Chapter 2

# REVIEW OF LITERATURE

Cognitive science, mental imagery and creativity will be covered in this chapter so that the reader will have a clearer view of how a designer thinks in the design process. Further, mental imagery will be explored because it is especially important to the designer as it is utilized in the definition and solution process of a design problem (Arnheim, 1969). Next, the case will be made that the design process is a specific application of the creative process (Csikszentmihalyi, 1996; Lawson, 1980). Many different kinds of drawings will then be described because these drawings are utilized in the communication of the design process and design solution (Fraser & Henmi, 1994; Herbert, 1993). Specifically, the chapter will focus on study drawings which show a record of how the designer defined the nature of the design problem and is also a record of the mental processes that led to the final solution (Herbert, 1993; Lawson, 1980).

## Cognition

In order to study creativity, and more acutely visualization in the creative process, it is important to first look at the mind and examine what is understood about its functions. Gardner (1983) described several “intelligences” he felt existed within the human mind. In his theory of multiple intelligences, Gardner (1983) described six intelligences that the human mind is capable of: linguistic intelligence, musical intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, and the personal intelligences.

It is important to note that these intelligences are "…useful fictions…" (Gardner, 1983, p.70) created for the convenience of "…discussing processes and abilities that (like all of life) are continuous with one another" (Gardner, 1983, p.70). These "…intelligences are being separately defined and described strictly in order to illuminate scientific issues and to tackle pressing practical problems" (Gardner, 1983, p70).

Other neuropsychologists have referred to multiple intelligences (Damasio 1999; Damasio, 1994; Hoffman, 1998; Pinker, 1997; Pinker 1994). Another division of the mind is visual intelligence, emotional intelligence and rational intelligence. Their studies explore patients with brain damage in specific lobes of the brain and the effects on personality, decision making and creativity. While there is no attempt to suggest that these intelligences occur independently, they are again divided up in order to understand actions and relationships that occur in the mind.

The intelligence of particular interest to this study is the spatial or visual intelligence. Spatial (visual) intelligence is the ability to see an object and mentally manipulate it through space in order to understand what the other facets of the object would look like. While spatial ability of the mind is the area of interest, it is important to note that spatial ability does not stand-alone and is dependent on many other abilities of the mind. As Gardener (1983) stated above, it is merely being separated for the purpose of learning more about the specific abilities of the mind.

Gardner (1983) defines spatial intelligence as being made up of the "capacities to perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and *to be able to re-create aspects of one's visual experience, even in the absence of relevant physical stimuli* [italics added] (Gardner, 1983, p. 173)." It is this particular (italicized) ability that allows designers to visualize their end result long before construction begins. Accurate visual perception and the ability to "…draw, imagine, or transform an absent world" are two different abilities and are not necessarily equal in every individual (Gardner, 1983, p. 173). Therefore, spatial intelligence (or visual thinking) is made up of many different abilities each of different strength within the individual designer.

Spatial intelligence, when linked with linguistic intelligence, becomes the basis for all problem solving activities (Gardner, 1983). Linguistic intelligence is the ability to think, reason, store and manipulate information in a verbal or word based realm. When a designer can store, manipulate and recreate visual information along with linguistic information, he or she has the necessary components for the kind of complex problem solving involved in design.

Gardner (1983) presents the argument, though, that having spatial or linguistic intelligence is simply the basis for problem solving. Visual and linguistic intelligence must be developed through experience (Damasio, 1999; Gardner, 1983). A visual or linguistic library must be built through seeing, reading and imagining experiences in order to be available to the individual to draw on in problem solving.

In support of Gardner's argument that a visual intelligence exists, there is a whole psychological field of study surrounding the ability see, visualize, or recall objects and places. The philosophies and studies in this area are grouped in an area of cognitive psychology referred to as mental imagery. The arguments, philosophies and studies are examined more closely in the following section.

## Mental Imagery

Mental imaging occurs when a designer imagines or visualizes the possible outcomes or solutions to a design problem using internal pictures (Block, 1981; Damasio, 1999). Imagery is a cognitive function of the brain, part of the spatial intelligence outlined above by Gardner (1983), and allows the designer to "see" and manipulate ideas and possible solutions (Block, 1981). Studies have been performed to test and analyze this phenomenon.

Currently there is a debate among researchers as to whether mental imagery is pictorial or descriptional (Block, 1981). Fodor and Kosslyn (Block, 1981) and Arnheim (1969) argue that mental imagery involves visualizing using pictures and descriptive terms. Knowing that there are no actual pictures in the brain, their argument is based on the idea that mental images represent in much the same way that a picture does. Pylyshyn and Dennet (Block, 1981) argue that visualization is strictly descriptional in nature. Their argument places mental imagery strictly in a linguistic representation. This study is founded on the argument that visual imagery as pictures and linguistic descriptions do exist and effect the information processing within the brain.

Arnheim (1969) who has written several texts on visual imagery and art suggested that there is a presence of abstracted visual information in memory. As an example, he discusses how an artist can draw something from memory and goes through a process of drawing and then checking that drawing against the mental image. Essentially the artist, when asked to draw something from memory, would begin a drawing and then continually return to the drawing to make corrections as the abstracted visual image brought more and more information to the forefront of memory.

Mental images can function as one of three types of images (Arnheim, 1969). Mental images can act as pictures, signs or symbols. Sometimes one mental image may serve simultaneously in all three types. At a very basic level all three types of images may actually act as a symbol for an idea or image that is far more complex than can be pictured.

A sign image will portray a particular concept or idea without actually showing the physical detail but may suggest simply the qualities of that thing for which it is a sign (Arnheim, 1969). The sign image is an abstraction only inasmuch as the sign itself is an abstraction of a more complicated idea or concept. Letters, numbers and mathematical signs fall into this category of mental image. A letter, for example, can be imagined as a sign, but the thought of the letter “A” may specifically be referring to a letter, a word, a grade or an evaluation.

Mental images acting as pictures will have a low level of abstraction and may inform on such levels as shape, form, color or movement (Arnheim, 1969;

Damasio, 1999). A picture image will not be an exact replica of the thing itself. Images as pictures will have ambiguities causing the thinker to make value judgements in the absence of needed information.

Finally, mental images can act as symbols (Arnheim, 1969). A symbol is a further abstraction of a picture. A symbol stands for something much more complex than that which the symbol actually is. Music notes are an example of symbolism. A music note on a staff can communicate at a glance the pitch of the tone and the duration of the tone.

Damasio (1994) asserts that thought is made up largely of images. Whenever an individual speaks, writes a sentence or draws an image, that thought begins with a visual image. “If those thoughts were not imageable, we would not know them and would not be able to manipulate them consciously (p. 107). Indeed images are the main content of thought.

On the subject of visual thinking, Damasio (1994) suggests that images of things that were experienced visually are more concrete than images of things made up. If the thing that is known is something that is experienced externally, the brain will record in detail all of the facts of what is seen. If the thing that is known is experienced internally it will be more vague or abstract, “…are images nonetheless” (p.108).

Hoffman (1998), on the same topic of visualizing and imagery presents a compelling argument that all experiences are in part a construction of our minds. After studying patients of brain damage, Hoffman developed a series of rules that the mind applies to constructing an understanding of visual input. Damage to

certain portions of the brain affects the patient's ability to construct a visual reality. The process for which this works is that first an image is projected onto the retina. The brain then interprets the meaning of the scene according to the visual input from the retina. The brain then utilizes both emotional and rational intelligence to construct the reality of what is being seen.

Damasio (1994 & 1999) Hoffman (1998) and Pinker (1994 & 1997) all seem to agree that visual imagery is built on experiences and is constructed and manipulated by the brain. Additionally all three authors believe that visual imagery is the foundation for thought and thus the foundation for creativity. Finally, they conclude that visual experience is the "raw material" (Hoffman, 1998, p.202) in all imagined constructions.

Thus a designer can experience, see and read and thereby collect the necessary information to create a library of mental images. It is because of this ability to call upon mental images that a dialogue may occur for a designer involved in solving a design problem. Mental imagery can also aid the designer to utilize creativity and the creative process to create a novel solution to a design problem.

## Creativity

Creativity can be simply defined as an illumination or epiphany of prior knowledge. The illumination drives the individual to a more complete and complex understanding of this prior knowledge. Creativity is best evidenced through viewing a creative product (Amabile, 1983). Most of the definitions of

creativity are concerned with the final product and not the construct of creativity (Amabile, 1983). Amabile (1983) presents this definition of creativity:

> A product or response will be judged as creative to the extent that (a) it is both novel and appropriate, useful, correct, or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic (p. 33).

By heuristic the author refers to a task that does not have a predetermined method for finding a solution or a predetermined goal of what the solution may be, where the individual must study the problem and determine possible solutions where no clear method of problem solving exists. Csikszentmihalyi's (1997) definition of creativity indicates that "…creativity results from the interaction of a system composed of three elements: a culture that contains symbolic rules, a person who brings novelty into the symbolic domain, and a field of experts who recognize and validate the innovation (p.6)". Therefore, creativity requires a field of information, a process, a product and an 'expert' within that field to validate the product.

Creativity takes time and intensity. The development of creativity is slow and does not follow a continuous process (John-Steiner, 1997). The time investment is in mastering the symbolic language of the domain (Csikszentmihalyi, 1997; Damasio, 1999). In interior design, understanding the symbolic language includes knowing the history, theory and practices of the discipline. Additionally it is important to understand the communication methods of interior design, the types of drawings and their standards for communication.

Finally, the designer should have a fundamental knowledge base of the elements and principles of design.

As the domain knowledge is acquired, an intense environment of study and experimentation is necessary (Csikszentmihalyi, 1997, John-Steiner, 1997). With study, experimentation and experience, the designer must also be willing to take risks and explore new options (John-Steiner, 1997). Fear, doubt and confusion plague the creative person, but a successful conclusion or solution translates into joy and excitement. There is a necessity for intensity in order to stay with the process through fear, doubt and confusion in order to keep pushing for a solution.

Creativity then is the ability to see more clearly or rearrange knowledge into dynamically new understandings based on information that is held subconsciously. When creativity is applied, there is at least generally, a process of activities one will experience. This application of creativity is the creative process.

## Creative Process

The creative process is typically expressed in five stages of activity (Csikszentmihalyi, 1996; Wallas, 1926). While these stages are accepted within the psychology community, it is understood that this process is more iterative than sequential. It can also be overlapping, where the creating individual is involved in the preparation stage of one problem and the verification stage of another problem. While creativity does indeed tend to sequence along these stages, quite often a wall will block the path and the creating individual may need

to return to the preparation stage as some important part of the equation may be missing.

The first stage, preparation, includes understanding the nature of the problem and learning all of what is “known” about the problem (Csikszentmihalyi, 1996; Wallas, 1926). During this stage the individual may be reading and thinking intensely about the problem. The creating individual will be trying to understand the problem as completely as possible.

During preparation, the creating individual will direct or control thinking applying logic to the problem (Wallas, 1926). This controlled thinking is typically directed at clarifying the problem in order to set a clear question to be answered. “Our mind is not likely to give us a clear answer to any particular problem unless we set it a clear question, and we are more likely to notice the significance of any new piece of evidence, or new association of ideas, if we have formed a definite conception of a case to be proved or disproved” (Wallas, 1926, p.84).

The second stage of the process is incubation (Csikszentmihalyi, 1996; Wallas, 1926). This is the time of reflection and quite often, relaxation. After the problem is understood, it is necessary to distract conscious thinking in order to allow subconscious thinking to take over the process. Wallas proposes two ways to approach this stage of unconscious thought. The first and most economical is to begin several problems at once and be actively engaged in a conscious mental effort while leaving the unconscious free to handle this stage. The second is to reach a level of complete mental relaxation to allow the subconscious the freedom to explore for new associations and new ideas. As mentioned above,

often there will be a missing element in the preparation that does not allow the process to continue. Then it would be necessary to return to the preparation phase.

Insight or illumination, the third stage, is the stage where the revelation happens. This is when the brain finally crystallizes the possible solution to the problem or a portion of the problem. This is an instantaneous point where the subconscious mind presents the conscious with an idea. If the revelation contains the solution to the problem, then the individual would move on to the fourth stage of the process. Many times the revelation is not a complete solution to the problem but a new way of looking at the problem. It can also bring insight to some facet of the problem that was not understood as well going in to the process. This sort of insight would cause the individual to go back to the problem stage and reevaluate, and then start the process again.

The fourth stage is evaluation (Csikszentmihalyi, 1996; Wallas, 1926). Evaluation is the stage where the solution is evaluated against the problem to see if it fits. This stage is very similar in nature to the preparation stage in that during this stage the designer returns to conscious directed thought. During the verification stage the solution that developed in the incubation stage is then tested against the original problem. The designer is applying the new idea to the problem and consciously testing the idea for fit and appropriateness.

At this point, if the developed solution is a good fit for the problem, the designer may move on to another problem or be able to focus on another concurrent phase of the creative process (Csikszentmihalyi, 1996; Wallas, 1926).

Typically in a design problem there would be several problems in different phases of the process and the illumination may bring new information to another design problem or may act as a catalyst to cause another illumination to occur within the larger scope of the problem. This is often done by the individual creating and may also be corroborated by an expert in the field. If the solution "fits" the problem the creative individual would proceed to the fifth stage, elaboration. If the problem is not wholly satisfied by the solution, it may be necessary to return to preparation to examine what is missing from the equation.

The fifth and final stage is elaboration (Csikszentmihalyi, 1996). Elaboration is where the insight or illumination is applied to the problem and modified and developed as a part of the whole. The application of the solution to the problem is likely to cause the creating individual to go back and reevaluate the design as a whole. The creating individual may choose to make changes either to the solution of a small portion of the problem or to the solution of the whole problem to make all of the elements work together into a whole.

Understanding how the creative process works is an important piece in understanding the design process. The design process is made up of the steps or stages required in creating a novel solution for a design problem. The idea is that the design process is a specific application of the creative process. Interior design students, then apply the creative process within the design process.

## Design Process

The design process is described as the steps or stages that a designer navigates in order to find a novel solution to a design problem (Jones, 1992,

Lawson, 1980, Mitchell, 1993). The process of design is not sequential in nature and must allow the designer to work simultaneously in several steps, often back and forth between steps. The traditional design processes (regardless of field) seem to go through the same basic steps.

The first step is problem definition and feasibility (Jones, 1992). This step is characterized by understanding the problem and conducting research. The designer may research different aspects of the problem in order to understand it better. This research may include interviewing the client, interviewing potential users or researching other designs where solutions and problems may have parallels.

This first step in design parallels the first stage of the creative process. Both first stages include problem definition and understanding the context of the problem. The designer will then start to imagine possible solutions to the problem often preparing sketches, drawings and notes. This is the second and third stages in the creative process and leads to the second stage of the design process.

The second step is preliminary design (Jones, 1992). In preliminary design the designer will predict and consider different solutions to the design problem. One of these predictions will then be selected for further development. This parallels and overlaps the second and third stages in creativity, the incubation and inspiration stages.

Within the design process the next stage is formalizing the design (Jones, 1992). The design is hard lined and then details are planned. In design, the

designer will complete the design details or they may be divided up into various responsibilities and given to other designers (designers with specializations or junior designers) depending on the scale and complexity of the problem. This design step prepares a formal solution to the problem where the fourth stage of the creative process, evaluation, can occur.

Next, the design will be evaluated for its appropriateness in solving the design problem. Typically the designer will have the solution approved by management and then it is brought to the client for evaluation. This is the fourth and final stage of the design process, the evaluating and implementing stage referred to by Jones (1992) as the planning stage.

Completion of the project and feedback from the client are included in the last stage of the design process. This is the implementation and feedback portion of the design process. In the comparison of the design process to the creative process, this step would be included in the elaboration stage.

The design process is constantly being modified and redefined. There is not one recipe to follow straight through that will always result in the correct or best solution. The current research in this field is seeking to shift the focus from product oriented design solutions to process oriented solutions (Jones, 1992 & Mitchell, 1993). Most traditional design processes, however, go through many of the same stages as the creative process and indeed the design process is involved in the creation of design solutions.

**Design Problem**

The design process starts with the design problem (Lawson, 1980). Often, the design problem is ill defined and open-ended. Design problems frequently are not apparent and must be discovered through experience and research.

Another concern with design problems is determining where to start and where to finish (Lawson, 1980). Lawson (1980) gives the example of a designer needing to design a door handle. Often the designer will escalate the problem past the original design parameters to wondering if there is actually a need for a door. Another example Lawson (1980) gives is that a student is asked to design a library. The student goes to research methods of storing and loaning books in a library and then continues to regress the design problem until it is a full scale research of library procedures and no longer a design problem.

Another characteristic of design problems is that they are ever changing (Jones, 1992). As the designer discerns the nature of the design problem, the designer will try to predict solutions for the problem. Sometimes, as solutions are applied, more of the design problem becomes evident or, what was believed to be the design problem, proves to be inadequate and a new problem is defined.

Because design problems are elusive and ill defined, there is no clear method for solving the problem. Amabile (1983) defined creativity specifying the necessity that the method for solving not be predetermined or by rote. It is this nature of design problems that parallels creativity and the creative process.

**Design Solutions**

If, as stated above, design solutions are ill defined and changing, it then follows that there is no one correct solution (Lawson, 1980). As design problems have many different facets and constraints, some solutions may be better suited to one aspect of the problem while another solution may be better suited to another aspect. Therefore, there are an infinite number of solutions to any given design problem.

The quality of design solutions is that they involve compromise (Lawson, 1980). The compromise may be that to solve one element of the problem leaves another element of the problem unsolved or not solved in the optimum way. Therefore, in order to find the optimal solution to the design problem, it is vital to explore the many possible solutions revealed through the drawing and visualization process.

A vital part of the design process is understanding and communication. Understanding the problem and communicating ideas, both from conscious to subconscious and from person to person, aids the design process and facilitates finding the optimal solution. Understanding and communication are enhanced through the use of drawing. Drawing allows the designer to divide the problem into components for better understanding. By drawing, the designer is able to apply solutions to the design problem and study them without committing the time and money of attempting a solution at full scale. Drawing also allows the designer to communicate ideas with other designers and the client.

## Drawing

Drawing appears in the design process in two major areas. Drawing is a means of communication with others in the field such as coworkers and allied professionals, and with some outside the field, for example, clients. Drawing also is an exploratory tool used by the designer to discern the nature of design problems and investigate solutions and approaches to specific design problems.

Architects and interior designers employ both uses of drawing, communication and exploration (Fraser & Henmi, 1994). In these professions, specific types of drawings are bound by sets of conventions that enable understanding as a pictorial or visual language. Drawing types include orthographic, axonometric, and perspective drawings, each drawing type emphasizes different qualities of the subject matter. Use of these different types of drawings provides the designer with the means to better explore and communicate the design.

### Orthographic Drawings

The first type of drawing, orthographic drawings represent a two-dimensional view while axonometric and perspective drawings represent the subject in three dimensions (Fraser & Henmi, 1994). Orthographic drawings enable the designer to see the subject matter in two dimensions, emphasizing the length and width of the space. Although information is lost when viewing a three-dimensional object drawn two-dimensionally, a two-dimensional drawing simplifies the subject so that the designer can focus on just the information included in that drawing. This allows the designer to create and see visual

relationships in space from room to room that may not be obvious in other drawings. Obviously, this loss of information can assist visualization of the design, but it can also hinder visualization. Two-dimensional depictions of space compress the third dimension and relationships that occur in this third dimension may be overlooked.

Typically, orthographic drawings are realized as plans and elevations of space (Fraser & Henmi, 1994). The benefit of orthographic drawings is that the drawing represents the space with all parallel lines represented as parallel lines in the drawing without distortion (Ching, 1985). Additionally, drawings may be scaled so that proportions of elements are not distorted. Plans, elevations and sections serve to illustrate positive and negative space as well as relationships between structural elements and surfaces.

The plan drawing cuts the space or object along the horizontal axis (Ching, 1985) (Fraser &Henmi, 1994). In a plan view, the emphasis is on the floor (floor plan) or depicts the ceiling (reflected ceiling plan). With a floor plan, the designer can visualize patterns along the horizontal plane without being distracted by the vertical plane e.g., by the rhythm of columns repeated across an area.

Elevations cut the space along the vertical axis (Ching, 1985) (Fraser &Henmi, 1994). In an elevation, the designer can focus on the vertical planes or, perhaps, see walls of the space and the rhythm of windows or changes in the surface of the walls. Because orthographic drawings limit the designer to

representations of space in only two dimensions, other types of drawings exist to express space in three dimensions.

**Axonometric Drawings**

Axonometric drawings are often referred to as paraline drawings. Paraline drawings are a drawing construction where parallel lines within the space are represented as parallel lines in the drawing. Additionally, vertical lines are represented as vertical lines and all lines that are parallel to the x, y, and z axes can be represented in scale to the existing space. Axonometric drawings are different from orthographic drawings in that they show all three dimensions of the space simultaneously (Fraser & Henmi, 1994). These drawings enable the designer to gain a sense of volume in the space. Axonometric drawings are easy to construct, model three-dimensional space, and can be drawn from many different viewpoints.

**Perspective Drawings**

Like axonometric drawings, perspective drawings show all three dimensions simultaneously (Ching, 1985) (Fraser & Henmi, 1994). Unlike axonometric drawings, with parallel lines, perspective drawings use converging lines that create the illusion of “being” in the space. Perspectives can be used to show the overlapping of forms, diminution of size, convergence of parallel lines and foreshortening. Perspective drawings eliminate the optical distortion caused by parallel lines, as in the paraline drawing. Also perspective drawings have the advantage of being the most readily understood drawing because they represent the reality of three-dimensional space, as we perceive it.

In perspective drawings, all sets of parallel lines not parallel to the picture plane appear to converge toward a common point referred to as a vanishing point. Perspectives that are drawn with one vanishing point show all parallel horizontal lines in the drawing converging on a single vanishing point (Fraser & Henmi, 1994). These one point perspective drawings typically focus attention toward one rear wall with two “side” walls projecting forward toward the viewer. In this way, three walls may be visualized simultaneously.

In contrast to one point perspective, drawings using two vanishing points show horizontal lines that recede to either one point or the other located on opposite sides of the drawing. A two point perspective drawing focuses attention on the one of the two converging walls of the space. This type of drawing allows the designer to visualize two walls within the space simultaneously.

**Summary**

Interestingly, these three different drawing types, orthographic, axonometric and perspective drawings are often utilized in sketching that occurs as the first part of the design process. Because these drawing types are commonly accepted forms of communication in the field, they are readily understood by the designer and make up the visual language that the designer uses to communicate not only to other designers and clients but to themselves during the design process. These drawing types are applied in many different drawing scenarios in the design process.

## Drawing Applications

There are several different applications for drawing in design. They are categorized for the purpose of this paper into five categories: referential drawings, diagrams, presentation drawings, visionary drawings and study drawings (Fraser & Henmi, 1994). Of particular interest is their use and benefit in developing study drawings, which are generated in a critical part of the design process.

### Referential Drawings

Referential drawings are drawings that are drawn from life, an attempt to accurately record what is seen (Crowe & Laseau, 1984; Fraser & Henmi, 1994). These drawings are used as tools to document and see existing things. When the designer sketches an architectural façade while studying it, that drawing becomes a reference that can be returned to at a later time to be studied. This is very convenient when the physical site, due to distance, is no longer available for study. Referential drawings benefit the designer more than a photograph would because the designers' perspective and unique way of seeing is recorded in the drawing. A referential drawing records not only what was seen but also how it was seen.

### Diagrams

Another application for drawing in the design is the diagram. Diagrams are sketches that graphically organize information (Crowe & Laseau, 1984; Fraser & Henmi, 1994, Laseau, 1986). In diagrams, information is recorded and organized symbolically. The diagram is created in order to "(1) discover basic relationships;

(2) include supportive information; and (3) express alternative configurations of the basic relationships," (Laseau, 1986, p. 18). Diagrams are created in many different forms to better simplify and communicate different types of information. Laseau (1986) describes many different types of diagrams including the bubble diagram, the area diagram, the matrix and networks.

The bubble diagram is used to organize and simplify many problems in design (Laseau, 1986). Bubble diagrams use zones, points and lines to describe and define design problem components. The bubble diagram may be utilized as a model depicting "…space, objects in space, program requirements, activities, or existing conditions," (Laseau, 1986, p. 25). The value of the bubble diagram is its ability to describe specific relationships between elements (without describing the character of those elements) and its ability to be manipulated in order to show alternative relationships between those elements. Show example here.

Area diagrams share many similarities to the bubble diagram (Laseau, 1986). One thing that is different about area diagrams is that they are drawn to show scale. This allows the designer to compare and contrast with relative information such as length, width, area and volume. Bar graphs and pie charts are some examples of area diagrams.

The matrix is a diagram that uses a grid for organization (Laseau, 1986). The grid is created primarily to show relationships between elements. It can be used in program analysis and space versus use associations. The grid is created with the elements to be compared placed on the x and y axes and the boxes are

completed using symbols that describe the relationships between the two elements at their intersection on the grid.

Networks are often used for organizational diagrams, critical path diagrams or decision trees (Laseau, 1986). Network diagrams consist primarily of lines and bubbles. In some networks, the bubbles represent the activities and in others, lines are utilized to represent activities. For both kinds of networks, the important information for each task is its duration, when it starts, when it finishes, and the title or description of the task.

**Presentation Drawings**

Presentation drawings are carefully drawn representations of the projected space (Fraser & Henmi, 1994). Typically, presentation drawings are the polished, rendered drawings that are shared with the client in order to communicate the details of the project (Fraser & Henmi, 1994). These drawings might include floor plans, elevations, axonometrics, and perspectives. The different drawings included in the presentation are utilized to describe the space as accurately and completely as possible. Often they are used to communicate the finished results of the design process to the client and also the builder for the project.

**Visionary Drawings**

Another type of drawing, visionary drawings, is elicited completely from the designers' mind (Fraser & Henmi, 1994). These types of drawings are fantastical netherworld drawings of things and places that do not exist anywhere else but in the designers own mind (Fraser & Henmi, 1994). Visionary drawings are at the heart of creative exploration. They can be utilized to study the effects

of combining and deconstructing ideas. Visionary drawings also extend the design process and give the designer the opportunity to explore ideas that may contain potential for future solutions for realistic design problems.

**Study Drawings**

The last application of drawing is the study drawing, which is the focus of this study. These drawings and sketches are typically created in the very beginning of the design process that enable the designer to explore ideas (Fraser & Henmi, 1994; Herbert, 1993). However, there will often be later phases in the design process that need further development and the designer may return to a problem solving mode and start creating study drawings again (Fraser & Henmi, 1994) (Herbert, 1993).

Study drawings lack uniformity across the field since they do not have a time honored process or set of rules to adhere to (Herbert, 1993). They can be abstract or representational (Herbert, 1993). Often study drawings are quick gestural drawings that record fleeting ideas early in the process, but sometimes they are slow contemplative studies of a particular facet of the design (Herbert, 1993). They can be constructed of heavy broad marker strokes or light sketchy lines (Herbert, 1993). Because of their immediate nature, study drawings are often improvised on available scraps of paper such as envelopes or note pads, although sketch pads may also be used (Herbert, 1993). Study drawings document the imagery process of the designer and are as unique as the designer creating them (Herbert 1993).

Study drawings are different from the previously discussed drawing applications because of their private or semi-private nature (Herbert, 1993). Because these drawings are completed early in the design process, they are a graphic conversation between the designer and the potential solution (Herbert, 1993). Because of their private nature and their explorative quality, study drawings are often rough sketches. They are typically drawn very quickly and roughly using drafting conventions only the conventions are simplified and loosely applied (Herbert, 1993). These drawings will often include information gathered in referential drawings or even include the referential drawings themselves (Crowe & Laseau, 1984; Herbert, 1993; Laseau, 1986). Additionally, as the design problem is explored, diagrammatic drawings and visionary drawings may be utilized. Study drawings are different from the other types of drawings as they utilize any possible graphic way to explore and test different ideas.

In the case of a larger project, the work may be shared by a team of designers where the study drawings may be completed by, and studied by, all of the designers within the group (Herbert, 1993). In this case, the designer may sketch while brainstorming with a team. The study drawings then create a pivotal point in the design process where several designers communicate simultaneously through sharing and manipulating the same study drawings.

### Principles of Study Drawings

As an interior designer starts to think about a design problem, he or she may produce some very loose sketches or drawings. Later in the design phase the designer may resort to sketching in order to solve a specific problem with the design. Daniel Herbert (1993), in his text Architectural Study Drawings, proposed five principles of study drawings. These principles describe the designer's process and utilization of study drawings. The first principle is concerned with the idea that the designer must understand the basic constructs of design and drawing. The second and third principles describe the ways that study drawings are able to add new information to the design problem and to the possible solution. The fourth principle deals with study drawings' ability to foster communication in the design process. The fifth principle defines how the study drawing is placed in the larger scheme in the design product and then evaluated in the bigger picture.

### Principle 1: Understanding the domain

The first principle of study drawings is that they utilize the designer's background knowledge of design constructs and the process benefits from their ambiguous nature(Herbert, 1993). The designer brings to the design task a drawing language and background knowledge of design principles, construction techniques and architectural detailing. The ambiguity of the drawing simplifies the complex design task of designing a space or a building down to a conceptual figure in the sketchbook. This simplification occurs because typically the designer cannot sketch with the same complexity that occurs in the imagination.

Other authors (Garner, 1993; Goldschmidt, 1991; Herbert, 1993; Schon, 1983)have alluded to this principle citing both the need to be able to communicate within the domain and this initial information loss or simplification of the problem. Design solutions occur within and affect many different domains. Herbert Simon (Garner, 1993) introduced the idea that when a person designs and contemplates a possible solution, he or she cannot anticipate all of the consequences of the solution in all of the domains that it affects. This is because of our limited information processing ability. Therefore, that move or solution needs to be projected into "reality" through sketching or modeling so that the qualities and consequences may be studied within all the domains that it affects.

**Principles 2 and 3: Creating new information**

The second and third principles of study drawings that Herbert (1993) discusses are so closely related that here they will be treated as a single principle. Both principles encompass the idea that study drawings create new information in the design process. The third principle is simply more specific about the processes involved. This principle states that study drawings are a medium where the graphic process and the cognitive process interact and influence each other to create new information in the design task.

Because of the ambiguity of the rough sketch, the designer may "see" something in the sketch that was not in their mind's eye when they first set out to draw. Therefore, the sketch itself helps to generate new ideas (Herbert, 1993; Schon & Wiggins, 1992; Garner, 1985; McKim, 1980; Goldschmidt, 1994). This infers then that the design process as a whole is ambiguous (Herbert, 1993).

Each stroke of the drawing serves to incrementally define the task and direct it's ultimate solution (Herbert, 1993).

Taking this idea another step, the designer conceptualizes a possible solution and draws it out, sees what has been drawn and then reacts to it by drawing again creating a conversation between sketch and designer. Each step in this brief conversation causes the designer to see, evaluate, reconsider and redraw ideas within the conceptual scope of the design (Herbert, 1993). Herbert (1993) refers to this conversation as "mark/interpretation/mark"(p. 62). Schon and Wiggins (1992, p155) also refer to this conversation between the designer and the sketch.

> We shall describe architectural designing as a kind of experimentation that consists in reflective conversation with the materials of a design situation. A designer sees, moves and sees again. Working in some visual medium – drawing, in our examples – the designer sees what is 'there' in some representations of a site, draws in relation to it, and sees what has been drawn, thereby informing further designing.

Garner (1985) has also found through artist interviews that they believed that their sketches created information within the design task. He collected data in several case studies that indicated that analytical and exploratory drawing "increas[ed] the potential of discovering or 'seeing' new information" (p. 44)

McKim (1980) and Goldschmidt (1985) also refer to the conversational nature of study drawings. McKim, who focuses on visual thinking, says rough sketches have no intention to impress or communicate with anyone other than

the thinker, that they are a type of graphic conversation between the sketch and the designer. Goldschmidt, in her studies, refers to the “dialectics of sketching”.

> “Hence our dialectics metaphor: In the exchange between imagery in the mind and sketch on paper, we reason by way of relating figures and concepts to one another until a satisficing good fit is achieved among them” (Goldschmidt, 1985, p. 174).

This generative quality of idea sketches is found in the idea that sketches are like thinking “[move] fluidly from the abstract to the concrete” (McKim, 1980, p.12) All of these researchers and authors cite numerous examples of designers drawing / thinking / drawing in order to create or generate new ideas.

In the study drawing process where the designer is experimenting with visual images, the designer may deliberately add ambiguity to the process by creating purposefully abstract drawings. For example, a designer may choose to create some marks that simply have a pleasing gestural quality. This creates a beginning building block that starts the process of mark / interpretation / mark (Herbert, 1993).

**Principle 4: Communicating the idea**

The fourth principle of study drawings is that study drawings utilize graphic conventions to organize cognitive imagery and to allow for communication during the design process (Herbert, 1993). Once a designer learns the graphic conventions that allow them to communicate within the field, he or she will communicate even in private drawings in that same language. Therefore, study

drawings for interior designers will typically be composed loosely of plan, elevation, section, perspective or axonometric drawings (Herbert, 1993).

Communicating, at least loosely in the accepted drafting conventions, allows the designer to move more smoothly into the actual planning phase where the more finished public drawings are created. McKim (1980) points out that working within a graphic language can be both beneficial and a hindrance. The graphic language can limit the imagination in study drawings, so the designer must be flexible enough to switch between different graphic languages during the ideation process (McKim, 1980). Additionally, using a graphic language that limits the imagination may cause the thinker to confuse the drawn image with the reality of the thing being drawn (McKim, 1980). The benefit, however, of a common graphic language is the ability to move with fluidity from abstract to concrete and from concrete back to abstract (McKim, 1980).

**Principle 5: Evaluating changes in the design**

The fifth and final principle of study drawings is that study drawings are utilized by the designer as source for comparison and contrast and as a reference for evaluating change in the design task (Herbert, 1993). The concepts of continuity and change are illustrated in context drawing and exploration drawing. Context drawings are typically drawings that “show the current design text as a whole, usually at some conventional scale,” (Herbert, 1993, p.109). Exploration drawings are a result of the designer focusing “on some selected feature of a design task and explor[ing] possible changes in it,”

(Herbert, 1993, p. 113). Exploration drawings might appear off to the side in a context drawing (Herbert, 1993). Show examples here

McKim (1980) expressed a similar concept for graphic ideation. Graphic ideation has two modes, developmental and exploratory. In the developmental mode, “visual thinkers gradually evolve a promising, though initially embryonic, concept into mature form,” (McKim, 1980, p. 122). In the exploratory mode, “visual thinkers probe their imagination with their markers, seeking to touch and record the vague and elusive imagery that usually accompanies the conception of a new idea,” (McKim, 1980, p. 122).

Context drawings bring continuity to the design process by defining the design task. Context drawings have two roles, “holding information in place and managing change” (Herbert, 1993, p. 112). Because context drawings are typically drawn using conventions and to scale, they contain all of the information that has been conceived to that point in the design (Herbert, 1993). Additionally context drawings manage change within the design task.

Exploration drawings, the drawings that occur on the margin of the larger design, explore changes to a particular piece of the overall design, introduce change into the context drawing. “The designer uses the current state of the context drawing as a guide for deciding what exploration studies to make next and then to evaluate the results of those studies” (Herbert, 1993, p. 113). In this way the context drawing creates continuity in the design process by managing all the aspects of change.

There are two additional facets of idea sketching that bring continuity to the design process. First, all of the sketches create a visible record of the working process (McKim, 1980). This visible record can be referred to and reviewed for new ideas or inspirations, or simply to track the development of an idea. Secondly, the idea sketches can be laid out side by side for comparison purposes (McKim, 1980). These aspects of study drawings contribute to the continuous quality of the working process.

> "Drawing not only helps to bring inner images into focus, it also provides a record of the advancing thought stream. Further, drawing provides a function that memory cannot: the most brilliant imager cannot compare a number of images, side by side in memory, as one can compare a wall of tacked up idea sketches" (McKim, 1980, p. 12).

Exploration drawings constitute the change portion of the working process. Here the designer can take one aspect of the context drawing, go off to the side and develop that one idea through more abstract ideation sketching (Herbert, 1993; Garner, 1985; Fish & Scrivener, 1990). Exploration drawings have to be abstract in order to introduce a new way of looking at the design task. "Within the design task, however, the initial statement, or restatement of the exploration drawing from it's parent context drawing, must be ambiguous enough to attract, admit and hold new information from the designer's cognitive experience as the drawing engages the schematization process," (Herbert, 1993, p. 116). Garner (1985) also felt that exploration drawings increased the "the potential of discovering or 'seeing' new information," (p. 44). Additionally, Garner (1985)

suggests that exploration drawings not only help in problem solving but also in problem defining. The exploration drawing's role then is to create change and introduce new meaning into the process and is thus the dynamic element in the design process (Herbert, 1993).

Study drawings are the visible record of the design process. They describe and record the exploration process of defining and creating a solution for the design task. Study drawings are also a communication tool for the designer, coworkers and clients. Additionally, study drawings create a reference for the entire design task. The dynamic and flexible nature of study drawings makes them a necessity in the design process.

## Current Drawing Research

Currently, much of the design process and study drawing research is being conducted to evaluate computer "sketching" software effectiveness. Other research studies that are being conducted are self-reports of the use of study drawings in the design process for architects, graphic designers and mechanical designers. No studies are currently being reported in the interior design field on the use or necessity of study drawings in the design process. Perhaps, in the interior design field, the act of sketching in the design process is simply taken for granted.

### Allied Design Field Drawing Research

Looking at the role of drawing linking the design process and the creative process in the arts, Garner (1990) performed a study that examined drawing in graphic design, sculpture and art. Garner's research utilized a case study

approach where he looked at different artists and asked them to talk about how they used drawing in the design process. Furthermore, Garner discusses the lack of information on drawing in the design process.

Garner (1990) interviewed and studied the artists who draw with a focus on exploratory and manipulative drawing. The artists that Garner interviewed liken drawing in the design process to a conversation with oneself. Additionally, artists refer to utilizing drawing not only in a problem solving process but also a problem finding process. Another artist spoke of how drawing increased his visual literacy. Many of the artists concurred that drawing in the exploratory phase was useful in understanding, remembering, and critiquing. Other artists discussed the purposeful practice of deliberately adding ambiguity to their sketches in order to trigger them to see something new in their drawings.

Garner (1990) concludes that drawing facilitates creativity and that there is an important relationship between drawing and the design process. Additionally, drawing styles differ depending on their purpose. Drawing aids in the defining and understanding of the design problem. Most importantly, however, Garner makes the case for teaching drawing as a means to allow students to understand and direct their creative talent.

Where Garner (1990) looks primarily at drawing in the design process as an aid to defining the nature of the design problem, Rusch (1968) sought to explain how each successive drawing progresses toward a potential solution. In his research, Rusch (1968) defines three different effects of drawing modifications: leveling, sharpening and normalizing.

In a pilot study of Pablo Picasso's lithographic bull, Rusch (1968) attempts to understand the purpose behind changes made to drawings in the design process. He outlines three different goals of drawing modifications. One modification to a design sketch is referred to as leveling. Leveling occurs when a drawing is changed in revision to eliminate certain features, such as lines or shapes or other detailing marks. Sharpening was defined as the opposite. Sharpening a drawing occurs when certain aspects of a drawing are brought to a higher level of detail in revision. The third term, normalization, occurs when a drawing becomes more representational in a revision.

Rusch (1968) viewed Picasso's process in creating the bull lithograph and determined that leveling and sharpening led the design to progressively stronger forms. He also noted that this progression through stronger forms motivated Picasso to continue the pursuit of a final solution. This idea of leveling and sharpening in revision drawings leading to stronger forms plays right into the design process of drawing being a conversation between the designer and the drawing.

Garner (1990) and Rusch (1968) researched physical properties and effects of study drawings on the design problem and the eventual design solution. Schenk (1991), in her research, was looking to define designers' insight into the effectiveness of study drawings in the design process. She was able to show how and when designers utilized study drawings and describe designers' feelings about the usefulness of study drawings.

Schenk (1991) completed a study of the use and effectiveness of drawing in the graphic design profession. In her study professional graphic designers were interviewed about their use of drawing in both the preparatory stage of design and the production stage of design. Her results revealed that most professional graphic designers used drawing during the preparatory stage of design to visualize and compare multiple solutions to the same design problem. Her respondents recorded that they utilized sketch journals and idea files to assist in visualization and in making creative decisions. “[Drawing] helps designers to assemble their first thoughts and a fluid free-ranging drawing style can enable a designer to explore a greater number of ideas quickly with an economy of effort” (p. 170).

Respondents also reported that it was in the preparatory stage that they did the majority of their drawing (Schenk, 1991). Often these drawings were utilized as a communication device on group design projects. As the project progresses, drawing is utilized to refine graphic design solutions. “At this point, drawing is no longer used only as a quick notation for ideas but also for combining and modifying visual elements, and for exploring subtle variations in composition and form (p. 173).” Drawing is utilized throughout the graphic design process and the professional graphic designers felt that drawing was an important tool in creating novel design solutions.

Additionally, the designers also reported the value of drawing in the design process (Schenk, 1991). Graphic designers believed that the “proper use” of drawing had a positive effect on the overall creativeness of the design solution.

Looking at the cost effectiveness of a design solution, the designer also reported that drawing during the design process had a positive effect both in time efficiency for the designer and overall cost reduction in production of designs.

In concluding on the results of her study, Schenk (1991) stated that "[a]lthough not all respondents thought that a wide range of drawing ability was essential for graphic designers, all thought it was useful, and the majority thought that a fluid and confident use of drawing was essential in the stimulation of ideas" (p.178). This study illuminated the professional graphic designers' perceptions and uses of drawing to create novel and unique design solutions. Schenk's study helped to define the use of drawing throughout the graphic design process and added a necessary dimension to the graphic design process model.

Ullman, Wood and Craig (1990) studied the necessity of drawing in the mechanical design process. They felt that drawing was as important in the field of engineering as in other design fields. They hypothesized that drawing and sketching were a preferred method of communication in the design process. They also wanted to illustrate that drawing served representational needs better than computer aided design systems or drafting. Finally, they set out to link drawing in the design process to cognitive imagery tasks such as generating and combining ideas.

The subjects in their study (Ullman, et.al., 1990), mechanical engineering designers, were given two design problems and a time limit for resolution. After the designs were completed, the process sketches and drawings were analyzed.

The researchers were analyzing the content and purpose of the drawings and sketches that were created in the course of solving the design problem.

Ullman, Wood, and Craig (1990) showed that mechanical engineers utilize drawing, either drafting or free hand sketches, the majority (86%) of the time. Only 14% of the marks used in the design process were text or calculations. They also found that 67% of the drawings created were freehand sketches while the rest were more formal drafting. This data supported their hypotheses that drawing was an important part of the design process and that sketching was the preferred method over traditional drafting.

This study also showed that drawing was a necessary tool in visual imagery for the mechanical design engineers (Ullman, et.al., 1990). They determined that “many drawing actions were not to document the results of design activity but were part of the design process itself” (p. 271). There was additional support for the idea that drawing aids the designers’ short-term memory, and that drawing allows the designer to see and evaluate simultaneously multiple design solutions.

Ullman, Wood and Craig (1990) utilized the results of this study to make recommendations for future computer aided design software. Additionally, they pointed out the need in engineering education to stress the use of graphic notation within the design process. Their recommendation was for more drawing experience both in formal drafting skill and in informal free hand sketching.

Fish and Scrivener (1990) have also looked at sketching, visual imagery, and the design process. Their study examines the use of sketching in the

problem solving processes found in art and design. Starting with a review of the purposes for drawing and how drawing affects visual imagery and how visual imagery affects drawing and sketching, the researchers propose that software, which facilitates sketching, would be helpful to the design domain. Fish and Scrivener make the case that verbal and imagery processes need to be integrated both in design education and in software design. Additionally, they call for the software to organize sketch information and verbal information in such a way that translation from verbal to visual be facilitated for the designer and the student.

Goldschmidt (1991) has written several articles from her research in drawing, visualization and creativity in the design process. One of her landmark studies seeks to answer the two questions about the role of sketching in the design process. One question asks about the type of reasoning involved in sketching and the other question asks about the importance of sketching in the design process.

This study was part of a larger study performed at the Massachusetts Institute of Technology (MIT) where a design student along with professional architects were assigned a design problem (Goldschmidt, 1991). They participated in think aloud sessions where they were recorded, both audio and video, during the design process. That information was later transcribed and the data were utilized in Goldschmidt's (1991) research.

Designing is the process of creating something new (Goldschmidt, 1991). For an interior designer this would mean developing the appearance and setting

of interior space. “Designing entails generating, transforming, and refining images of different aspects of that still non-existent artifact and making representations of it which enable communication and examination of the ideas involved (p. 125).” The final goal of this process is to create a visual representation of the space with enough detail to enable its construction or the construction of a visual model.

In order to study the reasoning process in the initial stages of design, study sketches were studied, analyzed and divided into two categories: “design moves” and “design arguments” (p. 125). Design moves are when the designer makes a mark on the page or participates in an act of reasoning that relates to the design problem (Goldschmidt, 1991). Design moves, as evidenced in drawing, occur when a change of thought occurs while actively involved in sketching, or when that change in thought occurs while reading from an existing sketch. Design moves can be made cognitively with no sketching input. Design arguments are rational statements made in defense of the design moves. The arguments are sensible statements that may have a bearing on the design as a whole or on just one aspect of the design. The audio data revealed verbal evidence of design moves and arguments while the video and drawings produced during the experiment provided visual evidence of design moves and arguments.

In the example given by the author, the architect’s verbal thinking is paired with her sketch and then subdivided into moves and arguments (Goldschmidt, 1991). Goldschmidt suggests that while this early design process is additive, it is

neither linear nor hierarchical. She also points out that there is no logical sequence of ideas. Concepts are not yet firm or consistent throughout the design task.

Visual images and drawings help us to see not only the structure of what is depicted but allow us to abstract from that image and see also what is not there (Goldschmidt, 1991). This abstraction allows the designer to tap an idea that might not have otherwise been available to them. An architect may refer to seeing or imagining something and then draw and then see or imagine again based on the feedback provided by the drawing.

In a simple problem solving exercise, simple imagistic reasoning may be enough to generate a solution to the problem. When the problem is complex such as designing with only a footprint of a building, this imagistic reasoning also becomes very complex. This is where sketching enters the equation.

In the design problem presented in this study, the building in question did not exist and imaging is based on the recall of other buildings the architect had stored in memory; therefore the building as a whole could not be “imaged” by the designer (Goldschmidt, 1991). “He or she starts by generating partial images of tentative aspects of the designed entity,” (p 130). The designer may draw on knowledge of architectural history or places he has visited to come up with these tentative images. A task as complex as coming up with a design for such a space can not be done all at once. Through sketching, the designer can come up with many ideas and images adding to and reading from one to the next. Again, it is not simply what is inherently sketched, but also that which the designer can

derive or abstract from what is not there in the sketch. One of their designers was quoted as saying that he “like(s) the fuzzy stuff. I can see in it more than I can the hardlined things.”

“The advantage of sketching is its dynamic nature: A sketch may be transformed by adding to it, by deleting parts or by drawing over it. The designer is not confined to a single sketch: he or she may generate as many sketches as required before satisfactory images emerge…” (Goldschmidt, 1991, p130). Interactive imagery is the process of sketching and drawing until a potential solution is found in the information generated in the drawing. “Sketching, then, is not merely an act of representation of a preformulated image; in the context we deal with, it is, more often than not, a search for such an image,” (p 131).

The thinking that occurs while the designer is sketching is divided into two modes: ‘seeing as’ and ‘seeing that’ (Goldschmidt, 1991). ‘Seeing as’, is when the designer is using preperceived information and sketching remembered images. This leads to ‘seeing that’ where the designer sketches something entirely new based on an abstraction of the ‘seeing as’ sketch.

The designer might vacillate back and forth from abstract imaging to perceived drawing during the process moving from ‘seeing that’ to ‘seeing as’ (Goldschmidt, 1991). Goldschmidt determined a pattern in ‘as’ and ‘that’ thinking alternating and spending an equivalent argument in ‘as thinking’ as in ‘that thinking’. These shifts happen both within moves and across moves that she refers to as the “dialectics of sketching”.

Goldschmidt (1991) also determines that it is significant that the shifts occur both ways from ‘as’ to ‘that’ and from ‘that’ to ‘as’. For example, the designer shifts back and forth between generic qualities and rules of shapes and forms, into the more specific appearance of those shapes and forms. Variations on the pendulum pattern described in this study may be due to a number of factors. Uncertainty and new inputs to the design may cause a shift in the pendulum action. Also the designers level of experience may effect this pendulum action. “The inherently creative process of form-production, then, at least in architectural designing, seems to result from a special systematic, causal relationship between two modalities of visual reasoning, induced by sketching,” (p. 140).

Goldschmidt’s (1991) study received support from Arnheim (1995), a prominent researcher in the area of visualization. Arnheim is particularly challenged by the proposal of sketching as a dialectic process of input and feedback to create a unique and creative solution to a design problem. Arnheim adds to the dialectic theory that the drawn image is not the same as the imagined image and through this the drawing can bring to light a new understanding that would not have been achieved without the externalization process of drawing.

Most of the research in drawing and design has been performed in the allied fields of design such as art, graphic design, industrial design and architecture. The new understandings realized in this research are important to the practice and study of interior design. Professionals and students alike can utilize this information to have more control over and better understand the

design process and thus, create optimal design solutions. In several articles published in the Journal of Interior Design Education and Research, the argument has been made that design education must prepare students not only for the vocational aspects of interior design but to prepare students to be critical thinkers as well (Fowles, D.,1992; Friedman, A., 1986; and Guerin, D., 1992). Part of that call to prepare students to be critical thinkers is to teach them to manage and direct the design process in order to develop creative solutions in a world of increasing technology and an increasingly diverse population.

**Interior Design Drawing Research**

Rey-Barreau and Whiteside (1983) became aware that their students who were skilled in drafting techniques were not applying the drafting conventions and drawings to the problem solving process. The students went straight to hardline drafting and concluded by pursuing solutions without the problem solving process. The result was that the students would jump straight into creating the design solution without a thorough understanding of the problem, the design process, or the solution itself.

Accepting the theory that drawing facilitates the design process, Rey-Barreau and Whiteside questioned what types of communication skills design students should have by their second year of design and what those communication skills should be at the time of graduation. Ultimately their matrix included written and verbal skills, informal graphics and formalized graphics. Many of the different types of drawings discussed previously were included in their matrix. In the schematic design step, where the designer is formulating

different possible solutions to a design problem, the following drawing methods were listed: bubble diagrams, freehand sketches, loose orthographic drawings, brainstorming, and tracing. Additionally, the researchers sought an understanding of how to teach graphic and communication skills and also allow the student freedom to explore creative solutions. Finally, the researchers were concerned with the best time to introduce students to construction methods and detailing which would potentially limit creativity in the design solution.

The researchers sought to develop a matrix of communication skills needed at every point along the design process (Rey-Barreau & Whiteside, 1983). Once the matrix was determined they resolved to create a two-semester class in design communication skills. The goals of the class were to allow the student freedom to explore creativity while learning communication methods and to introduce students to the design process and the relationship of verbal, graphic and written communication to each step of the process. Additionally, the students were expected to increase professionalism, increase visual awareness skills and to alleviate students' fears of drawing and verbalizing ideas.

The goal of this research was to facilitate communication in the design process (Rey-Barreau & Whiteside, 1983). Ultimately, the student should develop the ability to communicate first with themselves then with colleagues and finally with the client. The researchers felt strongly that communication and the design process should be taught simultaneously resulting in a "more creative student who can both think and communicate at all levels" (p.16).

The origin of the design process is found in cognitive science, mental imagery and creativity. Design, because of its visual nature, occurs through the assistance of different kinds of drawings (Fraser & Henmi, 1994; Herbert, 1993;

Lawson, 1980). The most dynamic of these drawings is the study drawing which is unique in that it may utilize any or all of the different types of drawings (Herbert, 1993). Study drawings are the vital evidence of the conscious and subconscious processes that occur as the designer attempts to define the many aspects of the design problem (Herbert, 1993; Lawson, 1980). Additionally, study drawings are the visual record of physical progress to the unique solution that is eventually proposed to the client or end user of the design (Herbert, 1993; Lawson, 1980).

The literature reported in this chapter highlights the importance of study drawings in the design process. However, the studies do not give a good understanding of the study drawings' role in the design process. More research is needed to define the influence of study drawings on the designed product.