notice the overlapping nature of the literature.

Informal case study observations

This stage, as well, occurred before any formal decision to conduct a case study. It consisted of informal observations of the design meetings in which I was participating with the Reading CAT project. At this stage I noticed multiple occurrences of discussions relating to visuals arising in an instructional design setting, and decided it would be a rich and varied source of data for a small case study.

Pre-Framework

Before starting this project, I had already begun, out of personal interest, to create a conceptual map of the overlapping domains related to learning, computers, and visual communication. This was brought about, in part by my participation in a course offered by Concordia's design department. The combination of both instructional and traditional 'design' courses led me to question how interface design, instructional design, and the study of visual communications overlap, and to lay the groundwork for the construction of the framework.

Literature Searches

The literature search was made up of 3 parts:

1) An initial literature search;

2) The literature review itself, and

3) A revised literature search.

The goal of the first part was to identify the main search terms, as well as the domains and corresponding literature bases that might inform the topic, (i.e. the domain of computer science, and the literature on human-computer interaction). This information, as well as the search terms found in the case study notes, was used to guide part two of the literature review.

1) Initial literature search

In this stage, I began looking for articles pertaining to visuals in general. No *one* article seemed to summarize the various factors related to the design of visuals in instructional multimedia. I started looking for articles that addressed components of the problem; e.g. interface design, metaphor, symbols etc.

I then began formally compiling search terms. Over time, I edited and added to this list, keeping track of which were appropriate and those with returned non-relevant results. Appendix 2 documents this. Searches were conducted both online and in library databases. I also used branching as a method of finding further articles. Part of the idea behind doing this was to try—as much as possible—to get back to the original sources of the theories and

ideas, whether they were in the form of an empirical study, or an important article from a well-known researcher.

One thing I noticed was the interconnected nature of the literature. Through an informal form of frequency counts, I observed that certain researchers and specific articles appeared more often in reference lists. These articles and books, it seemed, formed the conceptual basis for more recent articles. While newer articles bring the benefit of presenting concepts in a current context, the older articles I surveyed appeared to be the richer source of information. An example of this: author Nelson Goodman, whose theories regarding symbol systems have been referenced by researchers from such diverse fields as art history, anthropology, education, and communication theory.

To explore the extent of these links, I created a number of concept maps tracing the central references from various articles. Rather than map every reference from each article, I focused on mapping the names of the researchers who had become most familiar to me during my literature reviews over the past two years.

This process helped me to see how the articles from various fields were, in fact, interconnected, and more specifically, how seemingly unrelated articles and authors might actually share a similar conceptual basis. Seeing these links also made it clear to me that it would be possible to create some kind of structure and coherence out of the vast and varied body of literature on visual communications.

2) Main literature search

The main part of literature search was carried out over the course of about a year and a half. During this time, approximately 300 articles and books were found and retrieved. Out of these, approximately 200 were entered into a database system. Each of these was initially coded with combinations of keywords; e.g. metaphor, icons, illustration, semiotics, visual literacy, etc.

3) *Revised literature search*

After the bulk of the literature had been collected, the next phase consisted of sorting through, scanning, weeding out, and organizing the articles. As could be expected, upon closer inspection, a number of articles revealed themselves either minimally useful, or irrelevant. The rest were organized in binders.

Framework – Stage 1

As the literature was being collected, a focus was put on identifying and clarifying the terms and concepts found in the literature. Any new terms or concepts encountered in the literature that related to concepts being investigated were recorded. In some cases, these were also added to the search term list.

The concepts found in the literature review were used to create Stage 1 of the framework. The initial drafts of the framework concept maps can be seen in Appendices 3 and 4. As is readily apparent, preliminary concept maps still maintained a focus on the sources of the concepts: i.e. each concept is depicted as stemming out of its 'root' subject matter domain. For example, the concept of

"symbols" is shown as a sub-set of "semiotics", which in turn is a sub-set of "media studies".

Although representing the concepts as such was a useful exercise, the resulting concept maps were deemed non-satisfactory because of their over-emphasis on the structures of subject matter domains, a feature that resulted in the subordination of the actual concepts being investigated. I felt that a more effective approach would be to go about structuring the concepts according to the inter-relations among them.

A second concept map (Appendix 4) reveals a move closer to the above-mentioned goal. Subject matter domains are still present, although this time, concepts are grouped more according to their qualities; e.g. 'navigation, 'motivational', 'aesthetic', 'illustrative', and 'cueing/highlighting', are shown occupying the same horizontal line as a way of denoting that they are all terms relating to the "function of images".

Field Notes/Case Study—part 1

At the same time as the literature search was being conducted, participant-observer notes were being taken during the weekly design team meetings in which I participated. Notes were taken every time a discussion related to the design of visuals within the software took place. Initially, all notes were organized according to the date they were taken.

Over time, as more observations were recorded, it became evident that the notes could be classified into particular kinds of categories according to the types of issues that were discussed.

Framework – Stage 2

The above-described concept maps were shown to the thesis committee members in order to received comments and suggestions. One committee member pointed out that the appropriate terms for the label "degree of resemblance to reality" is "fidelity"—a term often used in the field of gaming and simulation. Another comment was made regarding the slightly unruly graphic format of the diagrams.

Most significantly, after the presentation of the concept maps, one committee member raised the question of how the concepts being examined related to current approaches in instructional design practice. This point prompted a much-needed rethinking of the structural aspects of the framework, resulting in the question: How do the concepts I am dealing with fit in with the general structure of instructional design models?

The big picture: situated in ID models

In reviewing my work to that point, I realized that my framework was too "zoomed in". Although the impetus behind making the framework was to outline the components of the topic, I realized that those components needed to be contextualized within the larger sphere of instructional design, in order to be relevant to instructional designers. I therefore set about creating a concept map to situate literature on visuals (namely, that which is being addressed in this thesis), within the way in which visuals are approached in instructional design literature. The resulting diagram (Appendix 5), shows visuals as being one of the

various symbol systems available within the medium of computer-based learning. In this sense, visuals are presented as being a subset of the body of literature related to instructional media.

Incorporating ID and Communication Approaches

This first diagram helped to account for the way in which literature related to visuals fit within the context of an instructional design approach. However, where, in this model would literature from other fields such as communication studies fit? In general, instructional design models present a process through which an instructional tool can be designed and created. In contrast, literature from communication studies generally approaches analysis of its subject matter from the standpoint of being *post* design and production. My challenge at this stage was to find a way for my framework to incorporate both of these approaches.

While conducting the literature review for the rationale behind this paper, I reviewed various pieces of research, (Braden and Clark-Baca, 1990; Jonassen, 1989; Moriarty, 1997) which had set about the task of creating diagrams to map out the dynamics of visual communication—both as a field and as a process. In my search for an appropriate representation of the 'big picture' of literature on visuals, I again turned to these articles for possible guidance in this area. It was during this time that I came across Moriarty's (1997) "Conceptual Map of Visual Communication" (Appendix 6). Moriarty's model is based upon her own extensive

interdisciplinary reviews of literature related to visual communication. Her model is a framework for conceptual ordering of literature in this domain. For my purposes, it provided a perfect overall structure within which to situate my own work.

In reviewing Moriarty's diagram, I made the realization that instructional design, as it is currently conceived in the literature (Smith & Ragan, 1999), mainly concerns itself with message production/construction, whereas the communications approach traditionally concerns itself with the sender/receiver model. While Moriarty's model is based on a basic sender/receiver communications model, it goes a step further, re-labeling the binary as 'production/reception'. Moriarty's model unites both aspects of the communication process—production and reception—depicting them as two over-lapping circles. The area where these circles meet is where the learner/audience/user interacts with the message.

It was this last permutation which provided the necessary conceptual clarification for me to be able to situate instructional design models in relation to communication studies methods. The next step in my framework development was to situate my chart within Moriarty's framework. The resulting diagram was Appendix 7, in which my original chart "Instructional Design Context" is placed with the "Message Production" section of Moriarty's chart. This is described in detail in the "Framework Description" section of this paper.

Going backwards to go forwards: the utility of reception analysis

Another way of describing the two main circles in Moriarty's model would be to say that the first consists of *constructing* a message, and the latter consists of methodologies for *deconstructing* messages. In the shortage of clear guidelines for constructing visual messages in instructional design, this paper draws on the information garnered from methods of deconstruction (i.e. semiotics), in the hopes that they will provide a needed conceptual basis that could eventually be applied to message construction (i.e. design). In this sense, it could be said that analysis is undertaken backwards, (i.e. post-design), in order that it may later be used forwards, (i.e. pre & during design).

Framework - Stage 3: Synthesis

Coding the literature

At this stage, the literature was revisited, and the initial keywords, which had been assigned, were compiled into broader category codes. In general, all of the articles collected could be classified according to one of five codes. In some cases, it was deemed more appropriate to classify them with combination codes; e.g. "interface design and instruction". In total, 11 folders were created, with either an individual or combination code, and the eleventh code was assigned as miscellaneous. The codes were as follows:

1) Symbol Systems
2) Visuals
3) Instructional Design

4) Interface Design

5) Reception

6) Instructional Design & Visuals

7) Interface Design & Visuals

8) Interface Design & Instruction

9) Semiotics & Education

10) Semiotics & Interface Design

11) Misc. (which included communication & design models, linguistics, design theory & practice and information design.)

Framework subsections

Once the articles had been organized into folders, they were scanned to determine which ones would provide the most solid and pertinent insights into the subject matter. As these were read, detailed notes were taken, paying particular attention to noting concepts and terms discussed therein.

These notes were eventually transferred to index cards. Individual cards were made for each author, with a listing of the concepts and terms provided in the article in question. Also included on each card were the code and sub-code of the folder the article had been assigned to. This way, every set of concepts could be matched both to its originator and to groupings of related concepts.

New concepts gleaned from the literature were used to adapt and alter the framework structure in an iterative fashion. The literature drove the framework development in two distinct, yet intertwining ways: providing additional variables

or specifications within a given sub-category of the framework, (e.g. an author's list of types of instructional pictures), and/or providing further insight into how a given component related to the overall framework structure, (e.g. an author's explanation of the continuum of realism in pictures). These initial mappings of relations among concepts eventually formed the basic structure of the framework.

Interrelated levels

Following the overall context presented in the "Instructional Design and Communication Context" diagram, the next step in framework development was to determine a structure to interrelate the main component concepts of the topic. These had been explored in a piece-meal fashion in appendices 3 and 4), but were not yet organized in a meaningful fashion. The starting point of this section of the framework is the image itself, as well as the ways and context in which it is used.

As will be explored further in the section "Description of the Framework", as the investigation progressed, it eventually became clear that each section of the framework was intrinsically related to the other sections. Therefore the sections came to represent descriptions of the various levels or areas of the whole, rather than distinct conceptual domains. Appendix 8 shows the first attempt at mapping out the concepts related to the image and its contexts. It is made up of three main sections; 1) the image as an entity unto itself (its characteristics etc.), 2) the ways in which the image is used, (in tandem with

other elements, instructionally, and in interface design), and 3) the ways in which a learner/user interprets and interacts with the image as it's presented. Each of these subsections was later elaborated upon in more detailed concept maps.

Evaluation 1 and 2

The final step was to apply the framework to the case study. This consisted of using the framework to illuminate and contextualize issues identified in the case study. Over time, as more observations were recorded, it became evident the notes could be classified into particular kinds of categories according to the types of issues discussed.

As the framework developed, so too did my understanding of the greater context of the problems examined in the case study. At this point, the original case study notes were reviewed in order that they might be organized into themes. Revisiting the case study notes with the perspective provided by the framework helped me to conceptually situate the particular problems encountered in instructional design practice within the theoretical structures provided by the literature. With the benefit of a 'big picture' view of the domain, I was easily able to group the issues encountered in case study into themes. These themes were as follows:

- Visuals as analogs to language
- Metaphor and Cultural codes
- Images maps: mapping meaning to images
- The role of illustrations

- Fidelity and virtual objects
- Representing concepts

Looking at the particular design problems recorded in the case study, I was able to relate each issue back to specific concepts within the literature, and therefore more clearly see where they might have originated, as well as possible approaches to dealing with them. These insights will be discussed in the final chapter of this paper.

Part II.

2.1 Introduction to Framework

Instructional multimedia makes use of many different forms of visuals, diverse both in format and purpose. This framework is an attempt at the creation of a structure to aid instructional designers with the task of sorting out and, ultimately understanding the various ways that visuals communicate meaning within instructional multimedia, as well as the underlying concepts which relate to them, so that they will be able to make well-informed decisions concerning the design of visuals in computer-based learning environments (CBLEs).

The phrase "visuals in multimedia instruction" is, admittedly, slightly vague and evokes quite a vast range of subject matter. As such, it merits further definition. Because a large part of this paper is centered on defining various aspects of visuals, I will avoid going into detail here. Concerning different *formats* of images, this paper will be primarily focused on 2D graphics, namely illustration and photograph-based images. (Although other forms of images used in CBLEs—video, 3D graphics, animations, and simulations—certainly deserve separate investigation, for our purposes, it is simply not realistic to include them here.)

In terms of the various *functions* that images serve in CBLEs, it is possible to construct an informal taxonomy of their uses simply through observation and common sense: as decoration, as icons or buttons, as a background scene, as

motivation, as an illustration of something, as a 'map' of the content, to emphasize something in the text, to give an overall feel or ambience to things, as a form of navigation, or to create a metaphoric representation of the content.

The small case study conducted as part of this investigation uncovered examples of some of the visual-related issues encountered in a large-scale instructional design project. Like the list above, the issues encountered over the course of the project were quite diverse, including: determining a visual theme or metaphor which would be appropriate for the target learners; questioning the role that illustrations play in supporting reading and motivating for children; determining if an image used for navigation is appropriate; finding a way to visually represent non-visual things such as concepts; questioning the extent to which objects depicted on the computer screen should be realistic, (among others). Viewed from a semiotic and symbol system perspective, all of these examples can be traced back to the issue of how a visual symbol corresponds to the message which the instructional designer is trying to communicate. The key to making sense of this correspondence is to understand the various levels of representation that can be communicated with visuals. This is the goal of the rest of this paper.

Once again, for the time being, we will say that this paper's scope will deal with two broad functions of images in CBLEs: instructional and interface functions. In approaching these issues from an instructional design perspective, however, it is essential to be able to sort out the details of these issues and identify which factors are at play in each of them; this requires quite a bit more

information than can be gleaned from common sense alone. In order to accomplish this, this framework presents instructional designers with a way of approaching these issues from a perspective which transcends the particular problems, and seeks rather to pin point the over-arching themes and concepts which govern each of them in relation to learning and interface design. It is meant to serve as a form of sieve for information; a method of finding common denominators among the concepts discusses in the various literature bases and of sorting through the terminology to get at the underlying meaning. Finally, it serves as an organizing system; a way of understanding how the specific issues discussed in one article, relate to the concepts discussed in other literature bases. The concepts included in it are drawn from academic fields as diverse as semiotics, art and software design; but no matter what the source, the framework serves to situate it within instructional design practice. This approach also offers the added benefit of weeding out aspects of the larger domain of visual communication that do not relate to the problem at hand.

A note regarding the inter-relatedness of the parts of the framework:

In trying to bring together the component aspects of visual communication in an instructional multimedia context, I have gone from a fine-grained analysis, back to the major over-arching themes that hold them together. I started out assuming I would be examining each concept individually—the various attributes of illustrations, the possible instructional use of images, how images are used to make up the navigation system of software, etc. I also assumed that I would also

end up describing some links between these factors and how they affect one another. In the end, I have discovered that every concept I am exploring is part of the same whole. With each new aspect that I explored, I realized that I was repeatedly hitting a specific brick wall; everything I explored ended up relating back to the issue of how we communicate meaning through symbols – in this case visual symbols, and the different levels of representation within visual communication.

Certainly, I expected that my analysis of a component such as a computer icon would relate to symbols in some way; an icon is often used to represent something symbolically. In this way, I initially thought icons differ from something such as an illustration that is usually meant to be an explicit depiction of something. Similarly, a navigational button on a website that is clearly marked with a text label – e.g. "home" - did not seem to relate to symbolic communication in any way; it seemed to me to function as simply a means to an end, like a handle on a door. In the end I realized that everything I explored could in some way be whittled away to reveal another level of symbolic representation. It is for this reason that the core of the framework is organized around the various levels of symbolic representation at which images in instructional media function.

The framework presents a fairly detailed analysis of the subject matter, but as outlined in the description of framework development provided in Section 1.7, an essential aspect of the framework is that it also seeks to situate these components within the context of instructional design practice. Additionally, the

entire framework is situated within an even broader level of analysis—that of communication in general.

With this approach in mind, let us first look at the overall context into which instructional design fits, and then approach the particulars of visual communication in instructional design and interface design.

Design and Communication Models

Primarily, in designing instructional multimedia, we are designing something that is meant help people learn. Instructional design comprises a number of different tasks; it is a form of design practice, but is not really design in the traditional use of the word; such as graphic design or industrial design. It does, however share a lot of similar attributes with other forms of design; such as a concern for the way in which the final product will be perceived and received by the people it is intended for. This abstract "person" is variously referred to as "the learner", "the user", "the audience", and "the consumer", depending on which field the person discussing it comes from. In instructional design, we usually use the word "learner", although in the case of computer-based learning, this abstract person is also a "user" of the system we have designed.

On a broader level, all forms of design can be considered forms of communication. The medium may differ, as might the purpose of the product, but in the end the aim is some form of communication, whether it is for educational purposes, practical purposes, and leisure or aesthetic purposes. In his discussion of the definition of "visual culture", Barnard (1998), makes a distinction between

visual artifacts which are *designed* and those that are considered *art*. That which is designed can be defined as possessing "functional or communicative intent", in the case of art, however, such utilitarian parameters are rarely as obvious. While it maybe argued that art might serve a function or possess communicative properties, such characteristics are not requisite for it being considered art. Similarly, although the design process might result in a product that is aesthetically pleasing, in the context of design, aesthetics is considered a subordinate goal to function; (Barnard quotes Louis Sullivan's phrase "form follows function").

Broadly then, we can say that things that are designed are done so for a *purpose* and that this purpose is to communicate something. In this sense, then, instructional design can be seen as a process of *communication*: a sort of 'conversation' that takes between the designer and the learner. A large part of what instructional designers do can be characterized as trying to determine the way in which the instructional 'message' of their design will be received by the learners. This is a characteristic which is shared with other fields of design, - e.g. industrial design, architecture, graphic design - although they do not all approach the process using the same methodologies. This is done in various ways:

- learner analysis
- formative evaluation & testing
- referencing findings from previous, related literature

At the other end of the equation, the field of communication studies, (or media studies), primarily concerns itself with analyzing media products – i.e. the results of someone else's design process. In this respect, communication/media studies can be said to be mainly concerned with a) the overall process of communication, and b) the way in which the produced message is interpreted by the audience – i.e. the reception.

Communication studies theorists have proposed various models to help visualize the complexities of these processes, a number of which can be (and have been), applied to create a model of the design process. The flagship model was Shannon and Weaver's (1949) transmission model, which laid the blueprints for most other models that followed. The basic factors that most of them have in common are the presence of a *sender* (the person who creates what is being communicated), a *receiver* (the person who receives what is being communicated), and a *message* (the information that is intended to be communicated). The idea is that the sender encodes a message, which is then decoded by the receiver. The key factor in this process is the extent to which this process is actually successful. Shannon and Weaver referred to any interference or distortion of the original message as *noise*.

Since the original model was presented, some communication theorists have leveled criticism against it, citing that it presents a rather behaviouristic view of human interaction (Chandler, 1994). Nonetheless, it has formed the basis from which other models have been created and altered over time. Later models, as outlined in Schramm's (1973) discussion of communication, emphasize the

significant roles that *context* and each person's field of experience play in how a message is delivered and received – a view that shares many similarities with Constructivist learning theories, (Driscoll, 2000). Others, notably McLuhan (1964), have emphasized that the medium through which a message is sent also plays a major role in the resultant message.

A primary distinction between Shannon and Weaver's initial model and more current views of communication is the acknowledgement that communication does not consist of a one-way signal that goes from sender to receiver; it is a cyclical interaction between the initiator of the message and those interpreting it. As Schramm (1973), explains: "We can accurately think of communication as passing through us—changed, to be sure, by our interpretations, our habits, our abilities and capabilities, but the input still being reflected in our output."

The linguist Roman Jakobson proposed his own model which is considered by some (Danesi, 1993) to be one of the more robust descriptions of the communication process. He incorporated three factors from the Shannon and Weaver model (sender, receiver, and message), and added three of his own factors (context, medium, and code). In more recent years, Jakobson's model has been taken up by members of the HCI community, (Scalisi, 2001) as a useful framework with which to analyze human-computer interaction. The basic elements of Jakobson's model, included with Schramm's mention of the role of field of experience are presented in Appendix 8.

Production and Reception

So, if instructional design is a form of communication, how then can we situate it within models of communication? In her survey of the interdisciplinary area of visual communication, Moriarty (1997) presents an overall framework with which to conceptually organize all of the diverse fields related to visual communication. Her diagram, "Conceptual Map of Visual Communication" (Appendix, 6), is similar in structure to basic communication models, presenting two overlapping circles surrounded by a larger circle which represents the context in which they meet.

However, her model differs from traditional communication models in that it is meant to represent bodies of literature and fields of investigation, rather than the actual act of communication. In Moriarty's model, the circle on the far left is labeled "message production" rather than "sender", and the circle on the far right is labeled "message reception" rather than "receiver". In this sense, "message production" includes all of the fields that deal with the *construction* of a message, whereas "message reception" includes the fields that focus primarily on *deconstructing* and interpreting messages.

For the purposes of the framework development within this investigation, Moriarty's has been used as an overall structure with which to organize and situate the various approaches to visual communication that are being examined, and to present to broader context of how they relate to one another.

Using her framework, then, we can situate instructional design, (or *any* form of design for that matter) within the area of "message production". Other

approaches, such as most of those included within communication studies, can broadly be included in the area of "message reception" in that they generally focus on analyzing messages after they have been created, (e.g. the analysis of a television program).

Let us now situate this investigation within Moriarty's model. Appendix 7 shows an adaptation of Moriarty's model in which the instructional process is overlaid on the "message production" section of the framework. Also included is "the receiver", which in the context of instructional design is *the learner*, and Jakobson's notions of *context* and *code*. Given our particular focus on visuals in multimedia instruction, our model specifies certain variables, namely, that the *medium* is "computer-based learning", and that the *code* is visual.

Code and Context

The use of the term "code" may bring with it the connotation of something esoteric. On the contrary, most aspects of our everyday lives revolve around codes of some sort. A student of semiotics would explain that the code is the way in which we organize symbols to communicate meaning to one another, (Danesi, 1993). Another way of describing this would be a symbol system; a system of communication that is based on signs and the designated inter-relations among them. Language, including its letters, vocabulary, punctuation, rules of grammar and syntax is an example of a code or symbol system. In short, any form of communication is mediated by a code/symbol system. Although there are many

different forms of symbol systems, and correspondingly many different ways of classifying them, the focus of this paper will be on the visual symbol system.

The meaning we derive from a code is largely dependent upon the context in which it is presented and in which we interpret it. An example of this is how the media are often charged with presenting peoples' statements out of context and in doing so, changing the meaning that was originally intended. The context can include how a particular message is presented in relation to other elements, (e.g. adding a text caption to an image), it can also include the way in which a particular element of a code is used – for example a crucifix being used as jewelry by a pop star like Madonna, (O'Brien, 1995).

The main sections of this framework are organized around these two central concepts, as can be seen in Appendix 8. The first sections deal with the *code*. Firstly, they explore the main aspects of symbol systems, as well as semiotic approaches to analyzing them. Next, they explore the specifics of the visual symbol system: how we represent things and concepts visually, as well as the differences and similarities between visuals and language. The final sections of the framework explore the *context* in which visuals are used within instructional multimedia and, more specifically, the ways in which they are employed in both instructional design and interface design. Throughout both of these sections, consideration will also be given to how these factors interact with the learners and their field of experience. The notion of syntax will also be explored.

2.2 Codes

Let us now take the time to review the implications of the line of reasoning presented in the previous section. Instructional design (ID) is part of the greater category of design practice, which has as its primary concern "functional [and]/or communicative intent". Design, and ID as a subset of design, can be described as a form of communication in which a message is exchanged between the designer (the sender), and the learner (receiver). This message is transmitted via a combination of signs belonging to one or more symbol systems (the code), and is further qualified by the context in which it is sent and received.

In order to help clarify how this applies to the context of this investigation – namely to visuals - we can draw upon the analogy of language. If we were to be holding a one-on-one tutoring session with a student, we would want to be certain that the way in which we communicated with that student was as clear as possible, as well as appropriate for them. In this example, the "sender" would be the teacher, the "receiver" would be the student, and the "code" would be whatever language they are speaking. Similarly, in the context of this investigation, the "sender" is the instructional designer, the "receivers" are the target learners, and the "code" is the visual symbol system.

Returning once again to Barnard's (1998) definition of design, it would follow that the main goal of including visuals within an instructional design context would be for either "functional or communicative intent", rather than for aesthetic purposes. It is relevant to note that such a definition might potentially

appear counter-intuitive to those who view images as serving mainly aesthetic purposes. Nevertheless, like language, images are simply another means of communicating meaning, albeit it their own unique form of code.

The relevant question that remains here for instructional designers is: I*n what ways do pictures fulfill functional and communicative purposes*? In short, if we are to understand how to use images within instructional design to their utmost functional & communicative potential, we must first fully understand the *code* of the visual symbol system. Before we do this, however, let us first concretize these concepts, by considering an example for the small case study undertaken as part of this project.

Case Study example

In designing a multimedia-based learning environment there is a tendency to aim at minimizing written explanations, and focusing instead on communicating in a non-verbal way, (Bonime & Pohlmann, 1998). In the context of design meetings within the design project used for the case study, discussions often fell on the issue of how to make the visual displays on the software (i.e., the graphical-user interface, or 'GUI'), adequately and accurately reflect the instructional goals.

An example of where an issue like this arose was in discussions around how the computer environment visually represented books. This theme had particular significance as the focus of both the software and the organization that

had commissioned the software, was centered on an instructional goal intrinsically related to books: literacy.

A major philosophical tenet of the client's organization is the notion of imparting and modeling concepts and practices related to books and "book culture". In making the move from a primarily paper-based program to incorporating a computer component, the client was concerned that this important message, as well as the 'feel' of book-based learning would be lost. The design challenge, therefore, was how to transfer these aspects to the computer medium.

Discussions of this issue mainly arose in relation to the story reading section of the software. The client expressed concern regarding the transfer of the reading stories from paper format to the computer, stating that they would like the computer version to maintain the look and feel of a real book. The team therefore set about designing an interface that would resemble a book. Problems arose, however in relation to the space constraints imposed by the difference in aspect ratios between books and computer screens. In short, what is a clearly legible convention of presentation in a book format is not easily legible when duplicated on a computer screen.

The design team met a crossroads when they realized that there were in fact functional and pedagogical reasons for *not* replicating the book presentation format. This problem was left in the hands of the graphic designers in the hopes that they might find a visual solution that would keep the 'look and feel' of a book, yet remain legible for reading. In the end, they designed the screen in such a way

that the stories were presented on an image that is it is a close-up view of half of a book – essentially forming a 'frame' in which to place the text of the given story.

Later in the development process, the clients mentioned that they would like for it to be possible for the student using the software to "turn the pages" of the onscreen book. (Up until this point, the pages in the book were made to advance by means of a key assigned on the keyboard.) The image of an arrow was suggested by the client as a navigational icon for this function. This issue was discussed in a design team meeting. The issue of exactly how realistic we could make the onscreen book was touched upon when the point was mentioned that "books don't have arrows in them".

The above is but one example of the kinds of issues encountered while designing visuals for instructional multimedia. While a certain amount of disconnect between a visual and its meaning or functioning might appear novel or "artistic" in entertainment-focused software, within the context of a computer-based learning environment occurrences of this could potentially cause disorientation and cognitive dissonance for learners (Chalmers, 2003; Faiola & DeBloois, 1988).

In the sections that follow, we will explore concepts that will be helpful in analyzing examples such as these; namely, a way of analyzing the symbolic meaning of various forms of visuals encountered in instructional multimedia. We will begin this investigation with an overview of the principles and concepts related to symbolic communication in general, and then move on to look at the

particularities of visual representation. Finally, we will engage in an analysis of these elements in context.

Signs & Symbol Systems

Introduction

Human beings communicate in many different ways. We use that which we find in the world around us - words, gestures, body language, images, sounds, etc. – as symbolic placeholders for the ideas and concepts that we want to convey to each other. These symbolic placeholders, the systems we organize them into, and the meanings we attach to them, make up the basis for all forms of human communication. The anthropologist Edward T. Hall, has said that *all* human communication is symbolization, (Hall, 1973, p.97). Another theorist (Cassirer, 1944; as quoted by Cassidy, 1982, p.79) has gone as far as the state that it is precisely our capacity for symbolic representation, rather than rational thought that distinguishes humans from other animals, ("that which differentiates human from other animals is not that humans are *animal rational*, but rather that humans are *animal symbolicum*.").

The study of humankind's use of symbols is a thread of investigation that has been followed by people from many different disciplines over many years. In a sense, the study of symbols implicates every field, some of the more obvious ones being linguistics, psychology, philosophy, art history, and anthropology. In his book Man and His Symbols, Carl Jung (1964) discusses the fundamental

function of symbols in humankind's experience of the world: "Because there are innumerable things beyond the range of human understanding, we constantly use symbolic terms to represent concepts that we cannot define or fully comprehend." (p. 4)

Anthropologist Edward T. Hall (1973) asserts that 'man's total life' is communication and, in turn, that "communication is symbolization". In his terms, culture itself is communication, even if we are unaware of it or assume it to be universally understood. Similarly, Katz and Kahn (1973, in Mortensen), in their review of communication models, describe human action as communication, stating that: "The world we live in is basically a world of people. Most of our actions toward others and their actions toward us are communication acts in whole or in part, whether or not they reach verbal expression." (p.175)

Taken fully, the logical conclusion of this line of thinking is that human existence – action, communication, thought - is governed by symbols. In his exploration of art, computers, music and language, Holtzman (1994) traces links between theorists as diverse as Chomsky, Kandinsky, Schoenberg, Saussure, Panini, Boulez and Leibniz, and Buddhist thought. The main parallel he cites is that they have all aimed at viewing their discipline in terms of its underlying structure and attending symbolic capacities. In the case of the Buddhist Nagarjuna, the whole world is viewed as being an abstract system. Gerbner (1974) mirrors these thoughts in his discussion of symbolic representation in learning:

> The symbolic world...is totally invented. Nothing happens in it independently of man's will, although much that happens

> may again escape individual awareness or scrutiny. The reasons that things exist in the symbolic world, and the ways in which things are related to one another and to their symbolic consequences, as in a play or story, are completely artificial. This does not make their production any more arbitrary or whimsical than the events of the physical world. However, it means that the laws of the symbolic world are entirely socially and culturally determined. (p.473)

If we apply this to the communication and design models presented in section 2.1, we are faced with the consideration that the codes we communicate with are primarily arbitrary, and are therefore not universal—nor universally understood. The implication here for instructional designers is that in order to assume that a designed message is properly understood, we must be certain of the code we are using, as well as—most importantly—the familiarity of the learner with that code. Therefore, the first step in understanding the "code" of visual communication, (or any form of communication), is first to understand how signs and symbol systems function.

Approaches to studying symbols

There exist two different, but often complimentary approaches to studying symbols: the 'cultural-epistemic' approach and the 'semiotic' approach, (Gardner, 1974). In general, the former is concerned with symbols as cultural and historical artifacts and how these form the basis of human knowledge. In this sense, it is closely related to sociology and anthropology, investigating cultural phenomena such as myth, religion, ritual etc. The latter, on the other hand, is concerned with the structural arrangement and interrelations among symbols within human

communication, namely signs and symbol systems. This paper takes a semiotic approach to studying symbols, referencing theories related both specifically to semiotics, and to the study of signs within the structures of symbol systems. We will look at each of these in succession, but first, let us examine more closely what we mean when we designate something as a 'sign'.

Semiotics

Anything in the world can be a sign - any given object, sound, gesture etc., can be used as a sign if it is designated as such by someone; a circle drawn in the sand can be made to represent the sun, a squiggle on a piece of paper can represent a sound we make while speaking; a particular set of hand gestures could be made to represent a word within a system like sign language; and the appearance of rain within a novel (in literature this is called a "pathetic fallacy"), can be made to represent the turmoil experienced by a particular character in the story. However, if, as Jaffe (in Jung, 1964) suggests, "the whole cosmos is a potential symbol", how are we to go about interpreting these signs? Does this mean that everything in the world has symbolic meaning?

Regarded by some (Cassidy, 1982) as the 'inventor' of semiotics, Charles S. Peirce (1931-58) argued that all experience is mediated by signs; they are the intermediary between the sender and receiver of any message (Chandler, 2002). In short, semiotics is the study of how one thing is used to refer to another; whether it is the letter 'a' referring to the sound 'ah', a stop sign referring to hitting the break pedal at a given corner, or a picture of a house being used to refer to

the concept of "home" – we can call this 'symbolization'. Semiotics is a method of analyzing these relationships among symbols and their referents, as well as among each other.

A sign's communicative capacity is only limited by the extent to which its symbolism is known by the receivers of the message. Not unlike a secret code created by children at play, any form of communication is based on a series of relationships that someone has created between one thing and another. It is therefore reliant on the premise that all those involved in the communication be privy to the established "code".

For instance, take the example of children at play; two friends in adjacent houses – Chris and Austin - might devise a system by which they can communicate via flashlights. Their system could be as follows: one flash means "hello", two quick flashes means "my parents are home", and three flashes means "goodnight". In this way, they are using a limited repertoire of types of flashes – e.g. two quick flashes – to refer to specific pre-determined messages that they might want to convey to one another – e.g. "my parents are home".

In this case, the number of flashes used to represent a message, bear no relationship to the actual message being communicated. Three flashes instead of one could just as easily represent "Hello". The value that the flashes carry is arbitrary, and only derives its meaning from the convention agreed upon by the two friends beforehand.

Signs & non-signs

So what is or is not a sign? To clarify this, let us refer back to Barnard's (1998) definition, paying particular attention to the clause "*has, or is given*", (...functional, communicative and/or aesthetic intent). This phrase brings emphasis to the essential factor that it is *human beings* that give and read meaning into things.

Sol Worth (1981) makes a distinction between *natural events* and *symbolic events*. The former is used to describe the elementary act of recognizing the existence of something, i.e. a sense perception. The latter is the act of recognizing the communicative nature of something. He goes one step further and outlines three possible kinds of events related to this:

1) A non-sign event: something that has only existential meaning, e.g. encountering a tree in nature.

2) An ambiguous event: a situation in which it is unclear whether or not there is possible symbolic significance.

3) A sign event: a situation where it is clear that meaning is being communicated.

In an eloquently written article in the journal *Semiotica*, Worth (1978) relays the anecdote of a discussion he had with the French filmmaker Louis Malle. Malle had been conducting presentations of his films and, in doing so, discussing the meaning of his work. The discussion centered on the question of whether it is the creator of a work of art who creates the meaning, or whether half of the meaning of art lies in what the reader/viewer brings to it. Worth relays that

a participant in the discussion cited a statement which Picasso was thought to have once made: "Do we ask a bird what his song means? Do we ask a bird to interpret and explain his song? Why do you ask this of the artist?" Worth explains his response to this statement as follows:

> The implication seemed clear. The filmmaker as well as the painter should not only not be asked what his work means, but we the viewers should also not expect that we can know what it means. Our job is to enjoy the song and make of it what we will. I couldn't help replying somewhat tartly that man is not a bird, and I did not want to treat filmmakers or painters as birds, and that, further, I did not want to be treated as a bird by a picture maker. (p.8)

It seems that Worth's response to Picasso's purported question would be that there is an important distinction to be made between that which occurs naturally and that which is created by man. Although natural objects make take on the functions of signs, it is humankind which interprets them as such. Here, Worth also makes the distinction between what most literature terms "a visual sign", which can include natural signs – e.g. the sound of rain being a sign that it is raining outside – and the concept of 'picture' which is necessarily a human-made creation and is therefore automatically a "social artifact" and sign event.

What is a Visual Sign?

So, what within the visual realm is considered a "sign"? The term "visual" can be used to refer to an extremely large range of things. In its most basic form, it refers to "anything related to seeing or sight", (Oxford, 2001). This could easily include: drawings, statues, facial expressions, sign language, letters, diagrams,

computer graphics, a company logo, a light show at a concert, the upholstery on a couch, highlighting in a text document, animation, 3D graphics, a painting, graffiti, a photograph, random splatters on a wall, etc.

In short, anything we can perceive with our eyes can be considered a visual. But, with the goal of narrowing our scope, let us set about distinguishing among these various visual forms, first with broad strokes, and later, with increasingly precise strokes.

In his attempts at defining the word 'visual', Barnard (1998), moves from the wide ranging definition: "everything that can be seen", to the barely narrower definition of: "everything produced or created by humans that can be seen". To these broad definitions he adds two further, non-exclusive qualifiers, this time defining visuals based on the functions they serve; the first being *functional or communicative intent*, and the second, *aesthetic intent*. As previously mentioned, this investigation is concerned primarily with the former of the functions, although the latter does factor in now and then as it is often inextricably linked to function. Barnard's final definition reads as follows: "anything visual produced, interpreted or created by humans which has, or is given, functional, communicative and/or aesthetic intent."

Let us now consider some of the implications of Barnard's definition. Of all of the things which the eye can apprehend, we are concerned with those which are assigned a function and involved in communication – i.e. which are purposely used to communicate some kind of message. Sticking with this definition would allow us to draw a distinction between those visuals which have been assigned

meaning – e.g. a company logo such as the Nike 'slash', - and that which has not been assigned meaning, - e.g. a random splatter of paint on a wall. It is conceivable that a random splatter of paint could appear similar in shape to the well-known company logo, but the important distinction here is the intention and purpose with which it was created.

For an example of this, we can return to the example of the two friends playing with their flashlights. Not only is the system of codes they devised *arbitrary*, but also the notion of flashlight signals carrying any significance whatsoever. If they had not assigned meaning to them, the apprehension of a flash of light from his neighbour's window would have no meaning for Chris and would probably go unnoticed – it would be characterized as a "non-sign event" or "non-sign stimuli". Of course, there can be a fine distinction made here between a natural event – e.g. someone apprehending the incidental flickering light of a flashlight produced by someone looking for something in the dark, or a situation where the flashlight sign is purposeful, yet is not interpreted as such because the person apprehending it is not familiar with the code.

So how are these codes constructed? How does an arbitrary thing such as a flashlight signal come to convey meaning and how can we represent the relationship between a sign and that which it represents. Various theorists in semiotics have created models to represent this process, as will be explored in the next section.

Semiotic models

The process by which an arbitrary thing such as a mark on a piece of paper (e.g. a written word), is designated as standing for a particular concept is variously called 'symbolization', 'signification' an/or 'semiosis'. Semiotics - the study of this process - has its roots in the theories of both the linguist Ferdinand de Saussure, and the philosopher Charles Sanders Peirce, (Chandler, 2000). Both presented their own models of how symbolization takes place, and both models have also since been altered and adapted by theorists, aiming at clearer and more accurate models.

Saussure's (1959) model of 'signification' presents the 'sign' as a two-part entity which is composed of the 'signified' (what is being referred to, e.g. the concept of apple) and the 'signifier' (what is being used to refer to a given thing, e.g. the sounds of the word "apple").

Peirce (1931-58) on the other hand, presents a model of 'semiosis' which is triadic, i.e. being composed of three main parts, as elaborated by Chandler, (2002):

- The **Representamen**: the form which the sign takes (not necessarily material);
- An **Interpretant**: *not* an interpreter but rather the sense made of the sign;
- An **Object**: that to which the sign refers.

This three-part model brings to the fore a concept that was also emphasized in various communications models (Schramm, 1973), as well as in

Constructivist learning theories (Driscoll, 2000): the notion that the person interpreting the sign, (i.e. 'receiving' the message), plays a role in the way in which meaning is constructed. Peirce refers to the dynamic between these three components as the process of 'semiosis'.

In theory, semiotics can be applied to any medium or symbol system—language, visuals, sounds, even gestures, or scents. However, given that it had its roots in linguistic theory, some aspects of it are not a "perfect fit" in terms of describing visual signs. For example, Saussure's (1959) model was centered on the dictates of language and in particular, emphasized that the nature of the correspondence between a word and that which it stands for is *arbitrary*. Such a view of symbolization is appropriate within the context of language, but in terms of our discussion of images, it is neglectful of an obvious key factor in visual representation: the fact that visual symbols often resemble that which they refer to, and are therefore not entirely arbitrary. The notion of resemblance is a key issue within theories of visual representation, as will be explored in succeeding sections of this paper, and as such must also be a key component of any semiotic model that is to describe visual symbols.

While there have been a number of variations on the models put forth by Saussure and Peirce – notably Ogden and Richards (1923) – most maintain the same basic structure of the original models, differing only in their use of terms. Similarly, of those surveyed by the researcher, most do not account for the particularities of visual symbols. Knowlton's (1966) model (Figure 2), is one of the few exceptions. In his seminal article "On the Definition of 'Picture'", Knowlton

presents a model which is based on the work of Ogden & Richards, yet is specifically adapted to the context of visual representation. The model maintains the original Peircian triadic structure, yet depicts the model in four possible permutations, each depicting a different relationship between the signifier and signified, ("sign" and "referent", in his terms). In this way, Knowlton's model presents visual signification as existing on a *continuum* that ranges from perception to total arbitrariness.

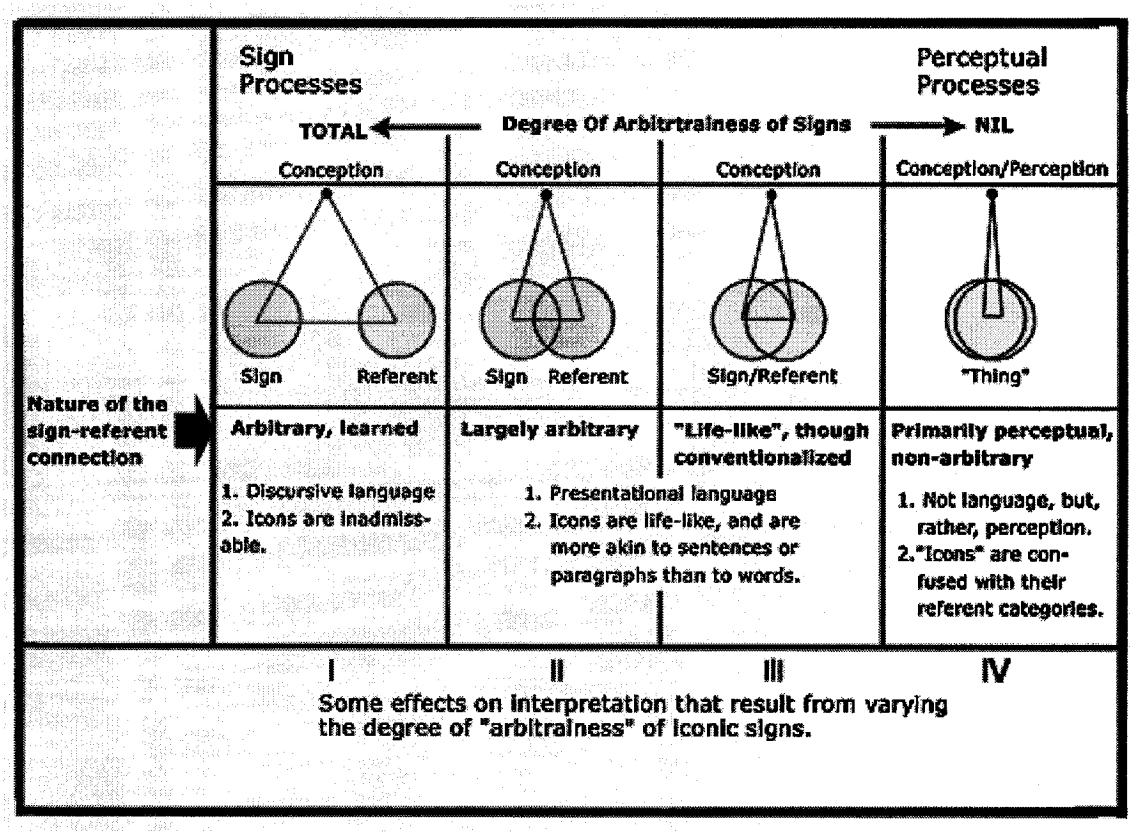

Figure 2 – Knowlton's model

Knowlton's model provides a very strong basis for any exploration of the symbolic properties of images. As such, it will be employed as the main semiotic model upon which this investigation will be based, and will be discussed in greater detail in subsequent sections.

As well, Knowlton's model provides a number of semiotic terms which are arguably more intuitive than other models. (The author would like to remind skeptical readers who might question the objectivity of the term "intuitive" that they are always welcome to take it upon themselves to replace the word "symbol" with "representamen".) This paper will therefore use the following terms (based on an adaptation of Knowlton's model, 1966), to describe the components of the semiotic model:

- The term "sign" will be used to describe the form that the sign takes, (depending on the sign's relationship to the referent, "image" or "picture").

- The term "referent" will be used to describe the idea, concept, or thing that is being referred to.

- The term "conception" will be used to describe the learner's interpretation of the sign.

- Note: As Chandler (2000) notes, term "sign" actually refers to the combination of *all three elements* that make up the sign. Most theorists in semiotics, however, use it to describe the signifier as well.

We will now take a more in-depth look at the various ways of classifying signs and symbol systems.

Classifying signs and symbol systems

There are various ways of describing and classifying signs and symbol systems. Gross (1976), for example, identifies five primary modes of symbolic behaviour: linguistic, social-gestural, iconic, logico-mathematical, and musical. Peirce theorized that there could be 59,049 types of signs (Chandler, 2002). Some symbol systems are highly formalized, such as language or musical notation, while and others tend to be less defined, and therefore more heavily dependent on the context in which they are used. Any given sign or symbol system can be described based on a number of different attributes: by the types of senses they engage; (i.e. visual, verbal, gestural etc.), by the structures and rules which govern them (syntax), and by the correspondence between the symbols they use and that which they refer to (semantics).

For our purposes, we will first examine three forms of categorization: 1) sense-based classifications (medium and modality), 2) types of signs based on correspondence between the symbol and the referent (semantics), and 3) the various ways that signs are organized and operate within symbol systems, (syntax).

Perceptual classifications*:*

As discussed in the literature review in the first section of this paper, literature in instructional design has often centered on issues related to media selection (e.g. Kozma, 1994 etc.). Efforts to explore this issue empirically have usually resulted in convoluted research findings (Clark, 1983), leaving

instructional designers with little information about the ways in which selection of media may influence learning.

Salomon (1979) and Olson (1974) have suggested that much of the confusion around media research is related to the fact that the cognitive influence of instructional media is more accurately described via an examination of the structure of the symbol systems employed, rather than the medium employed or sense modality engaged. As Gardner et al (1974) explain:

> The same medium (e.g. radio) may be a vehicle for different symbol systems (language, music) even as the same symbol system (e.g. natural language) may occur in different media (radio, print). (...) Important differences between language and other sorts of symbol systems are blurred in a classification by medium which stresses differences in sense appeal over more fundamental syntactic and semantic features... (p. 31)

In the same way as a focus on medium alone can result in overlooking the individual attributes at work in instructional media, focusing only on the *modality* of a symbol system can mask certain distinctions between them. In this sense, describing the "visual symbol system" as such is slightly misleading. Modality (e.g. tactile, visual, auditory), is but one of the many ways in which signs and symbol systems can be analyzed and, as Gardner et al point out, it is the *syntactic* and *semantic* features that serve as a more accurate description of a sign or symbol system.

Semiotic classifications:

Although he identified numerous types of signs, Peirce (1931-58), emphasized that there were three which he considered to be of central importance: the symbol, the icon, and the index (Chandler, 2002).

A "symbol" is a sign that has been arbitrarily chosen to represent something. Its relationship to the referent is based on convention (i.e. an agreed upon code), an example of this is the letters of the alphabet.

An "icon" is a sign that has a correspondence with its referent that is based on resemblance, (i.e. visually, physically, and auditorily). An example of this would be a picture of the sun. Within this category, and specifically for visuals, there are varying degrees to which a sign resembles its referent: a term used to describe this variance is "fidelity".

An "index" is a sign in which bears a *causal* correspondence to its referent, for example heavy, dark clouds being interpreted as an indicator of impending rain.

Peirce's categories can theoretically be applied to *any* sign, (visual, auditory, gestural etc.). What is often overlooked, however, is that in certain cases, these categories can be shown to overlap one another. This is particularly the case with visual signs which tend to incorporate both iconic and symbolic correspondences between the sign and the referent—for example, a picture of a dog being simultaneously used as a representation of a dog and as a symbol of the concept of 'loyalty'. As Gombrich (1972) explains: "Images apparently occupy a curious position somewhere between the statements of language,

which are intended to convey a meaning, and the things of nature, to which we only can give a meaning". The multiple and overlapping layers of symbolism in images are perhaps what makes reading the image so elusive.

According to type of symbol system:

While virtually anything in the world can be employed as a sign, a sign's communicative reach only goes as far as the code it employs is recognized and known by those receiving it. The likelihood of a sign being widely known is greatly increased if it is part of a larger communicative system, i.e. a symbol system. Language is a symbol system, although we often do not think of it as such. It is such an intrinsic part of our lives that we often assume it an almost transparent way of communicating, (de Man, 1979). The visual symbol system is part of another form of communication that we often take for granted, as is evidenced in the often-used phrase "seeing is believing".

Upon first inspection, it may not be entirely obvious why there is a distinction between a sign's modality and the symbol system of which it is a part. Sorting out these attributes can be confusing, because they are often non-discreet: sharing some of the attributes of other symbol systems, and yet differing in other respects. Language, for example, can take many forms: spoken language is auditory, whereas written language is visual; sign language, on the other hand, is a visual-gestural expression of spoken language. As well, when discussing the communicative properties of images, it is common practice for some to refer to images as being a "language".

Considering the above, it is understandable that the distinction between symbol systems might be confusing to some. If written language is essentially "visual", then what exactly do we mean when we refer to the "visual symbol system"? Furthermore, if we are to avoid sense-based classifications of symbol systems, how are we to make meaningful distinctions among them? In order to address these questions, and to further illuminate the particularities of the visual symbol system, we will undertake a brief comparison between linguistic and visual symbol systems.

Visual and linguistic symbol systems

At first glance, the differences between a visual symbol system and a linguistic one might seem obvious; one deals with pictures, while the other is concerned with words. In searching for similarities between them, one might identify that they are both are means of communication. Both, as well, could be said to be a familiar means of communication to the average person with at least a primary level education.

One major distinction that might not be immediately obvious is that fact that learning to produce and interpret linguistic content is considered to be a staple of a basic the educational curriculum, while little to no instruction is undertaken within the visual realm. This issue has been taken up by the interdisciplinary field of investigation known as "visual literacy". Visual literacy is a body of research that sprouted up in the 1970s. While a debate exists regarding the exact definition and the scope of research related to it (Braden, 1996), the term "visual literacy" is an attempt to make a metaphoric link between traditional

language instruction and visuals. The assertion behind it is that we should be taught how to 'read' visual content in school, in the same way that we are currently taught how to read linguistic content. This is based on the premise that our society – particularly due to the pervasiveness of the mass media – is becoming increasingly visual, and that people should therefore be taught how to understand and critique visuals.

The basic tenets of the visual literacy movement were based on noble intentions, however, several of its underlying assumptions have been met with criticism, notably that of Cassidy and Knowlton (1983). Their analysis of the movement points out that the term "visual literacy" is its self a misleading metaphor in that it is based on the assumption that visual and linguistic symbol systems are analogous, and that what is good for one is good for the other. Nonetheless, the debate surrounding visual literacy is a good illustration of the confusion that exists regarding the boundaries between visual and linguistic symbol systems.

In their analysis, Cassidy & Knowlton demonstrated that visual communication is structurally, as well as qualitatively dissimilar from language, and therefore cannot be taught in the same way. Their work drew heavily on Nelson Goodman's (1976) landmark and often-cited text "The Languages of Art: An Approach to a Theory of Symbols". As various authors (Salomon, 1979; Gardner et al, 1974) have pointed out, Goodman's work was considered a seminal turning point in the study of symbol systems, particularly because of its treatment of the often overlooked area of non-linguistic symbols. Goodman

outlines various characteristics of symbol systems, pin pointing some of the key ways in which one system differs from another.

Salomon (1979) provides an in-depth exploration of the applications of Goodman's symbol theory in the areas of cognition and learning. He defines a symbol system as a group of elements (a "symbol scheme"), arranged together according to two main classes of components: *syntax* and *semantics*. Syntax represents the rules for combining individual "atomic" elements to form a communicative whole; e.g. the arrangement of individual dots to form a picture of a face. While, semantics refers to the designated correlation between a set of elements and a field of reference; e.g. a set of musical notes and how they correspond to musical performance, or the alphabet and its correspondence to letter sounds.

Like Peirce's classifications for signs, Goodman (1976) describes the visual symbol system as being *iconic*, in that images are non-arbitrary, iconic, representational and/or pictorial, and share a resemblance (isomorphism) to the visual contour of the thing they represent. In contrast, he describes the linguistic symbol system as employing symbols that are arbitrary, digital, non-representational, or verbal (such as letters and letter sounds).

Using Goodman's criteria, Cassidy and Knowlton (1983) describe the differences between the linguistic symbol system and visual symbol system. They compare the critical attributes of the two systems in order to sort out where, if any, there is overlap between them. According to their analysis, the systems differ in an essential area: the linguistic symbol system meets the requirements of

Goodman's concept of notationality, while the visual symbol system does not. Similarly, Salomon (1979) states that it is the concept of notationality that "provides a yardstick for classifying symbol systems."

Put succinctly, a symbol system which is notational: "consists of a set of separate, discontinuous characters (e.g. a musical score) correlated with a field of reference which is similarly segregated (e.g. sounded pitches) so that any character in the system isolates the character that is correlated with it." (Gardner et al, 1974). In this sense, the alphabet is a notational system; each of the 26 letters used in written English has its own distinct shape, and symbolize something different from the other letters. Similarly, notes in musical notation, represent very specific pitches, and no two written notes can be said to represent overlapping pitches, as well, each notes can be clearly identified as being independent of other notes.

The same cannot be said for images. In pictorial representation, it is often unclear where one element ends and another begins, furthermore, there is no bounded set of characters such as an alphabet in visual communication; new and novel visuals can be created spontaneously, and theoretically, endlessly. As emphasized by Cassidy & Knowlton (1983) "For an iconic sign system to parallel a verbal sign system, it would be logically necessary that the iconic system specify all permissible combinations of these elements." (p.70).

Here it is useful to refer to the semiotic term "polysemy", meaning a sign that has multiple meanings. Although instances of this can be found in language – e.g. "orange" being used to refer both to a colour and a type of fruit – "the

iconic system allows the possibility that any and all orthographic variance may be potentially meaningful." (Cassidy & Knowlton, 1983). In short, while words may sometimes have multiple meanings, a given image can never be said to refer to one thing exclusively, (Salomon, 1979).

Pictorial elements can also not be said to follow basic rules such as grammar and syntax in the same way as language. These issues are explored in-depth by Worth (1978, 1981), the gist of which is eloquently summarized in the title of his 1981 essay "Pictures Can't Say Ain't". In it, he argues that:

> ...Picture interpretation is very different from word interpretation as regards its so-called pictorial code, convention, or "grammar", ...[and] that syntactic, prescriptive, and veridical aspects of verbal grammar are very different to apply to pictorial events. (p. 162)

A picture can only show what it shows, it cannot communicate the equivalent of a negative statement in language, e.g. a picture of an apple cannot represent the statement "this is not a pear". Neither, as Worth notes (1981), can a picture depict conditionals, counterfactuals, or past-future tenses. These aspects of the pictorial system mean that it is also difficult for iconic images to represent concepts or verbs, (e.g. "virtue" or "thinking"). The implications of these characteristics are that:

> Unless a pictorial sign is purposely conventionalized (made more or less arbitrary) for communication (e.g. nonverbal signs used to denote rest rooms and telephones), it cannot be said to have unambiguous and hence communicable meaning. (Cassidy & Knowlton, 1983, p72)

It is important to note here that while visuals cannot be said to be comparable to language in terms of *syntax* and *semantics*, it is still possible to

use these two important concepts to help describe and analyze visual communication.

In order to maintain the distinctions between language and visuals, it may be helpful to use terms which are less bound up in the workings of language. Gombrich (1972), uses the words *code* (semantics) and *context* (syntax), (as has been done in the paper), to describe the essential variables necessary to correctly interpret images, adding also the third variable of *caption* (the text accompanying the image).

2.3 Visual Representation

So now that we have looked at the basic concepts of semiotics, as well as the over-arching symbol system of which images are a part, we will now take a closer look at the particular characteristics of images by outlining a basic definition of pictures; as well, we will look at the various ways in which a given image can correspond to a referent, (i.e., theories of representation). In particular, we will look at these in relation to the type of images and symbolic functions of images in instructional multimedia.

Classifying visuals in instructional multimedia:

Use of terminology in the literature:

The literature on pictures in learning consists primarily of various taxonomies, created by researchers for sorting out and describing the possible applications of images in learning. A quick survey of some of the key articles in this area might leave an instructional designer a little bewildered, due to the often inconsistent and sometimes contradictory relations of one researcher's categories with another's. Without an understanding of the larger scope of the topic – i.e. the possible permutations and their interrelations – it is difficult to judge the relative merits of any researcher's categories. Let us take a look at the terms that researchers generally use to describe visuals in the literature.

Visuals in multimedia instruction can be classified in various ways. The ways in which we commonly classify visuals are often related to the terminology

that we have at our disposal. This terminology, however is not always the most useful or accurate. In selecting appropriate terminology, it is important to make a distinction between the perceptual aspects of the image, and the function for which it is being used.

A simple example of this is are the words "illustrative" and "illustration"; "illustrative" is an adjective used to describe an image which "[acts] as an example of something or explanation" (Oxford, 2001), the word illustration, on the other hand can variously be used to refer to 1) "a picture in a book or magazine", 2) "the action of illustrating", and 3) "an example that proves something or helps to explain it". The possible confusion here lies in the fact that, although the words share overlapping meanings, it is theoretically possible for an example of the first definition of "illustration" (e.g., a line drawing of a house), to be *used for a functional purpose that is not illustrative* (e.g. a picture of a house being used to represent various sections of an instructional CD-ROM). In this case, it is not so much the perceptual attributes of the image that are relevant to an instructional designer, it is the type of symbolic correspondence between the image used, and the chosen referent, i.e., *the message that is intended to be communicated to the learner.*

It is for this reason, that this paper emphasizes the distinction between the perceptual attributes of an image, and the symbolic function for which it is used in a given context, (which could be either an instructional function, or one of interface design). The last of these is a key tool to instructional designers employing images in their work, as it is a method for analyzing the semantics of

an image in a given context, and thereby clarifying the message that is being communicated visually. These two main factors will be looked at in turn in the sections that follow, but first, let us conduct a brief analysis of the ways in which visuals are discussed in the literature.

Perceptual classifications of visuals

Many different terms are used, both within the literature and everyday language, to describe visual phenomena;" visuals", "images", 'pictures", "illustrations', "photos", etc. However, the exact meanings and differences among them are not always clear. This lack of clarity in the terminology can potentially create confusion, both for those conducting research, and those whose would make reference to it. In terms of the focus of this investigation, the entangling of this terminology is a necessary step in constructing an unclouded overview of the types of images that exist, and the purposes for which they are used. What follows is a brief analysis of the various uses and definitions of some of these terms, as well as a clarification of the ways in which they will be utilized within this paper. Many of the examples presented below mix both perceptual and functional descriptions of images, they are discussed here as such in order to give the reader an idea of the very confusion that often exists regarding these terms.

If we refer to the Oxford dictionary, we can see that the words that are used colloquially to refer to visuals are often poorly distinguished from one another. For example, the term's "image" and "imagery", although appearing similar, are often used to mean varying things. According to the Oxford dictionary,

the word "image" simply means "a likeness of someone or something". For the word "imagery", two different definitions are supplied: 1) "language using similes and metaphors that produce images in the mind", and 2) "images as a whole". Imagery, therefore, can include both mental imagery and any use of images in general. "Visual" is defined as both an adjective meaning "relating to seeing or sight" or and a noun denoting "a picture, piece of film, or display used to illustrate or accompany something". To "visualize" something, on the other hand, means to "form a image of (something) in the mind". Finally, a "picture" is defined as being a painting, drawing or photograph; an image on a television screen; a cinema film; or "an impression formed from a description of something".

If the dictionary definitions present an overlapping and confusing account of the exact meanings of these words, it is not entirely surprising that parts of the literature are correspondingly discombobulated; often bearing an overall lack of consistency in the usage of terms associated with visuals. Words such as 'picture', 'visuals', 'image', and 'illustration' are used to mean varying things by various researchers. A major implication of this inconsistency is a possible weakening of research in this domain due to poorly defined research variables. A simple example of this can be found by a quick survey of the ways in which various researchers use these terms, and their relation to the actual variables of the research conducted. Table 1 lists a number of different researchers, and the terms they have used in reference to various aspects of visual communication.

Table 1 – Comparison of uses of visual terms in the literature

Researchers	Terms used	Referring to	Not referring to
Hill & Baker, 1983	visual imagery	mental imagery only	
Kosslyn, 1975	visual images	mental imagery only	"percepts", i.e. non-mental images
Levin et al, 1987	pictures	photos, drawings & mental imagery	figural images
Mayer & Sims, 1994	picture	animation	still pictures
Brody, 1987a	pictures	photos, drawings, paintings	mental imagery or figural images
Rankin, 1989	illustrations	figural images only	
Winn, 1987	figural images	figural images	any other types of images

Hill & Baker (1983), for example, use the term "visual imagery" as a way of referring exclusively to the mental imagery that is elicited by descriptive prose passages in instructional materials. In this example the use of word "imagery" follows the conventional definition, yet the addition of the word "visual" confounds the meaning because in truth, they are referring neither to the act of seeing, nor to any visible object. Similarly, Kosslyn (1975) uses the term "visual images" to refer to *mental* imagery. As he later mentions in passing, his discussion excludes "percepts", or non-mental images. Strangely, the terminology he has chosen does not make this last point readily apparent.

The terms "illustration" and "picture" have also fallen prey to confusingly liberal usages. Rankin (1989) purports to be investigating "illustrations" in learning materials, yet further inspection reveals that his study only dealt with charts, diagrams, and graphs. Mayer & Sims (1994) start out discussing the role

of "pictures" in instructional materials - mentioning still images, such as textbook illustrations in their literature review and article title – only to indiscriminately present a research methodology that focuses specifically on animation. Their article never discusses the possibility that there might be a difference between still and animated images, therefore making both their literature review and article title not entirely appropriate to what they actually studied.

Thankfully, some researchers make a point of clearly defining the terms they use and the variables they are investigating. Levin et al (1987), explicitly outline what they mean when they use the word "picture" in their research. Their definition includes photos, drawings and mental imagery, but does not include images such as charts, graphs, and diagrams. Although their variables are well defined, it is unclear why and how they have chosen to treat 'real' physical images and the mental images as equivalent stimuli.

As we saw in the section on symbol systems, definitions and classifications are heavily reliant on the intention behind what is being investigated. It is therefore logical that the various categories for visuals would vary slightly according to the aim behind the research. Trouble arises when authors use words without regard for their established meanings, (as in several of the above examples). Part of the problem in defining terms within the domain of visuals is that each term used is a form of delineation, a marking off of territory. In order to define a visual as being in a given category, it is often necessary to explain why it is not part of another.

Functional classifications of visuals

Let us turn now to the various functional purposes for which pictures are used within instructional multimedia. In the initial description of this framework, an informal taxonomy of possible uses of images in instructional multimedia was made, it was: as decoration, as icons or buttons, as a background scene, as motivation, as an illustration of something, as a 'map' of the content, to emphasize something in the text, to give an overall feel or ambience to things, as a form of navigation, or to create a metaphoric representation of the content. In general, these various things can be grouped into one of three broad categories:

- Aesthetic
- Instructional (photographs, illustrations, video, 3D graphics, animation and figural images)
- Navigational (icons, buttons, image maps and visual metaphors)

As previously stated, this investigation is primarily focused on the second and third categories. It should be noted, however that all three are very much interlinked. For example, an image which is used within an instructional context for 'motivational' purposes, is most likely being used as such because of its aesthetic properties as well. Similarly, as will later be examined, there is often a blurring and overlap between the navigational and instructional functions of the computer interface.

Most of literature pertaining to the instructional functions of pictures pre-dates the now extensive use of computers in education. For the most part, however, the images used in instructional multimedia serve quite similar

purposes as those originally employed in traditional formats such as print. The obvious exceptions to this are the use of animation, video clips, simulations and 3D graphics – the analysis of which would most likely benefit more from film-related literature. Another less obvious exception to this, is the use of the graphical user interface (GUI), as a means of structuring and cueing parts of the content. This too could be argued to serve an instructional function, as will be explored in a later section.

Levels of Visual Representation

As the above section explained, the classification of images is often muddied by a disregard for the difference between the perceptual, symbolic, and functional aspects of an image. The following is a proposed framework for sorting out these three aspects of images in instructional multimedia according to the representational levels upon which they function. It draws on the work of Plato, his theory of *Forms,* as well as his analysis of the dynamics of representation, as outlined in *The Republic.* It then looks at some critiques of Plato as presented by as Gombrich and Goodman, as well as their own theories. It presents a structure which integrates the basic elements of Plato's theory with Knowlton's more semiotic approach of viewing visual signs on a continuum. Lastly it extends these models, by elaborating further levels of representation in order to address the specifics of visual representation in computer environments. The theories of Plato and his critics will be examined before the framework is presented, in order to ensure that the conceptual groundwork has been established. Afterwards, the

overall structure will be presented (with cursory descriptions). Finally, each level will be explored in more depth individually.

Before we being, however, let us first take a moment to clarify the definitions of some of the words related to representation.

Definitions:

Representational: 1.) "Relating to representation", 2.) "Relating to art which shows the physical appearance of things".

Represent: 2.) "Be a specimen or example of", 4.)" Show or describe in a particular way", 5.) "Depict in a work of art", 6.) "Be a symbol of".

Representation: 1.) "The action or an instance of representing", 2.) "An image, model, or other depiction of something"

Usages:

Variations on the root word "represent" intersect in ways that might possibly be confusing, given the aim of this investigation. The main distinction I would like to make is between the words "representation" and "representational". The literature makes use of both terms about visuals, yet the terms are distinctly *not* interchangeable.

In general (and certainly for the purposes of this investigation), the term "representational" is used in the sense of the second definition given above; as a reference to a particular classification of images: those which bear physical resemblance to that which they represent. An illustration or photograph would be an example of this, (in Pierce's terms: an "icon").

The term "representation", on the other hand, is used in two ways that are pertinent to this study: in the sense of the first definition given above, meaning the general act of representing, and also as a noun to describe an instance or physical manifestation of representing, namely "*a* representation". The following section will be an examination of representation in the sense of the former; namely, how humans go about representing things, (both iconically and symbolically); in this case, specifically via visual means.

Plato's Theory of Representation:

In his writing, Plato describes the world as being made up of levels. He contrasts the world of human ideas, with the 'real world' of objects and people. He further makes a distinction between these both and what he calls "representation" or "imitation" – namely man-made objects and images. While his theories have been met with criticism, they form a conceptual basis from which to regard images and the levels of meaning they are capable of representing.

Plato's writings mark a basic ground zero for theories of representation, and have been revisited, reworked, and revised. They are therefore an essential starting point for clarifying the various levels of meaning that can exist in picture-based communication.

Plato was concerned with how humans perceive and make sense of the world, (how we discover true knowledge), as well as the veracity of these perceptions. He described the human mind as being capable of comprehending four different levels of reality: imagining, belief, thinking, and knowledge. In correspondence with these levels, are four levels of representation of an object: images, things, mathematical objects, and *The Good* or the *Forms*. They form the following framework:

Plato's Divided Line

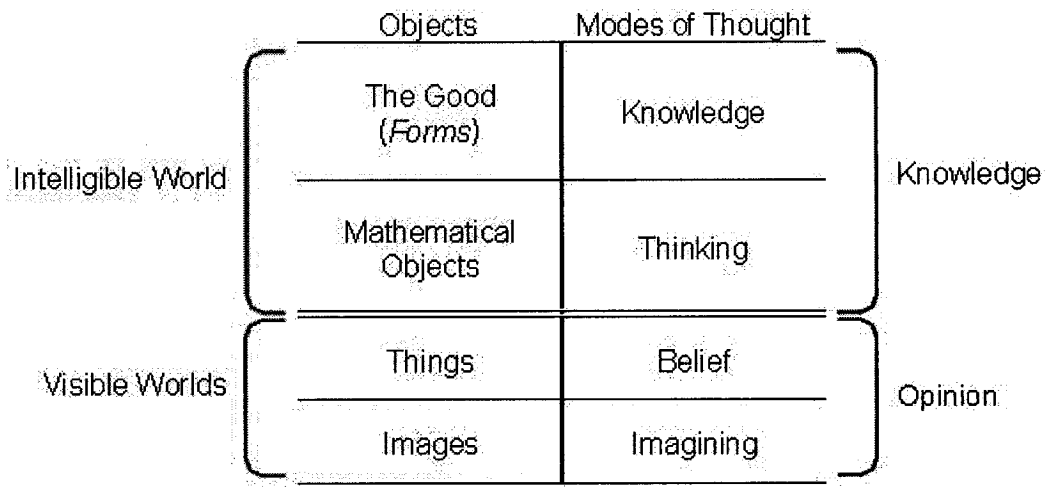

Figure 3 – Plato's Divided Line

As Stumpf (1977) explains: "The objects presented to the mind at each level are not four different kinds of real objects: rather, they represent four different ways of looking at the same object" (p.56). In this sense, according to Plato, there exists a hierarchy of representation.

Forms and Particulars:

For every thing in the world, there exists, (at least theoretically), a higher, perfect manifestation of it – a *Form*. Although there is some debate as to the exact definition, a *Form* is understood to be the abstract, prototypic manifestation of a real life object. In theory, everything in the world – people, objects, places etc. – would have a corresponding form. A simple example of a form is the notion of a perfect circle: the worldly manifestation of a circle is debatably never perfect, we can, however, imagine what a perfect circle might be. Stumpf (1977) describes the *Forms* as "...those changeless, eternal, and nonmaterial essences or patterns of which the actual visible objects we see are only poor copies" (p.60).

Second highest in the hierarchy, are 'Mathematical Objects', for example, the geometric formula for a perfect circle. Next down from these, are the actual things themselves. In Plato's terms, the everyday examples of things that we encounter are called the *particulars*. For example, a wheel is a particular of a circle.

Eaton (1964), describes the concepts of forms and particulars using the words *universals* and *individuals*, or more simply, "what" and "this". To allow for more accuracy, I will refer to them as "universals" and, rather than use the term individuals, I will use another oft-used term "instances".

In Plato's view, an instance of something – for example, a chair - is called an "*imitation*" in that it is considered to be imitating the original *Form*. To Plato, the Form is reality, a parallel, abstract reality, which we apprehend only through

knowledge. Things or "instances" are that which manifests itself concretely, our apprehension of which is based only on belief. Because our perception of an object is so heavily dependent on context for its meaning, Plato considered it deceptive. Therefore "seeing constitutes only believing" (Stumpf, p.58), and is not regarded as true knowledge of something. Our understanding of a physical object is limited by our perception. For example, if each time we went to a movie theatre, we were to arrive and leave when the theatre lights were turned off, we might be left with a certain impression of the surroundings. The upholstery of the seats, for example, which could be pale blue in colour, might appear dark blue to us, and we might very well believe it to be so, because our only experience of it has been in a darkened environment.

A basic example of this would be that when a carpenter constructs a chair, he is, in fact making an *imitation* of the *Form* of the chair. A painting of the chair made by the carpenter is therefore considered an *imitation of an imitation*.

While Plato's description of the concepts of Form and particular (or universal and instance), places them in hierarchical relation to each other, Eaton's account presents them as two sides of the same coin; inextricably linked to one another. Just as one would be at odds to describe darkness without relating it to lightness, any given object in the world is simultaneously defined both by its membership to an over-arching category, and its own unique characteristics. Although we may be able to identify individual characteristics of a given object, even the characteristics themselves – e.g., redness - are universals and as such escape our grasp, (as Eaton puts it "[one] is not presented with

sheer *whiteness* or *betweeness* or *beforeness.*"). In a sense we can say that our experience of both universals and instances is paradoxical: the seemingly abstract universal manifests itself through the instance, and the instance, when closely examined reveals itself part of a universal.

Family Resemblance:

The extent to which various particulars within a category share certain key attributes, is called family resemblance. The specific attributes of an object are what identifies it as being a member of a given group, as well as simultaneously identifying it as *not* being part of another group. Take for example, an apple: certain key factors such as general size, taste, shape, internal appearance, (i.e. the seeds), texture of the skin, make up what is generally agreed upon to be "appleness". Although there is certain variance in a number of attributes—e.g. the exact shape, taste, colour—even these are within a certain range of possibilities, (i.e. apples are not blue, and do not taste like cabbage).

These attributes are often how we go about classifying and distinguishing among things. Apples are part of the broader classification of "fruit", which, in turn is part of the broader category of "food". This act of mentally classifying the things around us also plays a role in our perception of them, (Knowlton, 1966).

When we perceive something – in this case, *visually* perceive something – we first identify it as being part of its larger, over-arching group, and then perceive its particular, individual attributes.

An example of this is when you think you recognize a friend on the street. If the person you see is at a distance, the first thing you notice is that they

resemble your friend – i.e. the person and your friend share certain key characteristics – for example, they both wear glasses and have similar winter coats. The person might also have a similar overall 'style' as your friend. In 'recognizing' the person, you have unconsciously identified him/her as belonging to a similar group (at least on a visual level), as your friend. Of course, if you approach the person, and observe further details, you may well discover that he/she is not, in fact your friend.

The same dynamic is true of inanimate objects. Seeing the front part of a bus peak out from around a street corner might lead you to believe that you are about to miss your bus. The object you perceive is the same colour and approximate size as a commuter bus, it also bears very similar markings, such as blue stripes; but as it pulls out from around the corner, and you observe more details, it is clear to you that it is a small, specialized bus for physically disabled people. This act of recognizing something is one of the first levels of visual perception. Even the word 'recognize' denotes the act of cognitively revisiting something that one has previously experienced. This factor also comes into play in the act of interpreting an image—if a person has never seen any sort of automobile, let alone a commuter bus, they are quite unlikely to recognize one if presented with a picture of it.

Images:

At the bottom of Plato's hierarchy, we find *images*. Images - in this case mainly defined as paintings and drawings - are regarded as being at least two steps removed from reality. With objects being considered to be at the first level

of representation, images – mere imitations or copies of objects - are relegated to the second level of representation. In short, Plato regarded any form of artistic representation as circumspect, claiming that it takes us in the wrong direction, focusing on appearances, and leading us away from reality.

Plato's ultimate condemnation of art and the obvious empirical deficits in his theory of Forms have lead philosophers to criticize the universal applicability of his theories. However, the basic tenets of his work remain the important building blocks for virtually any theory of representation.

Without taking his theory too literally, it is possible to view the *Forms* as merely representing the ideas and concepts we employ in thinking about the world around us and to relate a particular object to an over-arching category. This is a core aspect of thought, and as Stumpf (1977) explains, Plato himself regarded it as such, believing that:

> Thinking, therefore, represents the power of the mind to abstract from a visible object that property which is the same in all objects in that class even though each such actual object will have other variable properties: we can, in short, think the idea Man whether we observe small, large, dark, light, young, or old persons.
>
> ...Thinking and discussion proceed for the most part on a level above particular things. We speak in terms of the essence or universal that things illustrate, so we speak of queens, dogs, and carpenters. These are definitions of things and as such are universals or forms. (p. 64)

Like semiotics, Plato's theory of representation presents a basic model with which to analyze the correspondences between ideas, objects, and the way we represent these in systems of communication. The basic structure of Plato's

theory can be seen as a mapping out of the levels of human communication. The forms represent the ideas and concepts of human thought, the particulars are the things we encounter in the world, and the attendant levels are the various ways in which we try to communicate those ideas. This is how we make use of the basic structure of Plato's theory: as the starting point for a hierarchy of the types of representation encountered in instructional multimedia design.

Critiques of Resemblance

Plato's model of representation presents us with a useful structure with which to view representation, it does, however present a rather limited view of visual representation. Plato describes the correspondence between an image and its referent as one based on *imitation* or *resemblance*. Upon first inspection, such a notion might seem quite intuitive: "pictures, as we understand them in this culture, depict, or picture, what is. They are somewhat similar to the verb "to be" in its existential, not veridical, sense." (Worth, 1981). Since the time of Plato, various theorists have presented some significant criticisms of resemblance-based correspondence, notably Goodman (1976), and the art theorist E. H. Gombrich (1959). As Eaton (1988) explains, resemblance theory becomes severely strained when applied to certain things. An example would be two identical chairs; while it is clear that they *resemble* each other, it would be absurd to extrapolate that they also *represent* one another. Similarly, a strict adherence to resemblance theory would also dictate that Mona Lisa *the person* – given her resemblance to Mona Lisa *the painting* – could be said to be a representation of her own portrait.

Gombrich explains visual representation as a process through which symbols are manipulated with the goal of creating images that will access the *schema* associated with a given object. As Eaton (1988) explains:

> A stick drawing of a woman does not resemble a woman. It can be used to represent a woman, nonetheless, because it works as a sign of one. (p.56)
>
> Consider the drawing of a face. Why do most of us begin with a circle? It cannot be because we have seen circular, or even spherical, heads. We draw a circle because this is the schema, or word, we have learned for visually depicting faces. (p. 60)

A proposed model of levels of visual representation

What follows is a framework (Table 2) outlining a continuum of levels of visual representation. Levels are presented in descending order, starting with the conceptual level, (i.e. Plato's notion of the forms, or ideas), then with visual events in the natural world of a non-sign nature. Next is the realm of visual representation, which includes the basic elements, which are combined to form the particular attributes of an image. Also described here are the varying degrees of 'fidelity' ranging along a continuum from entirely realistic to entirely abstract. After this, the levels which follow are descriptions of *context* and *function*; namely ways in which images acquire meaning through their placement, both in relation to other elements, and in the intention with which they are used. Context and function are aspects that are intertwined, for this reason they are described together. Finally, the "functions" section describes the various levels upon which an image can be used symbolically in the instructional interface.

Table 2 - Levels of Visual Representation

Conceptual level
• The Forms/Ideas
Our concept of a given thing, e.g. "appleness", also as a subset of the groups "food" and "fruit".
Visual events:
• Particulars/Perception:
Various real life examples that which bears the characteristics of the thing—e.g. "appleness"—and the variety within this category. Also implicitly defines "non-appleness", e.g. a pear might slightly resemble an apple but it not an apple. Our perception of a thing in its entirety, e.g. from various angles, in different contexts, etc.
• Natural/Non-sign stimuli/Basic Elements:
Visual stimuli which is non-sign. This includes natural objects (e.g. an apple), random markings (e.g. accidental scratches on a wall etc), and the basic elements of visual representation before they are organized in any kind of purposive way, (e.g. dots, lines, blotches of colour).
Visual Representation:
• Basic Elements/Attributes:
This category is the first stage of representation. It includes all the various combinations of attributes which are used to form visual signs: e.g. form, scale, colour, perspective, shading, etc.
• Iconic-pictorial representation:
This category describes the type of representation of an image, more specifically, it is a continuum upon which any image can be placed based upon its degree of fidelity.

Table 2 (continued) - Levels of Visual Representation

Continuum of fidelity:
• photo realistic representations • realistic paintings & drawings • iconic/abstracted images • charts, graphs, and diagrams • arbitrary symbols that original from representational images • completely arbitrary symbols
Context:
• Medium:
This category accounts for the variable of how a medium in which an image is presented may alter and influence its reception.
• Syntax/Layout:
This category refers to the various shifts in meaning that can take place depending upon the context in which an image is presented, e.g. the influence of the text which accompanies it, or the elements surrounding it.
Functions:
• Representational images used as illustrations:
In instruction: The possible instructional uses of an image (e.g. to illustrate something, to elaborate an idea, as motivation etc.) ***In interfaces:*** Aesthetic and/or motivational purposes.
• Representational images used symbolically:
The possible uses of an image within interface design; e.g. A picture of an apple could be used as an icon/button, as such it could be used to represent various things; the categories which an apple belongs to (e.g. apples, fruit, food); something with which apples are associated via certain cultural conventions e.g. the concepts of "health", "sin", or "learning/knowledge".
Symbolic correspondences:
• Representation based on membership to a conceptual group. • Representation based on a cultural convention • Representation based on a metaphor
Metaphoric correspondences: e.g. virtual objects, image maps
• Recognition of the object depicted • Knowledge of the functioning and /or structure of the object in the 'real world' • Ability to transfer knowledge of the real object to the computer environment • Ability to adapt mental model if it does not match the manifest model

Descriptions of Levels of Representation:

- **Conceptual level:**

These are the representational levels discussed in the above section on theories of representation, and outlined in Table 3. In short, this is what Plato calls the "intelligible level": the realm of thoughts, ideas, and concepts, (as well as mathematics).

- **Visual events:**

This is the level of the "visible world" – i.e. that which we can perceive visually. This includes "the particulars", namely objects in the world with are manifestations or examples of "the forms". This level includes visual non-sign information, and natural objects.

Visual Representation:

- **Basic elements/attributes**

This level is comprised of the basic attributes of a given image. In her landmark book "A Primer of Visual Literacy", Dondis (1973), lists what she defines as the "basic elements of visual communication", these are: the dot, the line, shape, direction, tone, colour, texture, scale, dimension, and movement. Similarly, and in keeping with the spirit of Dondis' work, Morgan and Welton (1992), created their own list, renaming it "elements of analysis of the visual". Their list incorporates, as well as augments parts of Dondis's elements: the dot,

the line, shape, volume, scale, spatiality, balance, direction, lighting, colour, perspective, proportion.

Whether one chooses between the two, or combines them, the resulting list is a fairly comprehensive taxonomy of the primary building blocks of almost any form of visual communication, (a combined list would read: "the dot, the line, shape, volume, direction, scale, colour, tone, texture, lighting, dimension"). Within the current framework, we will refer to these as the "attributes" of an image.

Taken on their own, these elements could be seen a "non-signs stimuli", not denoting anything in particular. However, placed in relation to other elements and presented in a certain context, they begin to take on meaning, e.g. the dot at the end of this sentence in this context will be recognize by most as a period, representing a stop.

Iconic-pictorial representation:

As we saw in our examination of various semiotic models in section 2.2, Knowlton (1966) has suggested a continuum upon which to classify images. As previously stated, this continuum is based on varying degrees of closeness between a sign and its referent, namely the semantic relationship between the two. Another way of describing this is the notion of "fidelity". Fidelity is a concept which is common within the domain of gaming and simulation as a way of describing the extent to which a particular simulation is realistic or not. For our purposes, we will say that the closer a visual representation is to resembling its referent, the higher a value of fidelity it will be said to have.

Fidelity continuum:

- **Photo realistic representations**

This is the visual-pictorial representation level which is closest to the real object – excluding possible sculptural replicas.

- **Realistic paintings & drawings**

This category includes images such as drawings and paintings which bear a close resemblance to the object they depict—e.g. painting styles such as hyperrealism, (a style of art which aims at producing paintings and sculptures which are highly detailed and precise, and thus resemble photographs).

- **Iconic/abstracted images**

One step further along the continuum are "life-like, though conventionalized" signs, also referred to as "icons". This category includes what some authors refer to as "icons". The way in which the term is used in this section is according to the traditional use (Kennedy, 1974) of it to describe a certain style of representation; namely representational images which have been simplified in such a way so as to include only the salient features of an object. In observing the depictional style of most images used in interface design, it is easy to see how they came to acquire the name 'icon'; most of them are highly stylized, abstracted images which usually retain only the outline of the objects they depict.

The problem with using the term icon to describe both a depictional style and interface elements is that it muddies the distinction between an image and its

function. As well, with the current diversity of interface design approaches, it is possible that certain computer 'icons' might use images other than iconic-style pictures, therefore presenting potentially confusing territory for those aiming to accurately describe images in instructional multimedia. Furthermore, meanings for the word 'icon' extent beyond the domains of depiction style and interface design. A cursory investigation reveals the word "icon" as almost dizzyingly polysemic. Although the term icon has almost become common place in current computer related discourse, its roots do not come from computer science or interface design. In religious terms, an icon is a pictorial representation of Christ for prayer purposes. As well, as discussed above, there is Peirce's (1931-58) use of the term to describe signs that resemble their referents.

Although the word "iconic" is often used in the literature as a synonym for 'representational' in describing types of pictures, other descriptions of icons seem to suggest that icons need not be strictly representational. Sassoon & Gaur's (1997) description of icons describes icons as undergoing a process of gradual abstraction, whether under the hand of a designer, (e.g. the design of a logo) or through the wear and tear of use in a cultural milieu, (e.g. hieroglyphics).

Whatever the strict definition, icons seem to occupy a space somewhere in the middle of the continuum between representational/realistic pictures and abstracted/arbitrary symbols. The more a representational picture is abstracted and stylized – namely, "conventionalized"– the easier it is for it to be absorbed into use, and, in a sense, the closer it gets to written language.

The notion of "pictogram" is an embodiment of this; a conventionalized image that is meant to replace language in some way. Interestingly, the reading materials used within the curriculum of the program mentioned in the case study in this thesis, use pictograms within their texts as a way of including unfamiliar words within a reading text in a way that is manageable to young inexperienced readers. They are included as small images, sparingly incorporated into the text, where an otherwise unmanageable word would have appeared.

The intention behind the use of computer-based icons was to communicate the possible functions of the software – possible actions a user could take – without cumbersome text-based explanations or code commands. In this sense, they were meant to reduce the use of text in visual shorthand.

- **Charts, graphs, and diagrams**

Also near the middle of the continuum, are what Knowlton (1966), refers to as "logical pictures": pictures that resemble that which they refer to only by virtue of having a similar structure. Charts, graphs, and diagrams fall into this category. Winn (1987) refers to these as figural images and describes them as occupying a mid-way point on the continuum that stretches from realistic pictures to language. Figural images, he says, incorporate elements from both ends of the continuum: the use of arbitrary and abstract symbols, (like in written language), and the meaningful use of space and positioning, (like in realistic pictures). Another essential distinction between figural images and realistic pictures is that the visual elements employed in figural images are usually distinct from one another

in terms of where one ends and the next begins. Conversely, the boundaries of realistic images are often more ambiguous and even over-lapping.

A method of further specifying the important differences between realistic and figural images is Goodman's concept of notationality. Most charts, diagrams, and graphs meet the requirements of notationality. This is because, as Salomon's (1979) phrases it, they are "syntactically articulate, disjoint, semantically unambiguous, and differentiated". He points out that:

> An electric-wiring diagram, in spite of its pictorial appearance, is a notational system... No two electrical elements are represented by the same symbol, and no symbol represents more than one differentiated element. Furthermore, the symbols, like their referents, are disjoint and discontinuous. (p. 34)

Although most figural visuals adhere to the requirements of notationality, as Winn (1987) notes, some figural visuals often incorporate non-notational elements such text, abstract symbols and representational pictures. This inclusion of iconic elements places some figural visuals in a grey area of categorization. Conversely, although they are essentially "pictures" in the general definition of the word, the images such as those examined by Levin et al (1987), for example, exhibit some characteristics that are properly associated with figural visuals in that the correspondence between them and their referent is one based on structural similarity. Nonetheless, where the essential features are concerned, there is a major difference between these two classes of images, one which makes figural images a distinct category of images that, while meriting its own treatment, does not fit within the main scope of this investigation.

- **Arbitrary symbols that original from representational images**

Further along the continuum, are images which are "largely arbitrary", i.e., a "star" or a "heart" as commonly conventionalized. The majority of these types of signs are rooted in a resemblance-based depiction of their referent, but have been so abstracted over the years that they can no longer be regarded as representational. For example, Morgan and Welton (1992) note how the arbitrary symbol of an arrow is actually a highly conventionalized derivative of the gesture of pointing at something. Gombrich (1972) defines the arrow as "one of a large group of graphic symbols that occupy the zone between the visual image and the written sign." (p.92).

- **Completely arbitrary symbols**

At the opposite end of the continuum from realistic pictures, are images that are completely removed from any resemble-based correspondence to a referent. These correspond to their referent by convention alone, and are sometimes called 'digital' signs. Examples of these include letters, symbols for musical notation, some national flags, etc.

2.4 Contexts

This section is a continuation of the description of the levels of visual representation; it elaborates the various symbolic purposes for which visuals are used within the context of instructional interface design.

Representational images used as illustrations:

Case study example:

Within the computer-based learning environment (CBLE) that was produced within the case study project, there was a section which aurally presented sentences from stories for the learners to write. This exercise mainly focused on the child's ability to construct sentences, as well as spelling. The sentences that were presented were taken directly from the pre-existing stories with which the children were already familiar. Along with each sentence that was presented, there was an accompanying illustration from that section of the original print storybook.

The issue that was raised within a meeting was the extent to which the illustrations used actually relate to the sentences. Further questions related to determining the role that these illustrations serve in the learning process and the extent to which their correspondence to the sentences affects learning outcomes.

Analysis:

In instruction, representational or iconic images generally serve roles such as reinforcing or helping to explain the text aspect of the instructional content, (e.g. to illustrate something, to elaborate an idea, as motivation etc.). They can also server a motivational function, such as giving a learner a "reward" – e.g. a 'gold star' – for a correct answer on a quiz. Used in the sense described in the case study, care should be taken that what they depict corresponds appropriately with the accompanying text, therefore reinforcing the message of the text.

Representational or iconic images, when used in computer interfaces, as strictly representing that which they resemble, generally serve exclusively aesthetic and/or motivational purposes.

Representational images used symbolically:

Case study example – interface metaphors

Let us now look at another example of a design issue taken from the case study. At the beginning of the project, (February 2002), there were attempts at establishing an overall interface "theme" for the CBLE: the client suggested the idea of a "fantasy ranch", and the design team proposed an "Ewok"-style jungle village. These, and other possible themes, were discussed sporadically within design team meetings. The intention was to find something that would be aesthetically pleasing, as well as appropriate to the target learners.

As the project progressed, ideas about the requirements of the main interface theme developed. The past themes and ideas were eventually discarded; the fantasy ranch because the design team thought it might not be appropriate for the intended learners – low-income, city-dwelling children – and the tree village because the client did not like it.

For the purposes of the "alpha" version of the CBLE, it was agreed that the theme of a farm would be used, (see figure 3). The main screen was designed as follows:

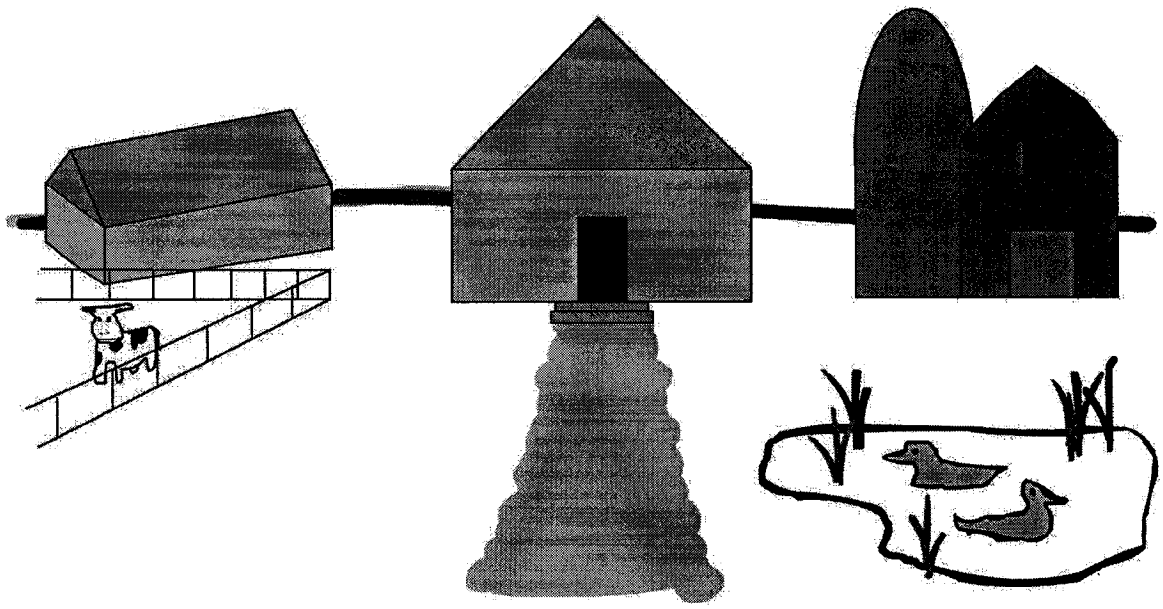

Figure 4 – Interface design for main screen of CBLE

This organization was based on the sections of the CBLE that had been developed up until that point in the project. The screen was divided into roll-over areas which would link to sections of the CBLE; the links were as follows: the house in the middle of the screen was a link to the reading section, the barn and silo on the right linked to the main activities, the duck pond was a link to the

writing section, the 'stable' in the background on the left was a link to assessment, and finally, the cow was a link to a 'professional development' section for tutors.

The evaluation of the CBLE alpha resulted in a number of critiques of the main interface. Concern was again expressed regarding the familiarity that city-dwelling children would have with a farm, particularly whether they would be able to distinguish between the 'barn' and the 'stable' parts of the interface. In the alpha evaluation, respondents mentioned how the link to the activities section should be centrally located, given that the activities are central to the curriculum. They also commented the possible negative connotation of cows being used to represent the tutor section.

Analysis of related concepts:

As discussed above, signs can be categorized according to the semantic relationship between the sign used and that which it is meant to represent. In the case of images, these semantic relationships can be depicted as existing on a continuum, with purely representational images at one end, more abstracted images near the middle, and totally arbitrary visual symbols at the far end.

This continuum describes the perceptual attributes of an image; to what degree it does or does not resemble an object in the real world. Such a form of classification, however, deals only with the way an image looks, and not with how it is used. A perceptually based classification is accurate so long as 'iconic' images are used for purely aesthetic, motivational and/or illustrative purposes—i.e. when their function is to represent that which they resemble, such as an

illustration in a story book for children. This type of use of an image can be said to conform to the descriptions of 'iconic' signs provided by Peirce (1931-58) and his followers.

Complications arise, however, in the cases where representational images are used to denote something other that which they resemble, for example a picture of an apple representing the concept of "sin" in Judeo-Christian iconography. In her semiotic analysis of the ways in which computer icons are employed on the websites of libraries Ma (1995) maps the correspondences between the computer icon used and its referent; describing the "many misleading, confusing, meaningless icons [which are] used to index resources on the library homepages".

In these cases, the image can be said to operate on a secondary level, one with is more akin to Peirce's (1931-58) classification of 'symbolic' signs such as letters. In an example such as an image depicting Adam and Eve in garden of Eden, the visual depiction of the apple would function on two different levels: 1) as a representational image of an apple, in which that particular configuration of visual attributes denotes the idea/form of "apple" and "appleness"; and then, 2) in which that depiction of an apple (in a given context, and with a given set of conventions), can be used to denote something other than, and possibly completely unrelated to, an apple.

In the case of the first level, the symbol and the referent share a relationship that is loosely based on resemblance. The second level of representation can most accurately be described as a sign *in which the iconic*

sign of level one is employed in a symbolic relationship with a second referent. In this example, the relationship between the "apple sign" of level one can be said to bear an arbitrary or conventionalized relation to the referent "sin". Looking at this example in semiotics terms, we can observe a number of interesting factors related to this form of visual representation:

Polysemy:

Firstly, we can acknowledge that, like most signs, the visual symbols symbol of an apple is polysemic – meaning that it can take on multiple symbolic designations; e.g. "sin", "health", "fruit", "food", even the city of New York. In reality, an apple, or even the concept of "appleness" has no object meaning whatsoever beyond referring to actual apples. To a child, or even an adult unfamiliar with any of its conventional symbolic uses, an image of an apple simply represents an apple. Furthermore, in some cases, such as people unfamiliar with the particular style of depiction employed, or even with apples in general, an image of an apple might simply be interpreted as a red sphere or circle, or possibly as bearing no meaning at all.

Syntax and Semantics:

Using the example of the symbolic use of an image to represent "sin". Let us examine how context and convention work in concert with each other to denote something. Let us imagine our picture of an apple within the context of the traditional Judeo-Christian depiction of Adam and Eve. The viewer's interpretation of the image (the viewer's conception) is dependent upon the

context in which the image is presented (the syntax), as well as the viewer's knowledge of conventional meanings associated with that particular configuration of elements (semantics). In this example, the syntax would be the way in which the apple is presented along with other essential images such as Adam, Eve, and most probably a snake and a tree (representing the tree of knowledge). Additionally, traditional syntax would probably dictate that the apple be shown as being held by Eve and handed to Adam.

The semantics of this arrangement are based upon cultural conventions, namely those of Judeo-Christian iconography. Therefore, an interpretation of the scene would depend upon:

1) Perceptual/semantic: the recognition of the forms man/woman/apple/tree etc.

2) Previous knowledge/semantic: familiarity with the cultural convention employed (code) of Judeo-Christian iconography (e.g. basic knowledge of the story of Adam and Eve from the book of Genesis, knowledge of the standard visual attributes used for representing the scene: e.g. two figures, one man, one woman, both without clothes, standing in a garden, usually near a tree, possibly with a snake etc.)

3) Syntactic: Recognition of the specific combination of these elements: i.e. they are not in the city, there is no third person, they are in front of the tree, not *in* it etc.

These elements, working in concert with one another, form the basis for a person's interpretation of the scene – and hence the meaning of the apple in this particular context. Without those key elements, in that particular configuration, the likelihood of the apple being interpreted as representing "sin/temptation" would be highly unlikely.

The use of representational images for other than strictly illustrative or aesthetic purposes has been described by Knowlton (1966) as picturing the "unpicturable". He further notes that, although such a use of representational pictures is less common than the illustrative use of images in instructional texts, it is of "extraordinary importance". The author would also like to note here that the frequency of such a use of images in instructional material has significantly increased since the advent of widespread use of multimedia in instruction, and by extension, the graphical user interface (GUI).

Metaphoric correspondences: virtual objects, image maps, navigation, and structure

The case study example of the 'virtual book' described at the beginning of Chapter 2, as well as the description of the metaphor used for the main interface, are good examples of where the lines between real objects and their computer-based representations are blurred. Visually, in the 'virtual book' example, the interface is made up of an image of a book – or at least part of a book. Additionally, employed in the context of interface design, this image of a book is

also assigned functional attributes. Symbolically, therefore, this virtual "book" incorporates a number of different layers of representation.

Similarly, the elements of the 'farm' metaphor used for the main interface function on both the level of an iconic-pictorial representation, and as a metaphor-based reference to the content of the CBLE, (as well as in setting the aesthetic tone of the CBLE).

Both these examples present designers, as well as learners, with a number of questions, for example, in the case of the virtual book, how are we to determine how it should *function*—does it adopt the same physical properties of a real book, or is it okay to assign new behaviours to it. A novel, yet not in-accurate way of illustrating this last point would be to ask the question: if an on-screen book does not have physical pages, how exactly is does one go about 'turning' them? (This is reminiscent of Philip K Dicks' question: "Do androids dream of electric sheep?", 1999). This will be examined in more detail in the section that follows.

Analysis of concepts involved:

Steven Holtzman (1994), describes the main assertion of his book "Digital Mantras" as being that "computers are the ultimate manipulators of abstract structures." His approach is one of a bird's eye view of art and communication: exploring language, music, visual art and computer science from the standpoint of the abstract structures that operate within them. Ultimately, he is looking at communication according to symbol systems.

Brenda Laurel (1993), discusses the symbolic nature of the interface as follows:

> The working definition of the interface has settled down to a relatively simple one—how humans and computers interact—but it avoids the central issue of what this all means in terms of reality and representation. (p. 14)

Laurel uses the theatre as the basis for what she views as a more appropriate model of human-computers interaction (HCI). She describes how, if a play is "working" properly, an audience is usually unaware of the technical aspects of the production, (e.g. the person overhead on the scaffolding arranging the lighting, the backstage where actors are changing into new costumes etc.). If an audience member is "engaged by and involved in the play, the action on the stage is all there is...". Similarly, when a user interacts with a computer program, the technical aspects of the software are behind the scenes and inconsequential unless they are represented on the screen. In this sense in a computer environment, "representation is all there is".

The issue of interface metaphors is a subject which has been discussed and debated by authors in the field of interface, but does not yet to appear to be a main topic of concern in instructional design literature. Bonime and Pohlmann (1998), describe the 'problem' of interface metaphors as such:

> One of the most controversial and often poorly used grammatical structures in interactive media is the screen metaphor. This device creates an elaborate visual environment in which information resides. The environment can be a desktop, a simple room, or a more complicated real-life structure. The entire title may be presented through one of the metaphors. Within the environment are objects that can be manipulated by the user to navigate and to

> produce data. The problem is that if the environment is too complex, it can be cluttered, and more difficult to navigate than the real environment it represents. (...) Screen designs...must make navigation easier than in a book or other traditional media.
>
> Unfortunately, most do not and here is why: The screen metaphor superimposes another layer of information over the primary subject matter of a title. The new layer consists of the physical layout of the environment, its idiosyncrasies, and its visual representation. This is extraneous baggage added to the direct exploration of the information. It may seem visually appealing, but it often works counter to direct intuitive access to the information. (p.138)

The problems involved in designing effective interface metaphors are a function of the convoluted nature of the symbolic codes employed in creating them. In constructing an interface metaphor, the designer is effectively taking iconic images, and using them as if they were part of a notational system like language. Unlike cases where an iconic picture is used as a representative of a particular group it belongs to—e.g. an apple denoting the topic of 'fruit'—the correspondence between an element in a visual metaphor and that which it represents, is often arbitrary. The above example of a house representing a content section related to reading is a perfect example of this type of arbitrary correspondence.

If interface metaphors present so many problems, then why do designers use them at all? The idea behind employing one is to present learners with something more intuitive than a command prompt or list of computer files. The way an interface design metaphor is meant to function is by presenting the user with an environment and objects with which they are familiar. The user can therefore project the schema they have for the real world object onto the virtual

object, thereby (supposedly) giving the learner the impression of an 'intuitive' interface.

Cooper, A (1995) outlines the basic levels involved in interface design. He distinguishes between three levels of representation within interfaces:

- *The manifest model*: how the program represents its functioning.
- *The implementation model*: how the program actually works
- *The mental model*: how the user thinks the program works

The relationship that exists among these three elements will greatly determine the extent to which a given interface will be successful in terms of providing the learner with a useful and appropriate means of interacting with the software. A good example of the interaction among these three elements is the metaphor used for the "garbage can" element in contemporary computer operating systems.

Analysis of the garbage can metaphor:

The garbage can first appeared on one of the early GUI displays created by Apple computers as part of their "desktop" metaphor. The idea was that the user's interaction with the computer be simplified using a visual metaphor with which the majority of users would already be familiar: a desktop. The elements of the GUI were designed accordingly; word documents were made to look like small sheets of paper and were kept in 'folders' and everything was accessible via a flat empty space that was meant to represent a desktop. Dragging the page-like icon of a document until it hovered over a small icon of a garbage can carried out disposal of documents.

Today the desktop metaphor is so prominent and commonplace that the act of describing its elements in such a way seems redundant and almost ridiculous. The basic interface design of both Mac and Windows computer environments is now exceedingly commonplace, even for casual computer users. As well, it has been the subject of much discussion and debate concerning the principles of interface design. It is, in part, for these reasons that I have chosen to analyze it here; for I feel that the more that is known about the basic example I use, the easier it will be for readers to focus on the concepts that are being discussed and less on the particulars of the example.

The garbage can icon as seen on most operating systems these days, is one of many icons learners interact with in computer environments. It is presented as a small, abstracted, iconic-style graphic in the corner of the screen. Therefore, primarily, we can say that it is a picture. We can describe the picture in terms of its perceptual attributes; it appears to be a cylindrical shape, with ruts in it, it is grey, it has a lid, etc. We can also describe it in terms of what type of picture it is; it is a representational drawing i.e. an illustration; it is also quite abstracted and conventionalized, thereby placing it on the "iconic" end of Knowlton's continuum. If we are to analyze it in the way we have explored in previous sections, we can say that it is an iconic-style picture being used as an "iconic" sign to refer to the thing "garbage can". The success of this reference is reliant on the viewer's conception of both the sign and garbage cans in general. If she is not familiar with this style of garbage can, or garbage cans in general then it will probably have no meaning for her. This level of representation involves the

learner simply recognizing of the object depicted. The conditions necessary for the metaphor to work are that the learner has knowledge of the functioning and /or structure of the object in the 'real world', as well as that she is able to transfer knowledge of the real object to the computer environment. If it happens that the learner's model does not match the manifest model, she must be able to adapt and make appropriate inferences about the functioning of the system without the aid of the metaphor.

Like the book in the case study example, the garbage can is a virtual object. As Gaver (1995) explains, metaphors in interface design work differently than in real-life. We are used to inferring things about an object based upon their physical appearance, however, in computer displays, the visual appearance of something does not necessarily bear any relationship to the way in functions. Gaver calls these two distinct aspects of a virtual object the "perceptual mapping", and "functional mapping". The former is the way a virtual object appears, and the latter is how it actually functions. He describes the metaphoric link made between the real-life object and the actual functioning of the computer system as a "conceptual mapping". He explains that the equating of real-world objects with a computer's functioning is rarely a precise mapping, adding, "metaphors from the everyday world may convey un-wanted implications about functionality."

Structure:

A final type of correspondence that is often made between virtual objects and/or image maps, and the content of instructional multimedia, is one based on

structure. In this way, the interface metaphor serves as a structural arrangement of content, in some cases, providing—whether wittingly or not—the equivalent of an advanced organizer for the content. Like in a textbook, the structural organization of the content can give learners cues as to the conceptual and hierarchical relationships among content elements.

In her book on the psychology of learning, Driscoll (2000) makes explicit use of concept maps at the beginning of each chapter in order to provide her readers with an overview of the contents and the structural relationships among them, she also discusses the learning benefits associated with this instructional strategy.

Debates exist as to the effectiveness of advanced organizers for learning. Some fear that providing learners with a ready-made conceptual structure will hinder them from developing their own understanding of it, while others contend that advanced organizers can be a useful scaffold for beginner students who may be unfamiliar with the "big picture" of the content. Driscoll (2000), cites Ausubel's suggestion that organizers be made in a way that presents information at a higher, more general level of abstraction, so as to accommodate more variance in the learners' cognitive structures. Whether they produce positive or negative effects, researchers seem to agree at least that advanced organizers have an effect on learning.

In addition to advanced organizers, Driscoll also discusses the importance of schema signals within instructional design. She points to the difficulties that can be encountered when learners encounter learning materials that present

material in a way that is inconsistent with their learning schema. She mentions Ausubel's assertion that learning materials must make sense to learners – i.e. correspond to their schema – in order for the information conveyed within them to be meaningful. An essential aspect of this is that the materials should help "improve the discriminability among concepts" and not cloud the inter-relationships among concepts by over-compartmentalizing them into discreet, seemingly unrelated sections.

This last point has implications for interface design. If the presentation of the content structure can have an effect on the likelihood of the student's understanding when it is presented in text form, then the addition of visuals as conceptual placeholders introduces a new level of representational complexity.

More specifically, this issue relates to the differing capabilities of words and images in terms of representing classes of things, (See Knowlton, 1966). The argument follows that using images to represent the structure of content could potentially complicate the learner's understanding of the contents' structure.

Conversely, if used in a judicious and informed manner, the use of the graphical user interface as a means of denoting content structure could potentially be used in a very useful and constructive manner. In this sense, the interface could be designed in such a way that it would become like an advanced organizer. Rather than presenting content in the linear format of a traditional table of contents, the interface could cue learners as to possible hierarchical

relationships within the content. In this sense, the software's structure would act as a conceptual model for the learners.

2.5 Summary of Framework

Essentially the framework presented above can be summarized as follows: Images can be classified along a continuum that runs between representational iconic-pictorial and totally arbitrary symbols. If used for illustrative purposes, iconic-pictorial images can be used in much the same way that they have been used in the print medium: as reinforcers of the given text-based content. The factors that should be accounted for here in terms of optimizing the learner's interpretation are a) that the level of pictorial fidelity does not overwhelm the beginner learner with a profusion of unnecessary details, and b) that the style of representation, particularly the convention used for depicting depth and perspective is one with which the learner is familiar, i.e. is not culturally biased.

When used in a capacity that is other than illustrative (or aesthetic/ motivational), representational images take on the characteristics of arbitrary symbols. In this sense, a representational image, for example an apple, becomes a symbolic placeholder for an idea or concept. Employed as a symbol, the image can be assigned various forms of correspondence to its referent, this correspondence can variously be based upon 1) the image's membership to a group (e.g. an apple as a representative of the group "fruit"); 2) culturally based

conventions related to the image (e.g. an apple used to denote the concept of "sin"); or 3) a metaphor or simile (e.g. an apple is to red as a banana is to yellow).

Within the context of computer interfaces, images can be made to function on a further symbolic level: as manifestations of the software's functioning and as representations of the content's structure. The learner's interpretation of such a symbolic code is reliant upon the learner's a) recognition of the object depicted in the images, b) knowledge of the inherent functioning or structure of the object in the 'real world', and c) ability to transfer knowledge of the real object to the computer environment, and finally, d) in the event that the 'world' presented in the software does not match the learner's mental model of the 'real world': an ability to adapt and modify previous knowledge to suit the world presented.

As Lohr (2000), points out, the goal of an instructional interface should be transparence in order to allow the learner to focus on the instructional content. Using images that have an appropriate correspondence with the task at hand is essential to ensuring clear communication of the instructional message.

By understanding how to analyze the layers of meaning in an image, as well as the meanings it acquires in various contexts, instructional designers become better equipped to identify and correct potentially unclear design decisions. Attention to issues of usability and clarity within instructional multimedia design helps ensure that images are used in a judicious, purposeful, and appropriate manner, and that their communicative capabilities are not assumed to be transparent.

3. Conclusion

The impetus behind this investigation was to create a framework that would serve as a way of organizing and making sense of the numerous concepts related to visual communication as it applies to the design of instructional multimedia.

The brief case study examples presented within this paper show the often confusing design decisions faced by instructional designers in relation to the use of images in instructional multimedia. The design of visuals for instructional multimedia is an ill-structured domain; as such it presents researchers and instructional designers alike with unpredictable research results and few ready-made guidelines upon which to base their work. Rather than rely on recipe-like approaches, instructional designers therefore need to be able to adapt their design strategies based upon the given context, in much the same way that a technical writer would adapt his writing style based upon his knowledge of the target learners. Attaining this flexibility, therefore, requires instructional designers to have a firm grasp on the principles of visual communication so that they may use images judiciously.

The articles reviewed bring to the fore a number of complex and not always clear-cut issues within this area. The topic area is considerably vast; I have therefore focused on those concepts most directly linked with the specifics of instructional interface design. One of the goals of this paper is to attempt to remedy the lack of clarity that exists regarding the role of visuals in instruction. While art, graphic design, and aesthetics play an intrinsic role in the resultant

messages conveyed in images—helping to shape the mood and feel of instructional media—the question of how and why certain images play affective or motivation roles is considerably intangible and subjective, therefore making the study of it better suited to research inquires in the field of cultural studies, (a pursuit which could indeed be taken up in further research). The main focus of this paper, therefore, was on what could broadly be called "information graphics"—namely on the intended, tangible, 'message' conveyed in a particular image.

The framework presented within this paper (in Section 2.3) is a proposed starting point in the task of sorting out the various levels of meaning conveyed within images in instructional interface design. The original goal was to produce something that would help to bridge the interdisciplinary literature bases in this area, and instructional design practice. In reflecting on this investigation, I realize that the resulting framework is not what could be described as a 'tool for practice'. This paper does not offer instructional designers specific recommendations in terms of what to do or not do in a given situation. In that sense, it can be described as more of a *map* than a set of directions. Ultimately, it is meant to stimulate thought around the various ways that images communicate meaning, as well as to provide the much-needed intellectual 'leg-work' necessary for sorting out the inherently over-lapping levels of meaning present in visual communication.

This paper is a starting point to building the concepts and vocabulary necessary to truly be able to discuss and think through visual design issues in

multimedia-based instructional design. While I have incorporated a number of examples of analyses conducted using this framework, the true test of the conceptual structure presented in the framework will be in its application to a wide range of instructional design contexts—something which was simply not possible within this constrains of this investigation.

The meaning conveyed with images is easily taken for granted when it is presented within the seemingly universal boundaries of North American culture. However, taken outside of a North American context, such issues become increasingly apparent. This last point highlights a particularly salient application for the concepts explored in the framework: as a structure with which to analyze images in instructional design for cultural bias. Issues of reducing cultural bias and increasing readability are particularly relevant within distance education and the increasing globalization of information resources and dissemination of learning materials to diverse populations, (issues currently explored by researchers such as Marcus & Gould, 2000; Singh, 2003).

It is hoped that this investigation and the concepts explored therein, will contribute to the discourse of instructional interface design by providing a conceptual framework with which to analyze the various levels upon which images function in instructional multimedia, and as such will help instructional designers to make informed decisions about the use of visuals throughout the phases of design, formative evaluation, and summative evaluation.

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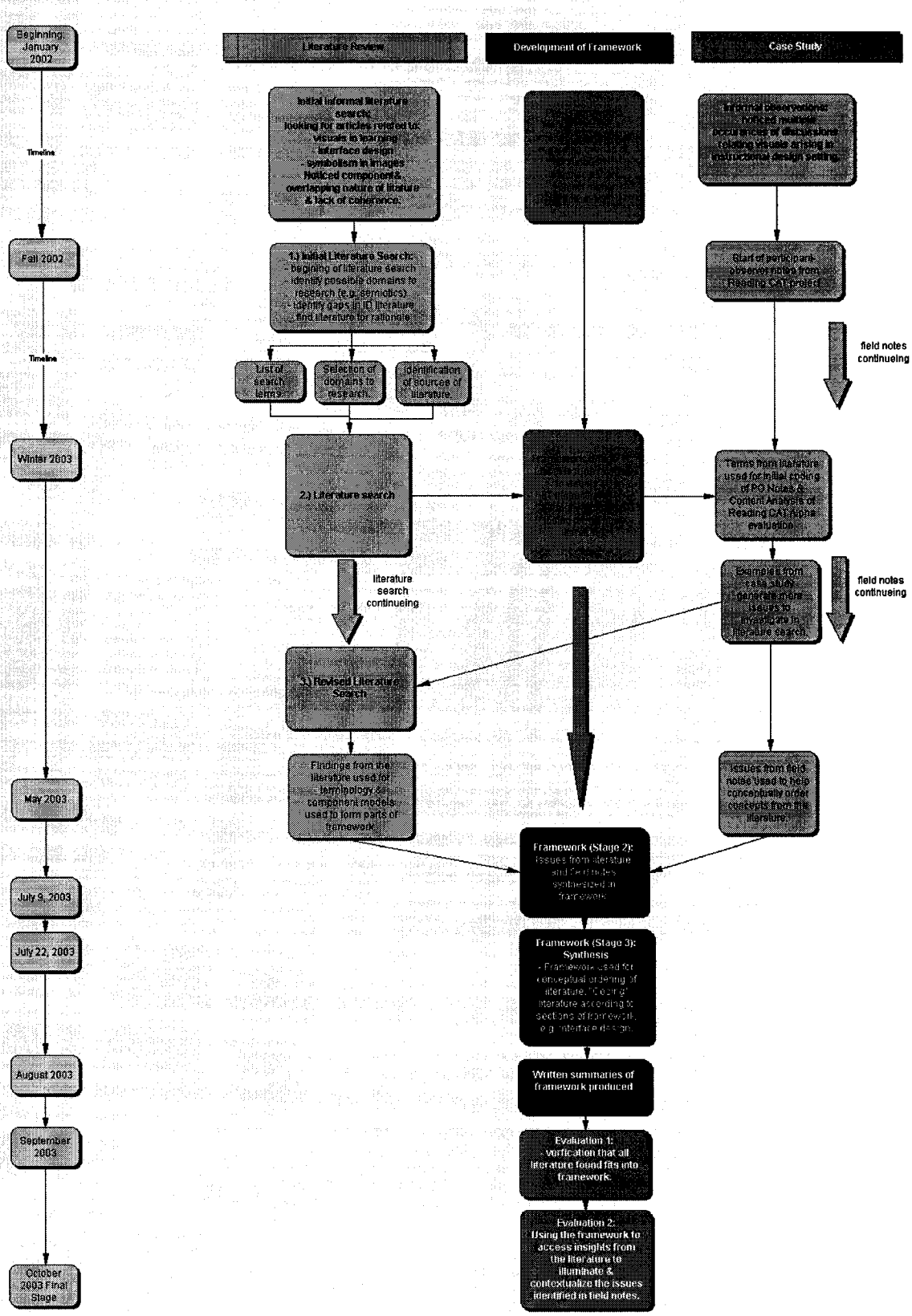
Appendices

Appendix 1: Approach to literature review, case study and framework development

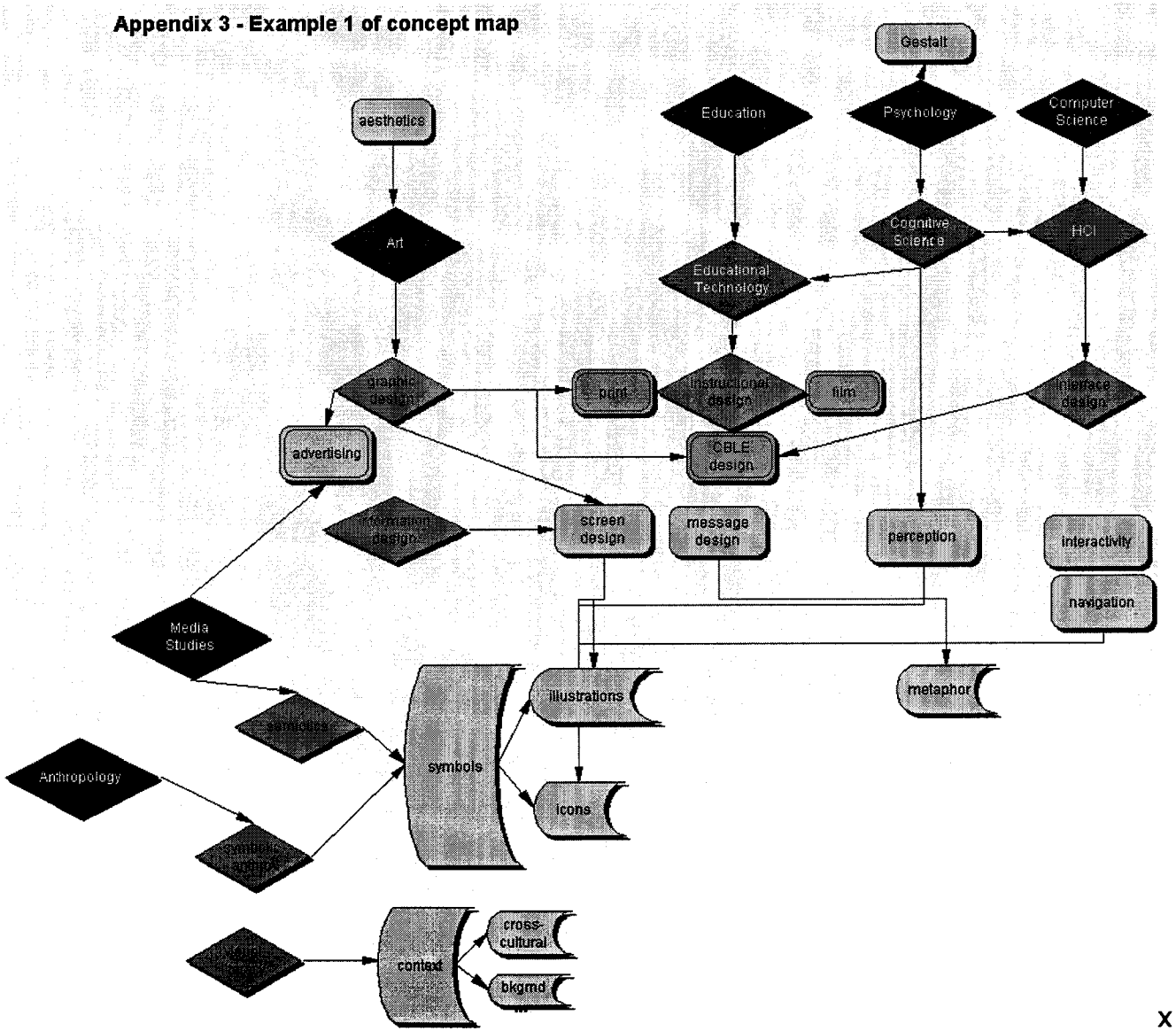


Appendix 2 - Search Terms Log

1-Nov	2-Jan	2-Mar	2-May
		Search combinations:	
visual literacy	visual communication	"interface & education"	signs
media literacy	message design	"instructional systems design"	symbols
visual education	information design		icons
instructional design	visual perception		symbol systems
GUI			HCI
interactive design			
communication theory			
semiotics (general)			
visual semiotics			
educational semiotics			
interface design			

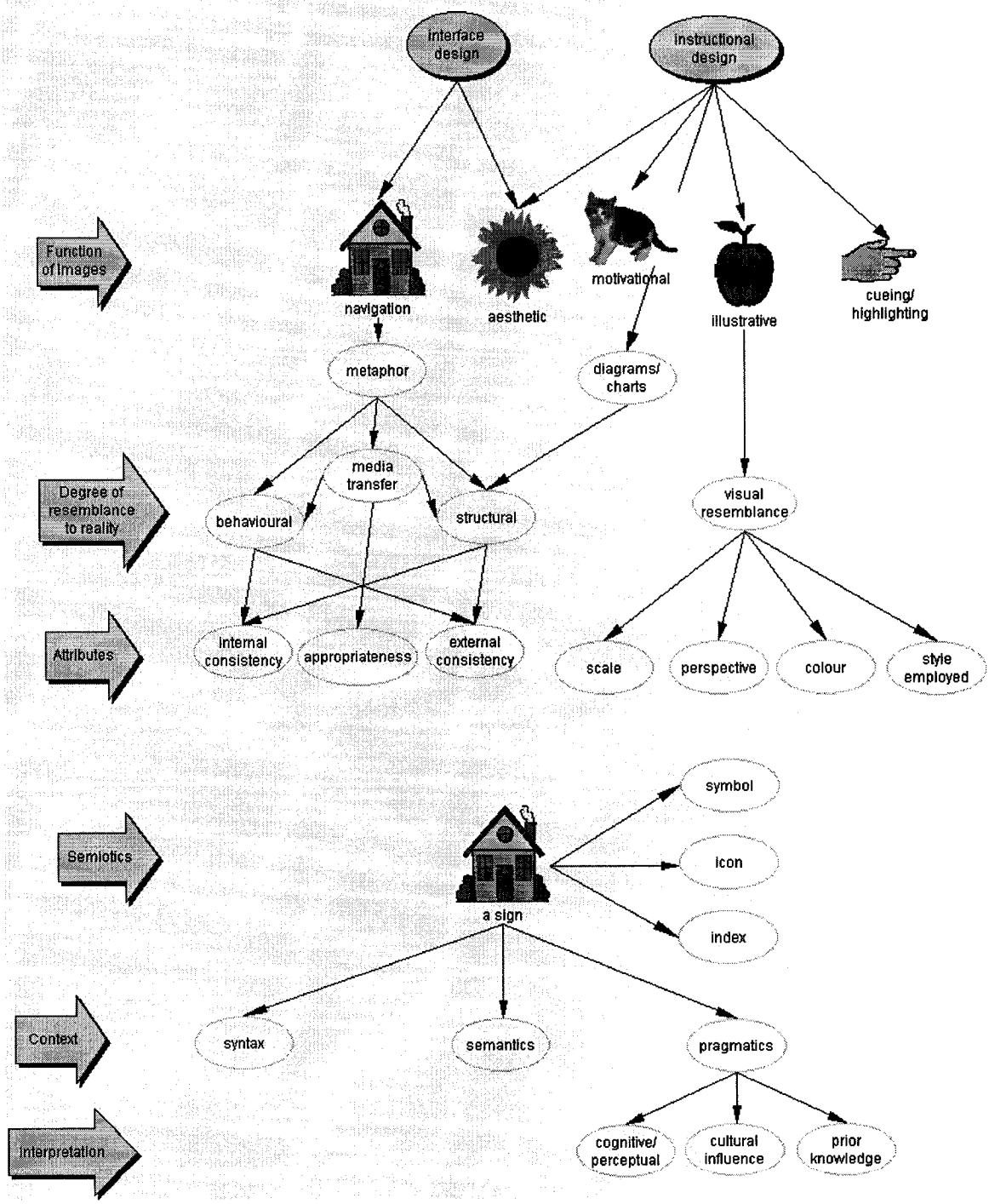
2-Jul	2-Sep	misc	
computational semiotics	context	visuals	
computer semiotics	cultural	visualization	
screen design	metaphor	visual imagery	
presentation design	illustrations	page design	
text design	pictures	layout	
visual design	non-verbal	graphic design	
cognitive dissonance	implicit meaning		
cognitive overload			
preferential selection			

Appendix 3 - Example 1 of concept map

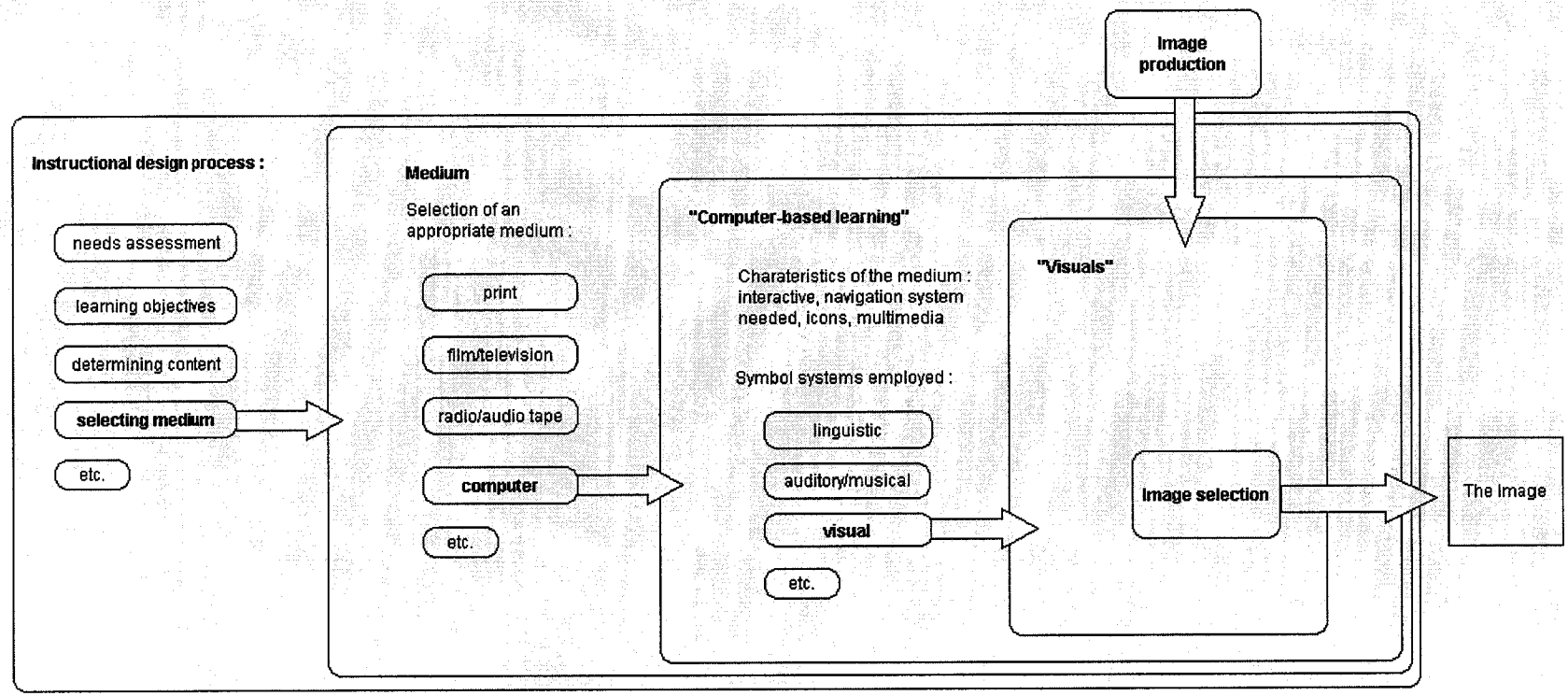


x

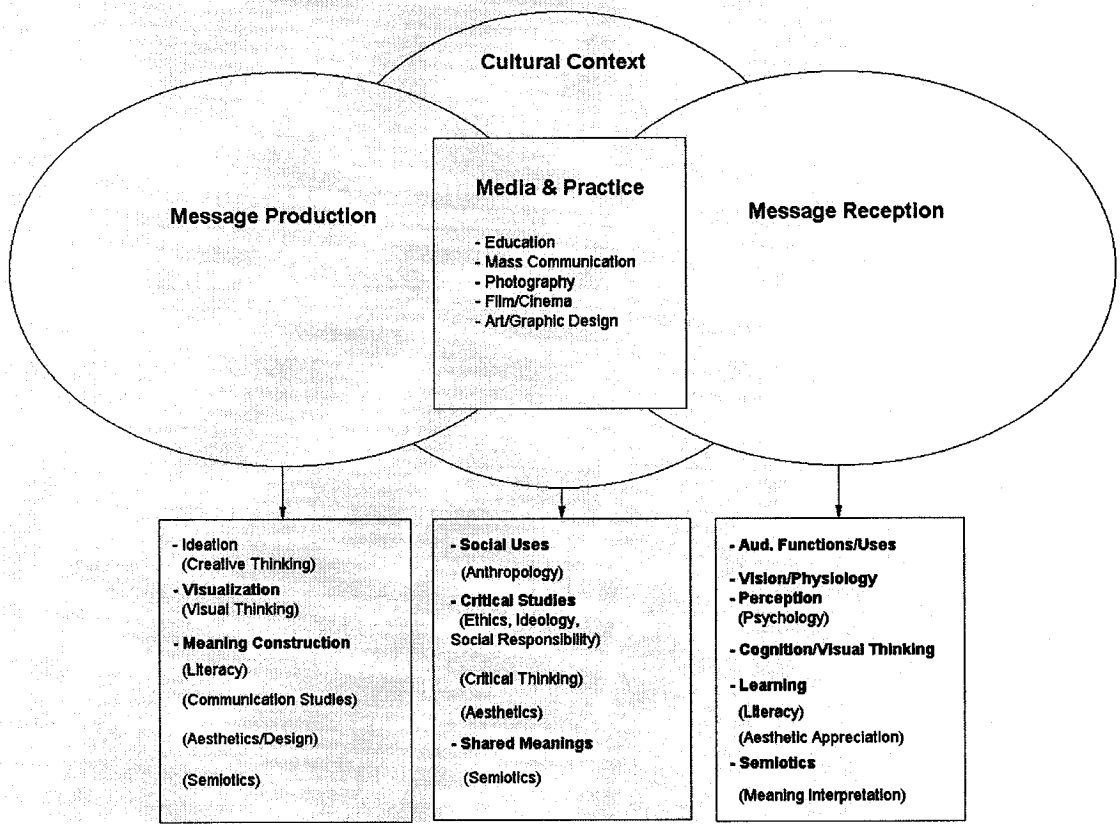
Appendix 4 - Example 2 of concept map



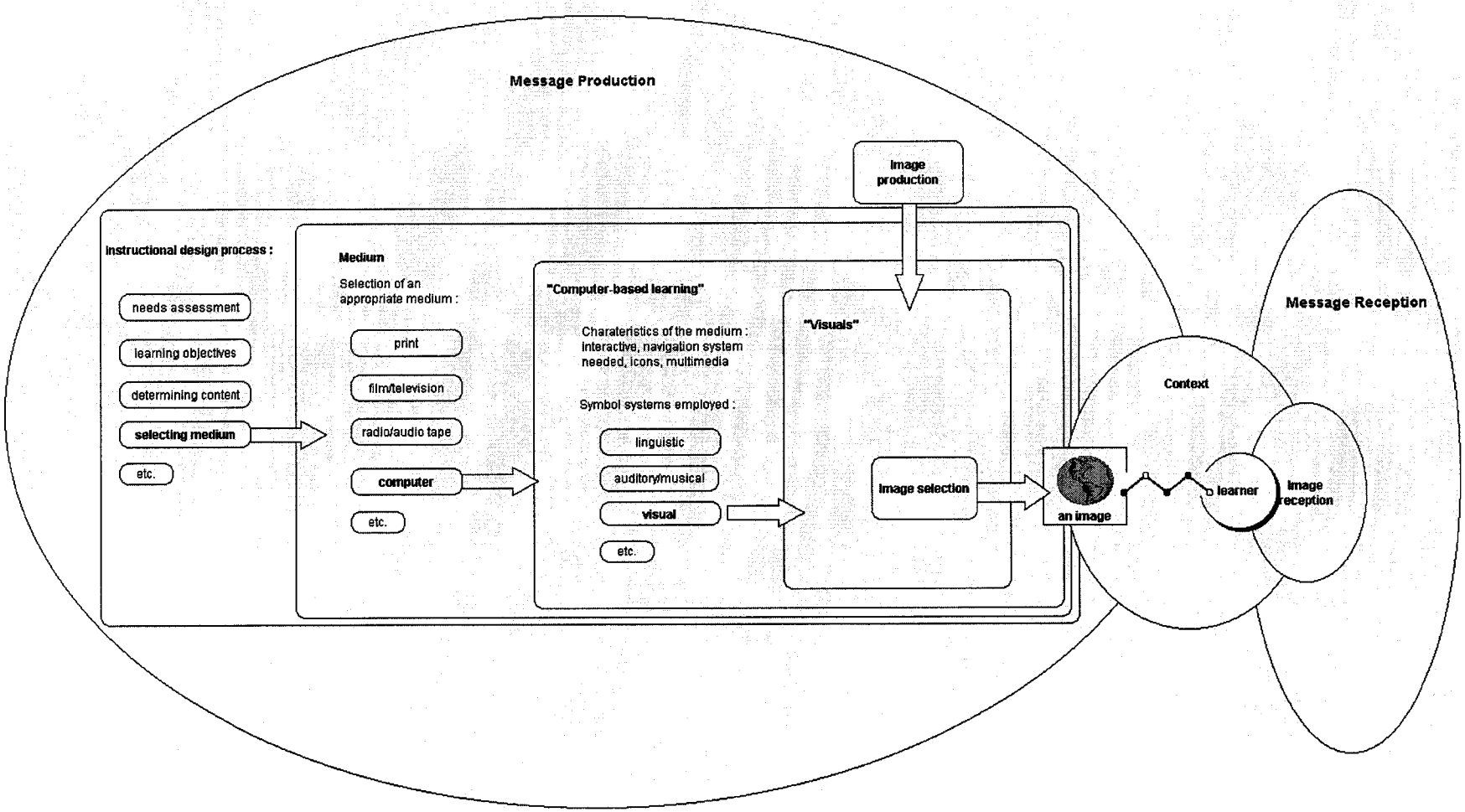
Appendix 5 - Instructional Design Context



Appendix 6 - Moriarty's Model



Appendix 7 - Conceptual Map of Visual Communication within an Instructional Design Context



Appendix 8 - Detailed view of Conceptual Map of Visual Communication within an ID context