ATTITUDES OF INTERIOR DESIGN STUDENTS TOWARD CREATIVITY IN DESIGN PROBLEM SOLVING USING CADD VERSUS CONVENTIONAL DRAFTING TOOLS

by

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(ABSTRACT)

This study was conducted to explore interior design students' perceptions and attitudes toward creativity in design problem solving using CADD versus conventional drafting tools and to research whether CADD stifles or encourages students' creativity in that manner. Students' level of CADD performance, past experience with CADD or other microcomputer software and level of CADD problems were used as the independent variables for this study.

During the last two weeks of the spring semester 1989, 32 interior design students, who comprised the population for this study, were given two design problems, one to be done with CADD and the other with conventional drafting tools. After that period students were asked to fill out a survey questionnaire and participate in a group discussion. The collected data then was a subject of a descriptive and analytical

statistical study.

Findings of this study showed no relationship between students' level of CADD experience and their attitudes toward using CADD in creative design problem solving. On the other hand, a significant relationship was found between the level of CADD problems that students had and their attitudes toward CADD. As a result, although students liked using CADD in design and 78% of them did not feel intimidated by it, more than 65% of the students felt that they could come up with more design ideas with conventional drafting tools than with CADD. Most of the students attributed this attitude to their long experience with design and drafting tools.

Other problems that caused discomfort to students when using CADD in design were lack of knowledge of DOS commands, unfamiliarity with computer hardware and software problems, and their limited time to work on computers.

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CHAPTER ONE

Introduction

The use of Computer-Aided Design and Drafting (CADD) for creative problem solving in interior design has been an issue since CADD was first introduced to the design profession in the 1970's. One respondent to a survey of designers believed that "computers have no place in the design of interior space and certainly do not aid the designer in the creative process" (Wolf, 1984). This attitude has abated with increased usage of CADD. Architects, designers, and manufacturers most of the time will accept computers as drafting tools, and as a time saving and mass production devices, but not as a design tools (Stoker and Wingarton 1983).

At this point, it is important to differentiate between a design tool and a drafting tool. According to Stoker and Wingarton (1983):

> drafting is a deterministic procedure which may be computerized with relative ease; while designing require a flexible and ever-changing set of tools to identify and manipulate the abstract relationships between a project's components (p. 19).

Thus, drafting may be done with a CADD system while designing may be a separate process done by hand. Indeed, some design firms will have both designers and draftsmen working side by side, where designers will design projects and give rough plans to draftsmen to produce the detailed CADD drawings. Although this may be true, a creative design

is not finished in one step. For example, a designer typically does not lay out the final plans of a design project without going through the early steps of exploring the design problem, diagramming and conceptualizing the various relationships between the different components of the design problem, and finally, refining the ideas for the end product of the design solution. These early stages of the design process may not easily be facilitated by the use of computers.

Thus, it is the interaction between computers and the design process that is the focus of this thesis. As designers are well aware, a creative design that is done on a computer is not approached before computers are effectively used. As a result, before computers are effectively used in the design process, several questions will need to be answered: 1) Will designers be able to use computers in the conceptual stage of the design process? 2) Do computers discourage or foster creativity during these early conceptual stages of design process? 3) How closely does CADD compare with conventional drafting and drawing tools in encouraging or discouraging creative approaches to design problem?

Purpose of the Research

The purpose of this research is to study interior designers' attitudes regarding creativity during the design process using computer aided design and drafting (CADD).

Research Objectives

The following objectives have been formulated to accomplish the purpose of this study: 1) to compare interior design students' attitudes and perceptions regarding creative design problem solving using CADD versus conventional drafting tools. 2) to determine whether interior design students believe that CADD fostered or stifled their creativity during the design process.

Need for the Study

Because of the out-of-date responses of some previous surveys to using CADD in the design profession and because CADD software has improved over time, the present study on using CADD in interior design becomes critically important to re-evaluate and update the image of using of CADD in creative problem solving in the design profession.

The publishing of results of this study will build another dimension of recognition and awareness that will be of interest to individual designers, educators, and design firms and institutions. Moreover, it will give insights into how to use CADD in the design problem solving process.

Even negative findings from this research study will be of serious value to the CADD software industry in defining where CADD could be further enhanced to provide more creative solutions to design problems. The results will help the CADD software industry to survey professional designers' attitudes and perceptions towards creative

usage of CADD in design problem solving, and assist revising the future versions of CADD software.

CHAPTER TWO

Review of the Literature

Early in the 1980's, the usage of commercial Computer-Aided Design and Drafting (CADD) began to increase. At that time only a few of the large dollar volume corporations used CADD because of its high cost. This situation is no longer true. According to Loebelson (1989), 92% of the top 100 interior design firms are using CADD.

In a reader poll mail survey done by S. Doubilet for Progressive Architecture (August, 1987, p. 15), it was reported that 84% of the participants used computers for CADD or other systems, 95% of participants plan to use computers for CADD and other systems, 53% of the participants used CADD, and 84% of the participants either have or plan to use CADD. The survey attracted 928 respondents.

Again, CADD usage is increasing among the Interior Design Educators Council, Inc. (IDEC) members who recognize their use of computers in teaching (approximately 70) and by 120 members of the Computer Network in IDEC (McLain-Kark & Rawls, 1988, p. 23).

On the other hand, there is no clear consensus on how CADD influences designers' creativity in the process of design problem solving. It is true that some architects, designers, and manufacturers feel that computers could stifle designers' creativity and inhibit creative thinking; yet, their beliefs are not backed with concrete

studies. Some of these people prefer to design and draft by hand, the old classic way, with the conventional drafting tools for its unique, personal and artistic end product.

To proceed with the purpose of this research, it will be helpful to clearly understand the nature of interior design and how designers think when seeking a problem solution. For an understanding of this subject, an effort was made to explain the following: the nature of the design process and how designers approach it, creativity and the design process, computers and the creative design process, as well as designers attitudes toward computers and the design process.

Design Process

Sanoff (1977) defined the design process as "the sum of stages, phases, or actions that designers follow in solving any design problem" (p. 24). He (1977) described the nature of this action in six sequential stages that follow:

1. **Recognition** is the primary introduction to the design process. It is based on the establishment of an existing problem and its need for a solution.

2. **Identification and Exploration** are essential to determine the nature of the problem. The designer may need to restate the problem into more useful and appropriate terms. Specific operational assumptions have to be established to clarify any restrictions that need to be considered in the design.

3. Searching and Expansion of the information related to the problem should be completed next. With a large body of gathered information, it is common to categorize the related data by breaking them into useful groupings. After that the designer can evaluate the importance of each grouping of data and develop the variables that are essential for a solution. When variables are clearly and carefully identified, each variable should be tested to specify its influence and relationships with other variables.

4. Classification and Analysis of the collected data should be assembled into a tentative format. In addition, the designer should examine the problem for any recognizable form or structure and study the need for any analogous problem solution in other areas of the problem.

5. Evaluation of alternative solutions is then carried out with respect to available information. By comparing solutions and testing them against the design requirements or sum of needs, decisions should be made according to the priorities previously established.

6.Implementation should now be carried out and activated through a presentation and public hearing. Designers should develop a plan for implementing effectiveness of the design solution. The gathered information about the user's satisfaction with the solution will be used for future problems.

The previous stages generally apply to many types of design problems. More specific design project phases are introduced in Figure

(1). In short, the model breaks the design process into five different phases. In the modified model of Sanoff (1977), these phases are: the program development phase, the preliminary design phase, the production phase, the construction phase, and finally the evaluation phase. This study will be mainly concerned with the preliminary design phase.

The preliminary design phase is normally divided into two different stages. First, the designer will try to develop a number of alternative design solutions. In this stage the designer will use the bubble diagraming technique for medium to large scaled design problems. Each diagram will have a number of bubbles where each one is used as a "model for physical space, object in the space, program requirements, activities, or existing conditions" (Blake, 1988, p. 49). As Blake stated, the main function of this form of abstraction is to represent the relationships between a set of elements and the relative case of manipulating the diagram to suggest alternative relationships or various arrangements.

Second, the designer will follow up these bubble diagrams with schematic designs. Schematics are often use by designers as a method of "visual thinking" and as a means of arriving at the finished design drawing with which the client or the public are familiar (Blake, 1988, p. 28). Before the designer begins making final design decisions, he or she diagrams all the required spaces and necessary relationships. In the diagram, different spaces are shown in different

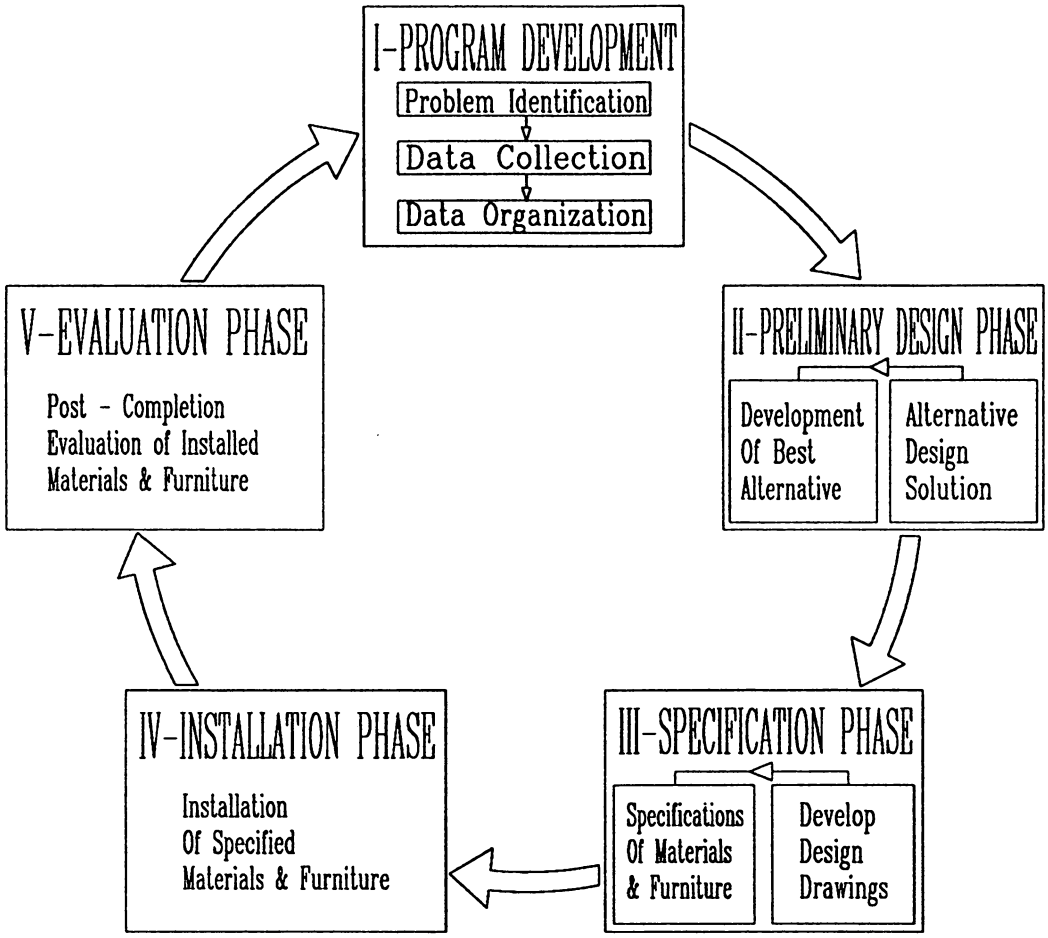

Figure (1)
Phases of a Design Project
(An Adaptation of Sanoff's Model)

sizes, and relationships between spaces are specified by their location near each other or near entrances.

Within both the stage of bubble diagraming and schematic designing, the designers ideational fluency should be activated to its maximum limit. By doing so, the best design will be given a chance to develop. According to Glover (1980, p. 11), ideational fluency stands for "the number of ideas a person produces." Simply the more ideas the more there is to choose from. Originality, on the other hand, is the "uncommonness or statistical infrequency of a person's ideas" (p. 11).

The next part of the preliminary design phase is the development of one alternative. This process needs a designers flexibility and elaboration. Flexibility is defined as "the number of different kinds of ideas a person develops" while elaboration means is explained as "the extent to which a person fills out his or her ideas" (Glover 1980, p. 11). Because creativity is so important to this phase, the next sections will discuss creativity and its relationship with the design process.

Creativity and the Design Process

By definition, interior designers are assumed to be well educated and trained professionals who "creatively solve problems pertaining to the functional quality of the interior environment" (IDEC, 1988). This part of the definition is endorsed by the following professional organizations such as: The American Society of Interior Designers

(ASID), The Institute of Business Designers (IBD), Interior Designers of Canada (IDC), The Interior Design Educators Council, Inc. (IDEC), The Foundation for Interior Design Education Research (FIDER), and The National Council for Interior Design Qualification (NCIDQ).

Amabile (1983) stated:

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

Heuristic tasks occur when the path to the solution is not completely straight forward. In fact, in many cases such heuristic tasks do not have clearly defined solutions or goals; therefore it is part of the problem solver's responsibility to identify them. On the other hand, algorithmic tasks have clearly identified goals.

In interior design most design problems are unique in their settings, yet, others may be similar to other problems. Thus the designer will use his past experience in problem solving, but he will have to accommodate his solution to the problem in hand. Such behavior requires a clear understanding of the limitations of the problem, which are defined by the needs of the client.

Although it is very hard to measure designers' creativity; there are keys and indicators to creative behavior (Sanoff, 1977). After collecting all the relevant data to the design problem, identifying them, categorizing them, and examining them, designers will fall in a long chain of thinking and data manipulation to plan and predict a problem solution. Planning and prediction are two related activities

that need advanced thinking about the design problem and the sequence of elements.

In Figure (2), to plan a problem solution designers practice four types of behavior which are fluency, flexibility, originality and elaboration. Glover (1980) defined fluency as "the number of ideas a person produces", flexibility as "the different kinds of ideas a person develops", originality as "the uncommonness or the statistical infreaquency of a persons ideas", and elaboration as "the extent to which a person fills his or her ideas". Later the designer has to evaluate all information related to the problem. In the evaluation stage all ideas should have an equal chance of serious study, so the best original and creative design can be identified accurately.

Finally, the designer reaches the data synthesis stage and end up with the solution. Here designers are required to integrate the evaluated data and bring the scattered pieces to form the design problem solution.

Through the programming stages of data evaluation and synthesis, designers spend a tremendous effort arriving to a solution. Accordingly, people in the design profession often consider the time and effort that might be saved by a device such as a computer (Sanoff, 1977). However, not every-one sees the computer as a helpful tool, nor do they believe that it triggers creativity in the problem solving process. Therefore, it is helpful to examine computers and the issue of creativity and the design process.

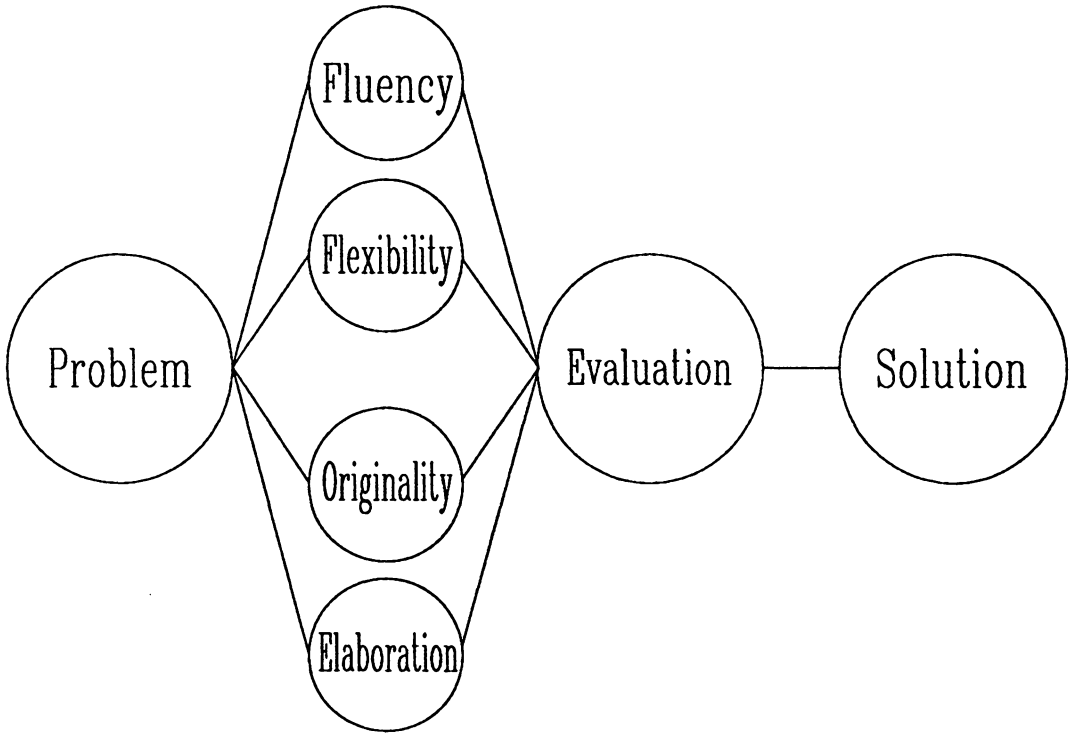

Figure (2)
Problem Solving

Computers and the Creative Design Process

Computers and creativity are two different things that need to work together in a fluid way for the sake of a successful design procedure. As a result the awareness of that harmony is still a controversial issue due to the lack of any dedicated study in this area. The following discussion will elaborate on the literature that was either for or against using computers and CADD in interior design because of its influence on designers' creativity.

Designers Pro Using Computers and CADD in Interior Design

G. Jones (April, 1985) said in his article "Can creativity be automated?":

> In thinking about the role of computers in the creative design, it is important to realize a basic difference between human thinking and computer rendering. Artists and visual communicators deal with imagination, which does not have to confine to the real world. The most powerful computer graphics systems, on the other hand, have been designed to model physical objects and their geometry, and natural laws. (p.74)

Computer experts Stoker and Weingarton (1983, p. 21) stated that "we must not think of CAD just in terms of cost benefits but stress creativity". Tisone and Wismar (1985) see that all individuals are creative in different degrees. They also believe that microcomputers can be used to enhance creativity. Such a belief is supported by the fact that with some software, microcomputers offer the followings: First, "freedom of choice" either from the menu selection or the keyboard. Other options are the mouse or the digitizer. Such freedom increases

the learning motivations which are beneficial for the creative process. Second, microcomputers introduce "interaction and branching". Interaction is the process of progress that the microcomputer user experience when the right command is selected. On the other hand branching takes place when a wrong command is used. At this point, the microcomputer user will receive a sound or a verbal massage to identify the problem or give a hint leading to the solution (p. 99).

Third, microcomputers send continuous "feedback" to its users so they can see their progress or problems. Such feedback takes the form of a written message or a musical sound. Fourth, "risk taking" comes as another offer to microcomputer users. This activity is known for its enhancement to creativity because it supports and stimulates microcomputer users trial and error and encourages testing hypotheses and seeking problem solutions without fearing the penalty of losing. Sixth, most features of microcomputers, interactivity or feedback, help to enhance the "divergent thinking" of its users. With this type of instructional medium, microcomputer users are encouraged to take risks, incorporate guessing or use any problem solving strategies they can develop. Finally, "convergent thinking" is emphasized in the majority of problem solving skills and strategies. Thus, by incorporating individual brainstorming ideas into the microcomputer, microcomputer users will systematically focus on the best idea to solve adequately the problem presented. Through the proper problem solving strategy, microcomputer users can enhance their convergent thinking

skills (p. 102).

In short, for some professionals, manufacturers, and educators computers do enhance creativity. Therefore, design firms and organizations will have to "automate or evaporate" said T. Frank, ASID (Thurston, 1988, p. 10) because the age of computers has arrived. On the other hand, there is another group of professionals, manufacturers and educators who look at computers as a device that might inhibit creativity because of its sequential performance and approaches (McLain-Kark & Rawls, 1988, p. 26).

Designers Against Using Computers and CADD in interior Design

Since creativity is associated with free and random thinking, then, any sequential approach to a problem solution might stifles creativity. As McLain-Kark and Rawls (1989) explained:

> In computer terminology, styles are analogous to the concept of modes in which the computer only responds to certain types of specific input data and rejects all data which do not conform to the specification. (p.p. 23-24)

Thus computer users are to be linear thinkers and step-by-step approachers which makes them fall in the serialist group. On the other hand holist individuals are known not to be sequential exploratory people who are solution-based oriented (Lawson, 1980) they are more random in approach.

The issue of serilist versus holist individuals, who can be designers, is very related to the left brain/ right brain issue. Edwards (1979) explained left brain and right brain by stating that:

> The left hemisphere analyzes, abstracts, counts, marks times, plans step-by-step procedure, verbalizes and makes rational statements based on logic. while right brain: is not good in sequencing... doing first thing first, taking next step, then the next. It may start any where or take every thing at once. Also it is being... predominantly spatial, holistic, nonverbal and intuitive. (p.p. 35-36)

Accordingly, computers seem to be suitable for left brain users. Such groups enjoy sequential procedures. For example to draw a floor plan with AutoCAD software, the designer has to turn on the computer, load the CADD program, select the new drawing number, select the architectural unit, set the limits, snap and grid and finally start drawing. Without following this procedure, the designer will not make any progress. Moreover, this sequence will stimulate the left brain and encourage it to dominate. Indeed, this domination is seen as an obstacle in the way of designers creativity (McLain-Kark & Rawls, 1988).

That sequential procedure may not always be true. For example, Apple Macintosh computers with Macdraw, Macdraft and VersaCAD are designed to allow right brain domination. The idea behind this is that left brain individuals are word-oriented while right brain individuals are symbol-oriented. Thus, since the early example uses symbols and icons, then the right brain can dominate (McLain-Kark & Rawls, 1988).

In the design process, designers are required to be as creative as possible. Therefore, all obstacles should be eliminated for the sake of free creative thinking. Some professionals see that conventional drafting tools give all the needed freedom with less restrictions.

Moreover, drawings that are done with such tools are often received with special considerations because of their unique personality and artistic touch (Stoker & Weingarten, 1983).

Since the influence of computers and CADD on designer's creativity has not been systematically researched yet, it is very important to see what designers think about using the automated technique in interior design and what their attitudes are.

Designers Attitudes Toward Computers and the Design Process

A number of surveys were conducted to study designers attitudes toward using computers and CADD in interior design. These studies were done by: (1) Roberts, 1982 and reported by Wolf, 1984, (2) Tang, 1985, (3) McLain-Kark & Tang, 1986, (4) Doubilet, 1987, (5) Thurston, 1979, (6) Plant, 1988, and (7) Lindsey, 1988. All the previous studies used self administered mail questionnaires to collect the needed data. The sample population that was addressed by these surveys came from a large population which included ASID members, architects, design professionals and educators, contractors, furniture dealer etc. Highlights of the most important and related findings of these early studies are addressed in the remaining sections of this chapter.

R. L. Wolf, 1984

In 1982 K. Roberts conducted a "Survey of Computer-Aided Design

Usage in Interior Design Education". The questionnaire was mailed to a random sample population selected from the 300 top dollar volume architectural/ interior design firms (as compiled by Interior Design magazine) and 100 of the 309 recorded schools of interior design (as reported in the 1981 FIDER listing). In 1984, an article about this study was presented in the Computer Graphic World magazine by R.L. Wolf under a new title which was "Interior Design Developments with CADD".

Respondents were 30% architects, 16% contract design firms, and 13% furniture dealerships. Twenty five percent were involved in office planning and design; while 11% were in health care facility design. Seventy two of the educational respondents and 61% of industrial respondents saw that computer technology has the capability to open up more time to think creatively, while only four percent disagreed with that issue.

Many from both groups believed that computers allow more time to reevaluate programming information, explore design options, address custom interior detailing, and strengthen the information flow. Forty-two percent of the respondents believed that many common misconceptions were eliminated by understanding that computers could not function without human direction. "... A sophisticated design emerges when the designer stops looking at CAD as an end in itself and begin using it as a design tool," replied one respondent.

R. Tang, 1985; J. McLain-Kark & R. Tang, 1986

The objectives in Tang's unpublished master's thesis (1985) and the subsequent article based on that research (McLain-Kark & Tang, 1986), were to explore the degree of involvement of the ASID members with computers in the design profession.

Self administered questionnaires were mailed to 500 ASID members A total of 179 were returned including 10 unusable surveys. In the findings, most participants were non residential designers, 82% designed office environments, 31% designed health care facilities, 23% worked with hotels and motels, 22% designed restaurants, and 20% worked with stores.

Computer applications varied among respondents according to the needs of their businesses. For example, 69% used computers for accounting, while three percent used it for energy analysis. In business and management, computers were used for space planning (22%), and for elevations and working drawings (16%). Computers were also used for design production such as: perspectives and isometric drawings (10%), lighting/acoustical analysis six percent, structural analysis six percent and energy analysis three percent.

In general, it was recorded that designers with computer experience had better attitudes toward using computers in design than those without computer experience. Moreover, non residential designers were more positive about using computers than residential designers. Finally, computers were used by a significant proportion of the ASID

members.

S. Doubilet, 1987

In the May 1987 issue of, Progressive Architecture (P/A) magazine there was a survey questionnaire of readers about "Computer Use". Discussion and findings from the study were handled by Doubilet and published in the August 1987 P/A issue.

Among the 928 respondents, 49% were from large firms that used CADD for drafting and design and 40% of the small firms were considering buying CADD systems. Over 75% of the participants felt that they could not be competitive without computers. With respect to the issue of computerizing design, about 59% of all respondents agreed with that idea and 51% of CADD users had a positive attitude toward using CADD in their profession. On the other hand 21% of the computer non users and 48% of the CADD users disagreed with the idea of computerizing design.

As one of the major concerns, 26% of all computer users believed that computers discourage design creativity while 33% of the non-computer users believed this to be true. Sixty-four percent of the designers and the draftsmen as compared with 55% agreed that computers increased their ability to investigate design options.

S.A. Thurston, ASID, 1987

In a Master of Science thesis, Thurston did a survey questionnaire to study "Interior Designers' Attitudes Toward CADD Usage". The survey was addressed to 1,064 randomly selected ASID professional members. Only 982 surveys were mailed back to the researcher in June 1987.

A total of 7.4% of the respondents agreed that computers block designers' creativity, while 63% disagreed with that. Another 25% felt intimidated by computers but 44% felt the opposite. Only four percent agreed that manual drafting was as fast as CADD drafting and 58% disagreed with that.

Some individual designers revealed that "CAD is only another tool for the design profession" and others stated that any computer were "only as good as what goes into it. It is a useful tool for a designer Another individual remarked that " if (one) does not have the ability and training, how can CADD make (one) a better designer?"

J. Plant, 1988

"Computer Utilization in Interior Design: Attitudes, Applications, and Equipment Usage. A Comparative Study (85-88)" was another Master of Science thesis done by J. Plant (1988) with a focus on computers and design. The questionnaires of this study were mailed to a randomly selected sample of 500 ASID members. The returned questionnaires were 119.

Most of the respondents worked with interior design, architectural/engineering with interior design service, contractors,

builders, furniture stores, department stores, corporations, institutions or other government agencies, etc. In 1988 there was a 17% increase over 1985 between the ASID members on using computers in the design profession. Among 171 design organizations, a total of 28% use CADD applications within the organization. This percentage reflected a 21% increase over CADD applications in 1985. Only 43% used computers for production and specifications.

P. F. Lindsey, 1988

The last survey study in this chapter was done by Lindsey for her master's thesis. The study was titled "Computer- Aided Design Teaching Methods, Materials, and Equipments used by FIDER Accredited Schools of Interior Design".

In 1988 surveys were mailed to 65 FIDER accredited schools. The frequency distribution of type of drafting taught using CADD in interior design with 26 participants was 26% for each of plan view, elevations /sections, perspective, lighting schematic, solid modeling, plumbing modeling, and heating, ventilation, and air conditioning (HVAC). About 50% of the interior design programs offered a CADD course to familiarize students with CADD; another 26% used CADD as a drafting tool. Almost 30% of the design programs used the CADD course to both familiarize students and provide them with the needed drafting experience.

In conclusion, both groups for and against computers had their

own experiences that support their attitudes toward using computers and CADD in interior design. However, most of what has been said falls under the realm of theoretical knowledge, but is not empirical research. Moreover, the majority of the empirical research cited in this chapter surveyed designers' attitudes toward using computers and CADD in interior design, but did not study the influence of computers and CADD on designers' creativity in design problem solving.

CHAPTER THREE

Methodology

General Background

The major objective of this study was to explore interior designers' attitudes and perceptions regarding the use of CADD in creative solutions for design problems. The issue of creative design problem solving and computers has been a major concern for designers, design firms and manufacturers, design institutions and educators as well as design students.

This concern in the design profession is a result the invasion of computers into all fields of knowledge and practice. People in this field were divided into two groups, one that approves CADD use in design and another group opposed to this issue. Both groups' attitudes seem to be influenced by three factors: past experience with CADD or computers, past experience with computer problems, and knowledge of better job opportunities.

The first factor affecting designers' attitudes toward CADD is past experience with computers. An early study of McLain-Kark and Tang (1985), followed by Thurston (1987) and Plant (1988) showed that designers' experience with CADD or computers influenced their attitudes toward using CADD or computers in interior design. Designers with such backgrounds are usually found to be more positive about using computers and CADD in their firms more than the ones without

such background. Past experience with computers is another factor that influences designers attitudes toward using CADD in design (Tang, 1985, Thurston, 1987, McLain-Kark and Tang, 1988, Plant, 1988). For instance, designers can always be a victim of a sudden power failure while they are working on their computers. Deleting or copying over an important file is another problem that can happen due to careless or unknowledgeable handling of computer commands.

Other problems that a designer may face include loss of files due to a damaged disk, too full a disk or general disk error. These problems may lead to a general fear of using computers or a mistrust of them. Sometimes this is compounded by the fact that a user may be hesitant about using the computer to begin with. The third factor that seems to seriously affect designers attitudes toward using CADD in design is the better job opportunities that are available with CADD experience. As Loebelson (1985) remarked, "... they [CADD systems] have become indispensable in the marketing of design services for major jobs". Accordingly, more designers and design students seek CADD training and professional experience that will give them a competitive entry level advantage and enable them to express their creativity in design.

Since creativity is an important factor in the design problem solving, designers are assumed to be creative to cary-on with their design responsibilities. Thus, it becomes very important to understand how CADD, in comparison with the conventional drafting tools,

influences interior designers' attitudes and perceptions toward creativity when seeking solutions for design problems.

General Method

A survey research was formulated to conducted this study. The population consisted of 32 interior design students (two CADD classes) from Virginia Tech. During the last two weeks of the spring semester of 1989, students were given two design problems to solve. The first problem was solved with CADD and the second one was solved with the conventional drafting tools. At the end of the semester studied, the students were asked to answer a self-administered survey questionnaire. The goal behind that survey was to collect the needed data for testing the seven researched hypotheses. All seven hypotheses of this study addressed interior design students' attitudes and perceptions toward using CADD versus convectional drafting for creative design problem solving.

Hypotheses

The following hypotheses were formed as the basis of this research study:

1. Design students who had higher levels of CADD experience including the semester studied would have more favorable attitudes toward using CADD than using conventional drafting tools for creative solutions to design problems.

2. Design students with higher levels of CADD experience would believe that they had more ideational fluency with CADD for design problem solving than would students with lower levels of CADD experience.

3. Design students with higher levels of CADD experience would feel that CADD did not inhibit their creativity more than students with lower levels of CADD experience.

4. Design students with higher levels of CADD experience would have more favorable attitudes toward using CADD instead of conventional drafting tools in the conceptual design phase than students with lower levels of CADD experience.

5. Design students who had experience before the semester studied in using CADD or any other microcomputer software package would have more favorable attitudes toward using CADD in design problem solving than students without computer experience.

6. Design students with many difficulties in using CADD would have more favorable attitudes toward using conventional drafting tools than using CADD for creative design solutions.

7. Design students with many difficulties in using CADD would be more afraid to use CADD on future projects.

Operational Definitions

CADD: stands for Computer-Aided Design and Drafting. AutoCAD Release 9, from AutoDesk, was used for this study.

Conventional Drafting Tools: the set of hand drafting tools that design students used to establish their conceptual and working drawings for the Designers' Touche Showroom-Office project. Such tools may included a T-square, a triangle, a compass, a french curve, templates, pencils, inking pens, a shell, and eraser, etc.

High Level of CADD Experience: students who have had more than 100 hours of CADD experience.

Low Level of CADD Experience : students who have had 100 hours of CADD experience or less.

Creative Solutions: the number of novel, useful appropriate, and valuable designs that students came up with for their given design problems.

Design Problem: the set of obstacles or parameters that design students faced in this study in the form of design requirements.

Favorable Attitudes: the acceptance of design students to using CADD in interior design problem solving.

Computer Software Packages: softwares such as word processing, accounting, statistics, graphics etc.

Ideational Fluency: the number of different design ideas that students submitted for each given design problem in this study.

Difficulties in Using CADD: any kind of machine or man interface problem could occur while using CADD.

Conceptual Design Phase: the early or initial stage of design the design process that students faced when coming up with bubble

diagrams, schematics, sketches, or thumbnail drawings to help in determining a creative solution.

Sample / Setting / Design Problems

Population in the Study

The population in this study consisted of 32 interior design students (two CADD sections of 14 and 18 members). All participants were students of the College of Human Resources at Virginia Tech who were taking the required Computer-Aided Design course offered in the Interior Design program for the first time in the spring semester of 1989. The group of students included one graduate female, and 31 under-graduates (2 males and 29 females). Participants were assumed to have had the prerequisites for this CADD course. Prerequisites included Design Drawing, Presentation Techniques, Two-Dimensional Design, Three- Dimensional Design, Interior Systems, Interiors, and House Planning.

This study was conducted with the cooperation of the two sections of interior design students who were enrolled in the CADD course at the time of the study. The class meeting for that semester was scheduled for Monday and Wednesday from 1:00 P.M. to 2:50 P.M. for the first section, and from 3:00 P.M. to 4:50 P.M. of the same two days for the second section. All CADD classes were held in Wallace Hall on the Virginia Tech campus.

Since 29 students were introduced to CADD for the first time, this survey study was applied during the last two weeks prior to the final examinations' of the semester studied to maximum studnets' CADD learning experience. Student were expected to have a minimum of 60 hours of CADD training hours before both design problems (III-A & III-B) were to be introduced.

CADD Laboratory Setting

The Computer-Aided Design Laboratory in the Interior Design program was used to examine students' attitudes toward creativity for this study. The laboratory was furnished with 10 IBM computer work stations, three printers, and two plotter. The IBM computers included two AT's, four PS-2/ model 50's and four PS-2/ model 70's. All computers had 12" color monitors except one AT computer that had a 12" monochrome monitor. The lab also included two Epson printers model EX-1000, one NEC laser printer model LC08, one Houston instruments DMP 42 plotter for C and D size vellum paper, and one Zericon plotter. In addition, there were six Summagraphics drawing boards and digitizers and three CalComp drawing board and digitizers.

The CADD lab was opened from 8:00 A.M. to 5:00 P.M. from Monday to Friday. To use this room at other times before and after the official class time students were asked to check out keys to the CADD lab from room 218 in Wallace Hall. CADD assistance was available on Tuesdays and Fridays from 2:00 P.M. to 4:00 P.M. by the CADD graduate

assistant. AutoCAD Release 9 was the latest CADD package that the design department had available for use. Students used that package to design one of the problems on computers.

Design Problems

To proceed with the creativity study two small scale design projects, III-A and III-B were given (see Appendix A). Students were asked to design and draft project III-A (The Gallery and Art Center) with CADD. On the other hand, project III-B had to be designed and drafted with conventional drafting tools. Each design problem had a set of six to seven requirements. Students were also given two full weeks to finish working on all design phases of both projects. The final solution(s) for each project consisted of the following:

1. a graphic presentation of a bubble diagram to show the relationship between all design components.

2. a graphic presentation of a schematic drawing for the suggested design solution(s) to show the design relationships in the given interior space.

3. a furniture plan to show a graphic display of the interior space utilization for furniture and traffic.

4. a longitudinal section (elevation) to display a side view of the furniture and accessories.

Final drawings of both projects were either plotted or hand drafted at a scale of 1/4" = 1'- 0" for visual presentation, see Appendix B for

drawings' samples.

Data Collection

The primary source of data collection for this study were self-administered survey questionnaires (see Appendix C) that were given to all participants after the four phases of both problems were turned in to the instructor for grades. The surveys were designed to collect some demographical, attitudinal and behavioral data concerning creative usage of CADD versus conventional drafting tools in creative design problem solving. Collected data from this survey were subject to descriptive and analytical statistical study.

Data Analysis

From the surveys, the researcher used items 11 to 23 to test the seven hypotheses of this study. The independent variables were classified as:

1. **Students' level of CADD experience.** Students who had more than 100 hours of CADD experience were classified as group one which had the higher level of CADD experience. On the other hand, students who had 100 hours or less of the same experience were put in group two as students with lower CADD experience.

2. **Students' past experience in using CADD or any microcomputer software.** Once again, students who had such experience before they enrolled in the CADD course were classified as group one. Other

students who lacked that computer experience were approached as group two.

3. Students' level of difficulty in using CADD in design problem solving. Item 17 from the survey was used to divide the population into two groups. Students who responded with five or more on the scale of 1 to 10 for that statement were defined as group one which had many CADD problems; four or less were classified as group two who had few CADD problems.

Relevantly, the dependent variables were identified as the following:

1. Students' attitudes toward using CADD rather than conventional drafting tools in creative solutions to design problems.

2. Students' level of ideational fluency when using CADD in design problem solving.

3. Students' attitudes toward using CADD versus conventional drafting tools in the conceptual design phase.

4. Students' fear of using CADD on future design projects.

The researcher used the Statistical Analysis System (SAS) to t-test the hypotheses addressed by this study. The T-test for was set with alpha equal to 0.05.

Limitations

Due to the small size of the population, non random selection of subjects, and limited CADD experience, the specific and general

findings of this research can only be applied to interior design students of this study. The findings can not be generalized to other design students or professional designers. Furthermore, AutoCAD Release 9.0 from AutoDesk was the CADD software used to conduct this study because of its availability in the CADD lab and its strong architectural application. Release 9.0 was used with 10 IBM computers installed in the CADD lab. at the College of Human Resources at Virginia Tech.

CHAPTER FOUR

Results and Discussion

This chapter is a discussion of the results of this study and is organized into four major sections. The first section will cover the demographic characteristics of the population. The second section, will be a brief description of students' previous experience with computers and CADD. The third section details students' attitudes toward creativity in design problem solving using CADD versus conventional drafting tools. This section also contains a discussion on hypotheses regarding students' attitudes toward using CADD in design based on their previous experience with CADD. The last section will cover in general students' attitudes toward using CADD in design problem solving.

Although all participating students were very helpful and sensitive to this study, there were few missing answers. Such incidents will be reported with an (-X) sign to attract the reader's attention.

The survey questionnaire was taken by 32 interior design students in two days. At 1:00 p.m., on Tuesday May 2, 1989, 15 students turned in their projects, answered the survey questionnaire, and participated in a group discussion. On Wednesday May 3, 1989 at 10:00 a.m., another 15 students followed the same previous steps. Only two students missed the discussion part; however, they turned in their projects and answered the questionnaire individually at another time. Both

discussion groups were led by Dr. Joan McLain-Kark, the class instructor, and the researcher.

Characteristics of the Population

Thirty students (94%) were females while only two students (six percent) were males, see Table (1). Also, the majority of the students were undergraduates with only one respondent who was a masters' student. Undergraduates were divided into 17 juniors (53%) and 14 seniors (44%). Half of the population were interior design majors for their entire college career and the other half came from other majors. Students who change their majors from architecture and landscape architecture to interior design formed 16% of the population. Matching architecture, five students (16%) of the population were in general studies majors in the College of Art and Science. Other majors included business, education and math education, hotel and restaurant management, and textile management. In the population of this study there were five students (16%) who have declared minors, mainly from Art.

Students' Past Experience with Computers and Conventional Drafting Tools

General Word with Microcomputers

Most of the design students have had some kind of experience with

computers. For example, 29 students (91%) have used CADD or other microcomputer software for one reason or another, see Table (2). Only three students (nine percent) said that they had no previous experience with computers.

Word processing recorded the highest first selection for type of practice with the computer. Word processing helped about 19 students (59%) to be familiar with computers, see Table (3). A computer literacy course taken in the computer science department rated number two in influencing students' computer background. Participants in that corse formed a total of 12 students (38%) of the population. It should be noted that this course was previously a requirement in the interior design curriculum.

Overall, only five students (15%) had some experience with CADD (three with AutoCAD, one with AutoSketch and one with MacPaint). Other types of computer experience included computer games, general work with computers, and computer work in sociology and accounting courses, maybe writing papers.

Students' Experience with CADD and Conventional Drafting Tools

In the self estimation process of the total hours of CADD usage in interior design, students' experience varied from 60 hours to 200 hours, see Table (4). CADD usage average (mean) was 124 hours with a range of 140 hours. On the other hand, most of the design students had a difficult time estimating their total hours of experience with

Table (1)

Demographic Data About the Participating Interior Design Students.

Description	Percentage	Frequency
Sex:		
* Male	2	6
* Female	30	94
Academic Level:		
* Junior	17	53
* Senior	14	44
* Graduate	1	3
Previous Major (only if Interior Design has not been the major) :		
Others	16	50
* Architecture & landscape Arch.	5	16
* General Studies (Art & Science)	5	16
* Business	2	6
* Education Math & Education	2	6
* Hotel & Restaurant Management	1	3
* Textile Management	1	3
Total	16	50

N = 32 Interior Design Students.

Table (2)

Students With Past Experience With CADD or Any Other Microcomputer Software.

Description	Frequency	Percentage
Students With Previous Usage of Computers:		
* Yes	29	91
* No	3	9

N = 32 Interior Design Students.

Table (3)

Type of Past Experience in Using Computers.

Description	Frequency	Percentage
Type of usage:		
* Word Processing	19	59
* Computer Science	12	38
* CADD	3	9
* Computer Games	3	9
* General Work with Computers	2	6
* Accounting Course	1	3
* Sociology Course	1	3
* MacPaint	1	3
* Autosketch	1	3

Table (4)

Students' Self Estimation of Total Hours of Experience and Self Rating of Performance in Using CADD Versus Conventional Drafting Tools in Design Problem Solving.

Description	Frequency	Percentage
Self Estimation of CADD Hours:		
* 50 - 75	6	19
* 76 - 100	8	25
* 101 - 125	4	13
* 126 - 150	7	22
* 151 - 175	1	3
* 176 - 200	5	16
Mean (X) = 124		
Minimum Hrs = 60		
Maximum Hrs = 200		
Self Rating of CADD Performance:		
* Excellent = 5	1	3
* Very Good = 4	14	44
* Good = 3	14	44
* Fair = 2	3	9
* Unsatisfactory = 1	0	0
Mean (X) = 3.41		
Self Estimations of Conventional Drafting Hours:		
* 100 - 500	10	31
* 501 - 1000	11	34
* 1001 - 1500	1	3
* 1501 - 2000	3	9
* 2000 +	4	13
* Too Many Hours to Estimate	3	9
Mean (X) = 1558		
Minimum Hrs = 200		
Maximum Hrs = 7000		
Self Rating of Conventional Drafting Performance:		
* Excellent = 5	7	22
* Very Good = 4	19	59
* Good = 3	6	19
* Fair = 2	0	0
* Unsatisfactory = 1	0	0
Mean (X) = 4.03		

N = 32 Interior Design Students.

conventional drafting tools. The lowest amount of conventional drafting experience was 200 hours while the highest was 7000 hours. Three students said that they had "too many hours to estimate" in conventional drafting. Moreover, the range between the highest and the lowest self estimation of conventional drafting experience was 6800 hours. Such a high range clearly reflects the seriousness of the problem that students had when estimating the hours of their conventional drafting experience.

In short, the average (mean) time using CADD was about 124 hours. On the other hand, the mean of the total hours of experience with conventional drafting tools was 1558 hours. That makes the ratio between the two types of experiences 1 to 12.6 respectively.

On the self rating process, more students were satisfied with their conventional drafting experience than with their CADD experience. A close look at the same table reveals that seven students (22%) rated themselves excellent in designing and drafting with conventional drafting tools, while only one person identified his or her performance with CADD as excellent. Likewise, in the very good category, there were 19 students (59%) for conventional drafting tools and 14 students (94%) for CADD.

The means for this item also reflect the students' greater confidence with their performance with conventional drafting tools. The mean for CADD performance was 3.41 while the mean for conventional drafting tools performance was 4.03.

Students' Attitudes Toward Creativity in Design Problem Solving Using CADD Versus Conventional Drafting Tools

Because the interior design students' attitudes toward creativity in design problem solving using CADD versus conventional drafting tools formed the focus of this study, more than one third of the survey questionnaire was designed to explore this attitude. Items numbered from 11 to 23 were designed with a scale from 1 to 10 to score students attitudes. Students were told that scale 1 stands for STRONGLY DISAGREE, while scale 10 stands for STRONGLY AGREE. Results of items from 11 to 23 are presented in Table (5).

To convert the 1-10 scale into agree and disagree scale, the following break down was selected for its appropriateness:

* 9 - 10 = Strongly Agree
* 7 - 8 = Agree
* 5 - 6 = No Comments
* 3 - 4 = Disagree
* 1 - 2 = Strongly Disagree.

All fractional percentages were rounded to the nearest full number to fit in Table (5). As a result, the total percentage of some statements may add up to 98% - 99% while other may go up to 101%.

With a mean of 5.97, almost two thirds of the population, 20 students (64%), felt more comfortable with CADD than with conventional

drafting tools in designing their future projects, see item 11. Only four students (12%) disagreed with that attitude where one student strongly disagreed with it. A stronger attitude toward using CADD in design came out clearly in response to item 12. Twenty five students (78%) enjoyed the challenge of using CADD in design problem solving; however, three students felt the opposite.

With a mean of 4.06, more than half of the population enjoyed using CADD rather than the conventional drafting tools in design problem solving. In response to item 13, 17 students (54%) declared they enjoyed using CADD in design more than the conventional drafting tools, although they have much longer experience with manual drafting than with CADD, while 11 students (47%) felt the opposite.

Since the CADD learning curve has an influence on students attitudes toward CADD in design, 19 students (59%) disagreed with statement in item 14 which states that "The more I learn about CADD the more I enjoy designing with conventional drafting tools". The mean for this item was 3.31. Only seven students (21%) agreed with the content

of this item. However, it was hard for students to decide which set of tools stimulated their ideational fluency more than the other. In response to item 15, 12 students (37%) against 10 students (31%) felt that CADD helped them to generate more ideas than the conventional drafting tools. On the other hand, a close look at item 16 shows that the attitudes were reversed. Fourteen students (43%) agreed that the conventional drafting tools stimulated their creativity through easy

thinking and developing design solutions, while 10 students (31%) felt the other way around. Maybe that confusion was related to the degree of attractiveness that students felt toward CADD versus students' long experience in designing with conventional drafting tools.

Although many students in the discussion group part said that they had many problems with computers, CADD and their diskettes, more than half of them were able to overcome their problems. According to the responses in items 17, 19 students (60%) denied that they had a lot of problems working with CADD; however, 7 students (21%) admitted their problems. Thus, 24 students (75%) were not afraid of using CADD for their future projects. The mean on item 18 was 2.38, indicated that most of the design students plan to use more of CADD in future projects.

Students' had more positive attitudes toward using CADD than conventional drafting tools in the initial design steps. With a mean of 5.06 on item 19, 13 students (41%) agreed that CADD was easier than conventional drafting tools when used in bubble diagraming, drawing schematics, and doing thumbnail drawings. Ten students (31%) disagreed with this item.

In response to item 20, 17 students (53%) believed that CADD did not inhibit their creativity in the design problem solving process, while seven students (21%) felt the opposite. The mean of those who responded to this question was 5.94. On the other hand, 15 students (47%) believed that having to use CADD at the school lab at certain

Table (5)

Interior Design Students' Attitudes Toward Creativity in Design Problem Solving Using CADD Versus Conventional Drafting Tools.*

Item	Frequency / Percentage (Mean)									
	S.Dis.									S.A.
	1	2	3	4	5	6	7	8	9	10
11. I feel more comfortable using CADD now than using conventional drafting tools for designing my future projects.	1	0	2	1	1	7	7	5	4	4
	3	0	6	3	3	22	22	16	13	13
	(Mean=5.97)									
12. I enjoy the challenge of using CADD in design problem solving.	0	1	0	2	1	3	3	7	6	9
	0	3	0	6	3	9	9	22	19	28
	(Mean=6.94)									
13. I enjoy using conventional drafting tools more than using CADD in design problem solving.	3	4	4	6	0	4	3	4	2	2
	9	13	13	19	0	13	9	13	6	6
	(Mean=4.06)									
14. The more I learn about CADD the more I enjoy designing my projects with conventional drafting tools.	3	6	7	3	3	3	0	1	3	3
	9	19	22	9	9	9	0	3	9	9
	(Mean=3.31)									
15. I can come up with more different design ideas when I'm working CADD than with conventional drafting tools.	2	1	3	4	5	5	3	1	3	5
	6	3	9	13	16	16	9	3	9	16
	(Mean=5.25)									
16. I can come up with more different design ideas when I'm working with conventional drafting tools than with CADD.	3	0	3	4	4	4	3	6	3	2
	9	0	9	13	13	13	9	19	6	9
	(Mean=4.88)									
17. I had a lot of problems working with CADD.	3	4	7	5	1	5	3	2	1	1
	9	13	22	16	3	16	9	6	3	3
	(Mean=3.50)									
18. I am afraid of using CADD for my future projects.	12	2	8	2	2	2	1	1	1	1
	38	6	25	6	6	6	3	3	3	3
	(Mean=2.38)									

* 1=Strongly Disagree (S.Dis.) to 1=Strongly Agree (S.A.)

Continue Table (5)

Item	Frequency Percentage (Mean)									
	S.Dis.									S.A.
	1	2	3	4	5	6	7	8	9	10
19. It was easier to use CADD than conventional drafting tools for the initial design steps such as bubble diagrams, schematics, thumbnail drawings etc. to generate all kinds of new ideas.	3	1	2	4	5	4	2	1	6	4
	9	3	6	13	16	13	6	3	19	13
	(Mean=5.06)									
20. I don't believe that CADD inhibits my creativity in the design problem solving process.	1	0	3	3	3	5	2	3	5	7
	3	0	9	9	9	16	6	9	16	22
	(Mean=5.94)									
21. Having to use CADD only at the school lab at certain times bothers me and distracts my creativity in design.	1	2	4	0	2	8	3	6	2	4
	3	6	13	0	6	25	9	19	6	13
	(Mean=5.31)									
22. I enjoy designing and drafting with conventional drafting tools more than CADD because I can use them at any time and place I want	0	1	6	4	2	7	2	7	1	2
	0	3	19	13	6	22	6	22	3	6
	(Mean=4.84)									
23. The small size of computers' monitors in comparison with using 24"X 36" vellum paper inhibits my creativity in design.	3	9	4	2	0	5	3	4	1	1
	9	29	13	6	0	16	9	13	3	3
	(Mean=3.47)									

times bothered them and distracted their creativity; however, seven students (22%) disagreed with item 21.

The response to item 22 indicated that 12 students (37%) enjoyed using conventional drafting tools more than CADD because they were able to use these tools at any time and place they want. Eleven students (35%) disagreed with that. With a mean of 3.47, 18 students (57%) believed that the size of the monitor (12") did not inhibit their creativity (see item 23) while nine students (28%) believed the opposite. Overall most of the design students had a positive attitude toward using CADD in design; however, it was important to test statistically that attitude against all the seven hypotheses that were constructed for this study. The next section will be constructed around that objective.

Attitudes Toward CADD Based on Previous Computer Experiences

This section is a report of the t-test results regarding the seven hypotheses of this study. These hypotheses explored the relationship between the independent variables of CADD experience and the dependent variables of the design students' attitudes toward using CADD for creative design problem solutions. Items in Table (6) were used to t-test the first four hypotheses.

The first hypothesis stated that design students who had higher

level of CADD experience including the semester studied would have more favorable attitudes toward using CADD than conventional drafting tools for creative solutions to design problems. Items number 11 and 12 were used to test the first hypothesis, see Table (6). Results of both items failed to support the first hypotheses. Therefore, at 95% level of confidence it is not true that design students who had higher level of CADD experience including the semester studied would have more favorable attitudes toward using CADD than using conventional drafting tools for creative solutions to design problems.

The second hypothesis stated that **design students with higher level of CADD experience would believe that they had more ideational fluency with CADD for design problem solving than students with lower level of CADD experience.** Items 15 and 16 from Table (6) were used to test this hypothesis. None of the two items supported the second hypothesis. Thus, at 0.05 level of significance it can be said it is not true that design students with higher levels of CADD experience would believe that they had more ideational fluency with CADD for design problem solving more than students with lower level of CADD experience.

The third hypothesis stated that **design students with higher levels of CADD experience would feel that CADD did not inhibit their creativity more than students with lower levels of CADD experience.** Items 19, 20, and 21 from Table (6) were used examine this hypothesis. With a p-value equal to 0.0134, item number 21 was the only one among

Table (6)

Mean Scores and T-Test Results on Interior Design Students Attitudes Toward Using CADD Versus Conventional Drafting Tools in the Design Process Based on Students' Levels of CADD Experience. *

Item	Mean High CADD	Mean Low CADD	T-test	p-Value
11. I feel more comfortable using CADD now than using conventional drafting tools for my future projects.	6.412	5.467	1.2446	0.2229
12. I enjoy the challenge of using CADD in design problem solving.	7.175	6.667	0.6866	0.4976
15. I can come up with more different design ideas when I'm working with CADD than with conventional drafting tools.	5.529	4.933	0.6225	0.5383
16. I can come up with more different design when I'm working with conventional drafting tools than with CADD.	4.882	4.867	0.0168	0.9867
19. It is easier to use CADD than conventional drafting tools for the initial design steps such as bubble diagraming, schematics, sketches, thumbnail drawings etc. to generate all kind of new ideas.	5.176	4.933	0.2362	0.8149
20. I don't believe that CADD inhibits my creativity in the design problem solving process.	6.176	5.667	0.5521	0.5849
21. Having to use CADD only at the school lab at certain times bothers me and distracts my creativity in design.	4.294	6.447	-2.6289	0.0134

* N = 17 for students with high level of CADD experience (101 hours or more).
N = 15 for students with lower level of CADD experience (100 hours or less).

the three items that supported the third hypothesis. The mean for the students with high CADD experience was 4.294 and for the students with low CADD experience was 6.447. As a result, having to use CADD only at the school lab at certain times bothered students with higher level of CADD experience and distracted their creativity in design more than it did to students with fewer CADD hours of experience.

The fourth hypothesis was tested against item 19. That hypothesis stated that **design students with higher levels of CADD experience would have more favorable attitudes toward using CADD instead of conventional drafting tools in the conceptual design phase than students with lower levels of CADD experience.** As in Table (6), the p-value for item 19 was (0.8149), which was much higher than alpha (0.05). Thus, the t-test result of item 19 failed to support the fourth hypothesis.

The other important issue in this part of the study was to explore the relationship between students' past experience in using CADD or any other microcomputer software and students' level of CADD performance. For this test, students were divided into two groups: one with experience, and the other without experience. As a matter of fact, students with CADD and other microcomputer software experience came to 29 students (91%), while the second group consisted of only three students.

In Table (7), items number 12, 13, 14, 15 and 20 were used to test the fifth hypothesis which stated that **design students who had experience before the semester studied with CADD or any other**

microcomputer software package would have more favorable attitudes toward using CADD in design problem solving than students without such experience. Items 12, 13, 15 and 20 did not support this hypotheses; however, item number 14 did.

The t-test statistic was -4.9116 with a p-value equal to 0.0001. The experienced group had a mean equal to 5.448 while the inexperienced group had a mean of 8.000. Thus, it can be concluded that at a 95% confidence level that the fifth hypothesis was true only for statement 14. This means that design students who had experience, before the semester studied in using CADD or any other microcomputer software package would benefit from their new learning experience at the CADD class and enjoy designing with CADD more than with conventional drafting tools. On the other hand, students without such experience would feel the opposite.

The sixth hypotheses used the highest number of items to test. This hypothesis stated that design students with many difficulties in using CADD would have more favorable attitudes toward using conventional drafting tools than CADD for creative designs.

Results of t-tests and p-values of items 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, and 23 were used to test this hypothesis; see Table (8). Item 17 from the survey was used to divide the population into two groups. The first group, 12 students, consisted of all participants who selected five or above on the scale from 1 to 10. Members of this group were classified as students with many CADD problems. The other

Table (7)

Mean Scores and T-Test Results on Interior Design Students' Attitudes Toward Using CADD Versus Conventional Drafting Tools in the Design Process Based on students' Past Experience With CADD or Any Other Microcomputer Software. *

Item	Mean W/Exp.	Mean No Exp.	T-test	p-Value
12. I enjoy the challenge of using CADD in design problem solving.	7.034	6.000	0.8164	0.4207
13. I enjoy using conventional drafting tools more than using CADD in design problem solving.	4.103	3.667	0.2550	0.8005
14. The more I learn about CADD the more I enjoy designing my projects with conventional drafting tools.	5.448	8.000	-4.9116	0.0001
15. I can come up with more different design ideas when I'm working with CADD than with conventional drafting tools.	5.345	4.333	0.6170	0.5419
20. I don't believe that CADD inhibits my creativity in the design problem solving process.	6.137	4.000	1.3882	0.1753

* N = 29 For Students With Experience (W/Exp.) in CADD and or Other Microcomputer Softwares.

N = 3 For Students Without Experience (No Exp.) in CADD or Any Other Microcomputer Software.

Table (8)

Mean Scores and T-Test Results on Interior Design Students' Attitudes Toward Using CADD Versus Conventional Drafting Tools in the Design Process Based on Students' Levels of Difficulty in Using CADD in Design and Drafting. *

Item	Mean Many Pro.	Mean Few Pro.	T-test	p-Value
11. I feel more comfortable using CADD now than using conventional drafting tools for doing my future projects.	4.833	6.650	-2.4853	0.0187
12. I enjoy the challenge of using CADD in design problem solving.	6.333	7.300	-1.2873	0.2078
13. I enjoy using conventional drafting tools more than using CADD in design problem solving.	5.333	3.300	2.1104	0.0433
14. The more I learn about CADD the more I enjoy designing my projects with conventional drafting tools.	5.500	5.800	-0.2928	0.7717
15. I can come up with more different design ideas when I am working with CADD than with conventional drafting tools.	3.917	6.050	-2.3347	0.0264
16. I can come up with more different design ideas when I am working with conventional drafting tools than with CADD.	6.000	4.200	1.9948	0.0552
18. I am afraid of using CADD for my future projects.	3.667	1.600	2.4246	0.0216

* N = 12 For Students With Many CADD Problems (Many Pro.).

N = 20 For Students With Few CADD Problems (Few Pro.).

Continue Table (8) *

Item	Mean Many Pro.	Mean Few Pro.	T-test	p-Value
19. It was easier to use CADD than conventional drafting tools for the initial design steps such as bubble diagraming, schematics, sketches, thumbnail drawings etc. to generate all kinds of new ideas.	4.750	5.250	-0.4725	0.6400
20. I don't believe that CADD inhibits my creativity in the design problem solving process.	4.500	6.800	-2.6761	0.0120
21. Having to use CADD only at the school lab at certain times bothers me and distracts my creativity in design.	5.500	5.200	0.3180	0.7527
22. I enjoy designing and drafting with conventional drafting tools more than with CADD because I can use them at any time and place I want.	6.000	4.150	2.4103	0.0223
23. The small size of computers' monitor in comparison with using 24"X36" vellum paper inhibits my creativity in design.	4.416	2.900	1.5526	0.1310

* N = 12 For Students With Many CADD Problems (Many Pro.).

N = 20 For Students With Few CADD Problems (Few Pro.).

participants who selected four or less on the same scale were classified as students with few CADD problems. This group had 20 members. Since the p-values of statements 12, 14, 16, 19, 21, and 23 were higher than alpha, then, none of them supported the sixth hypothesis. On the other hand, at 0.05 level of significance, items number 11, 13, 15, 18, 20, and 22 supported this hypothesis.

With a 0.0187 p-value and a t-test equal to -2.4853 item 11 had a significant difference between the means of the two groups. The mean of students with few problems was 6.650, but the mean of students with many problems was 4.833. This indicated that the more design students learned about CADD the fewer problems they faced when using CADD in design and the more they liked to use CADD rather than conventional drafting tools in designing future projects. On the other hand, the more problems students faced in designing with CADD, the more they turned to use conventional drafting tools in design.

Once again, the relationship between ideational fluency and the number of problems students faced when designing with CADD was vital. Results of item 15 in this test showed the means of students with many problems equal to 3.917 while the mean for the group of students with few problems was 6.050 with a p-value of 0.264. As a result, it can be stated that the fewer problems students had with CADD, the more creative they could be with it; however, the more problems students had with CADD, the more they turned to conventional drafting tools for creative designs.

Not only did problems when using CADD affected students' ideational fluency, but it also made them fear using CADD in their future projects. In item 18 there were more than 2.0 difference in mean scores for students with many CADD problem over students with few CADD problems. With the t-test equal to 2.4246 and a p-value of 0.0216, it can be stated that the sixth hypothesis was true when tested against item 18 at 0.05 level of significance. This means, the more problems students had with CADD, the more they would rely on using the conventional drafting tools and the more they might be afraid of using CADD for their future projects and vice versa.

When testing the level of CADD problems against item 20, the result supported the sixth hypothesis. The t-test was -2.6761 with a p-value equal to 0.0120. Students with few CADD problems felt that CADD did not inhibit their creativity in the design problem solving process. The mean score for this group was 6.800. At the same time, the mean score for the second group who had many CADD problems was 4.500.

The last item in this series supporting the sixth hypothesis was 22. The convenience of using the design and drafting tools seemed to have an important influence on students, attitudes toward selecting their design tool. Students with many problem when using CADD in design seemed to enjoy designing and drafting with conventional drafting tools more than with CADD, because they can use these conventional tools at their own desired time and place. The t-test of this item against the sixth hypothesis was 2.4103 and the p-value was 0.0223. Thus, at 95%

confidence level the previous hypothesis was supported by item 22 because of the convenience of the conventional drafting tools over CADD.

The last tested hypothesis in this study is number seven. It states that **design students with many difficulties in using CADD will be more afraid to use CADD on future projects.** Item 18 supported this hypothesis. At 0.05 level of significance the difference in the means between students with few CADD problems over students with many CADD problems was about 2.0. Thus, at 95% confidence level it can be said that design students with many difficulties in using CADD will be more afraid to use CADD on future projects.

Students' General Feeling Toward CADD

Up to this point, it is equally important with testing the study's hypotheses to explore the students' feelings and attitudes toward using CADD versus conventional drafting tools in design problem solving using the students' own words. As was mentioned before, students had to solve both design problems using two completely different design and drafting tools which were CADD and conventional drafting tools. Although the phases of both design projects were almost equal, students had much more experience designing and drafting with the conventional drafting tools than with CADD. Through the survey, students were asked to select the design and drafting tools they were most comfortable with when solving both design problems. A total of 20 (62.50%) of the

students selected CADD while 12 students (37.50%) selected conventional drafting tools.

Students who selected CADD as their favorite design and drafting tool based their selection on a number of reasons, see Table (9). On the first and the second ranking order, 20% and 35% of the students respectively selected CADD because in their opinion it was the best design tool. Next, 50% of the students selected CADD because they were familiar with it. Finally, 20% of the students selected CADD because it stimulated their creativity. Only 10% of the students selected CADD because of their easy access to the CADD lab. Another 10% chosen CADD because it was fast and challenging, CAD drawings are neat, and because CADD was flexible for changes and adjustments.

The other 12 students (37%) preferred conventional drafting tools for designing and drafting their projects because of the following reasons. First, 42% of the students used the conventional drafting tools because they were more familiar with it. Second, 42% of the students selected these tools because of their easy access to the tools. Third, 42% of the students selected these tools because they were the best design tools that could serve their purpose. Seventeen percent of this group selected conventional drafting tools because those tools offered a free selection of drafting tables and easy to see lines connected. Moreover, drawing with those tools produced clean drawings, stimulated designers' creativity, and provided flexibility to change drawings because "one can be in total control of the

Table (9)

Reasons of Comfort for the Selected Design and Drafting Tool(s).

Reasons	RO	F	P	CF	CP
Reasons for Selecting CADD: (N=20)					
* It was the best design tool	1	5	20	15	75
* It was the best design tool	2	7	35	15	75
* Total familiarity with CADD	3	10	50	16	80
* CADD stimulated my creativity	4	5	20	10	50
* Easy access to the CADD lab	5	2	10	15	75
* Others	5	2	10	10	50
* CADD is fast and challenging				7	70
* CADD drawings are neat				2	20
* CADD is flexible for changes and adjustments				1	10
Reasons for Selecting Conventional Drafting Tools: (N=12)					
* Total familiarity with the drafting tools	1	5	42	12	80
* Total familiarity with the drafting tools	2	5	42	12	80
* Easy access to the drafting tools	2	5	42	12	80
* Easy access to the drafting tools	3	5	42	12	80
* They were the best tools to serve my purpose	4	5	42	8	67
* Others	5	2	17	5	42
* Free selection drafting table				1	8
* Easy to see if line are connected or not				1	8
* Neatness and flexibility of hand drafting				1	8
* Total control of the tools				1	8
* Conventional drafting stimulates my creativity				1	8

RO = Ranking Order of the Selection According to Its Importance to Students.
F = Frequency of the Selection.
P = Percentage of the Selection.
CF = Cross Frequency of the Selection as It Appears in the Total Ranking Order.
CP = Cross Percentage of the Selection as It Appears in the Total Ranking Order.

conventional drafting tools" said a respondent.

Students were asked to rank in order five things they liked the most about CADD and another five things they hated the most about CADD. The same procedure was repeated for the conventional drafting tools. Results on both sections indicated a wide range of important issues. The number of any missing responses on both categories were referred to with a (-X), where X was the number of the missing answers.

Students' Attitudes Toward Using CADD in Design Problem Solving.

All design students in this study were subjected to like and hate questions about using CADD in design problem solving. Students responses to both issues were grouped according to their degree of response. Scale 1 was used for things students liked or hated the most about CADD while scale 3 was for things students liked or hated the least about CADD.

From Table (10), 25% of the students liked CADD the most because it was a fast process and CADD made it easy to draft. Another 25% showed the same attitude because of the flexibility that CADD offered when correcting mistakes. Nineteen percent of the students enjoyed the clean finished drawing done on CADD, while only 9% of the students were attracted by the useful CADD commands.

Using the same format, students ranked the things they hated the most about using CADD in design problem solving, see Table (11). Nineteen percent of the students cited that what they hated the most

Table (10)

Things Students Liked the Most About Using CADD in Design Problem Solving. (3 = Like the Most, 1 = Like the Least).

Things students Liked	F1	P1	F2	P2	F3	P3(-2)
* Fast & easy drafting	8	25	8	25	9	28
* Flexibility to correct mistakes	8	25	3	9	2	6
* Clean finished drawings (Printing, Plotting)	3	9	3	9	3	9
* Neater than hand drawings	3	9	3	9	2	6
* CADD has many useful commands like mirror, move, copy etc.	3	9	8	25	4	13
* Convenience of computers	2	6	0	0	0	0
* CADD stimulates my creativity and help me generate ideas	1	3	2	6	3	9
* 3-Dimensions drawings	1	3	0	0	0	0
* Good line and lettering quality	1	3	2	6	2	6
* CADD allows easy space planning	1	3	0	0	0	0
* Precision in drawings	1	3	1	3	0	0
* I can control the quality of my drawings	0	0	1	3	0	0
* CADD provides the advantage of layering	0	0	1	3	2	6
* CADD allows copying files and storing them for future need	0	0	0	0	1	3
* CADD allows printing the whole project or parts of it	0	0	0	0	1	3

F(1,2 or 3) = The Frequencies of the First, the Second, or the Third Thing that Students Liked the Most When Using CADD.

P(1,2 or 3) = The Percentages of the First, the Second, or the Third Thing that Students Liked the Most When Using CADD.

(-2) = The Number of the Missing Answers.

Table (11)

Things Students Hated the Most About Using CADD in Design Problem Solving (3 = Hated the Most, 1 = Hated the Least).

Things Students Hated	F1	P1	F2	P2	F3	P3
* Fail to understand computer problems	6	19	2	6	4	13
* Losing files or drawings	5	16	3	9	4	13
* Zooming in/out to see details or mistakes	5	16	2	6	0	0
* Having to use computers at a specific time	4	13	0	0	1	3
* Computers are time consuming	3	9	0	0	0	0
* Using commands limits my control	1	3	1	3	2	6
* Hard to start space planning	1	3	1	3	0	0
* Disk error and disk full	2	6	2	6	0	0
* CADD is not precise	1	3	0	0	0	0
* lines don't match when look like they do	1	3	1	3	2	6
* It takes time to regenerate drawings	1	3	1	3	1	3
* Lack of computer operating skills and knowledge	1	3	1	3	0	0
* Tiring and cause eyestrain	0	0	3	9	0	0
* Can't do free form shapes or sketches	0	0	2	6	3	9
* Messed-up computers, plotters and digitizers	0	0	2	6	3	9
* No one around to help	0	0	2	6	0	0
* Have to mentally picture the whole plan	0	0	1	3	0	0
* Takes a long time to plot	0	0	1	3	0	0
* Inserting Blocks	0	0	1	3	0	0
* Lack of CADD knowledge	0	0	1	3	2	6
* Can make too many mistakes	0	0	1	3	0	0
* Lack of privacy in the lab	0	0	1	3	0	0
* Can't verify line weight	0	0	1	3	0	0
* Few lab keys for check-out	0	0	1	3	0	0
* Few computers in the lab	0	0	1	3	0	0
* The CADD lab is too cold	0	0	0	0	2	6
* Hard to draw furniture without templates	0	0	0	0	1	3
* Messed up drawings and files	0	0	0	0	1	3
* Some times computer does not stimulate my creativity	0	0	0	0	1	3

F(1,2 or 3) = Frequencies of the First, the Second, or the Third Thing Students Hated the Most When Using CADD.
P(1,2 or 3) = Percentages of the First, the Second, or the Third Thing Students Hated the Most When Using CADD.

about CADD was their failure to understanding computer problems while 16% of them showed the same feeling for losing files or drawings. Another 16% recorded having to frequently zoom in and out to see details or mistakes and 13% were bothered with the restricted schedule for using the CADD work stations.

Students' Attitudes Toward Using Conventional Drafting Tools in Design Problem Solving.

By contrast, students were also asked to document their responses to using conventional drafting tools in design problem solving. The same procedure and scale that was used with CADD was repeated for conventional drafting tools.

Again students were very open and unlimited in revealing their feelings toward using conventional drafting tools in design problem solving. These results are presented in Table (12). Forty one percent of the students liked using conventional drafting tools in design and drafting because of their convenience. Another 9% of the students were influenced by the fact that with conventional drafting they could see their drawing in its entirety. Only 6% of the population showed the same feeling because of their familiarity with the tools and their ability to do free hand sketches with it.

In Table (13), students recorded all the things they hated the most and the least about using conventional drafting tools in design in the same way they did with CADD. For example, 38% of the students hated

Table (12)

Things Students Like the Most About Using Conventional Drafting Tools in Design Problem Solving (3 = Like the Most, 1 = Like the Least).

Things Students liked	F1	P1(-1)	F2	P2(-2)	F3	P3(-2)
* Convenience of the tools	13	41	9	28	4	13
* See drawings in actual size	3	9	3	9	1	3
* Familiarity with the tools	2	6	4	13	5	16
* Free hand sketching	2	6	0	0	1	3
* Feeling a sense of accomplishment	2	6	2	6	0	0
* It stimulates my creativity	2	6	3	9	3	9
* Produce precise drawings	2	6	0	0	2	2
* I can use templates	1	3	0	0	2	6
* Easy for bubble a schematic diagraming (initial drawings)	1	3	2	6	1	3
* I can present my work better with conventional tools	1	3	0	0	0	0
* I control the tools	1	3	1	3	0	3
* Add personality to drawings	1	3	1	3	0	0
* Easy to show line weight	0	0	2	6	1	3
* Can use trash paper	0	0	1	3	0	0
* Relatively inexpensive tools	0	0	1	3	0	0
* It help generating new ideas	0	0	1	3	0	0
* Working with conventional drafting tools is more relaxing working with CADD	0	0	1	3	2	6
* Concentrate on the design but not the tools	0	0	0	0	1	3
* Easy to correct mistakes	0	0	0	0	1	3
* No eyestrain	0	0	0	0	1	3
* Fewer equipment malfunction	0	0	0	0	1	3
* Easy to measure	0	0	0	0	1	3
* Can shade drawings	0	0	0	0	1	3

F(1,2, or 3)= Frequencies of the First, the Second, or the Third Thing Students Liked the Most About Using Conventional Drafting Tools.

P(1,2, or 3)= Percentages of the First, the Second, or the Third Thing Students Liked the Most About Using Conventional Drafting Tools.

(-X) = Number of the Messing Answers.

Table (13)

Things Students Hate the Most About Using Conventional Drafting Tools in Design Problem Solving (3 = Hate the Most, 1 = Hate the Least).

Things Students Hate	F1	P1	F2	P2(-2)	F3	P3(-3)
* Smearing and smudges	12	38	8	25	1	3
* Conventional drafting is time consuming	7	22	2	6	4	13
* Erasing	2	6	1	3	2	6
* Hard to erase and move drawing around on the paper	2	6	4	13	6	19
* Redraw basic plans	2	6	1	3	1	3
* Line weight problems	2	6	4	13	2	6
* Inking	1	3	1	3	0	0
* Cluttered tools and material on the drafting table	1	3	3	9	3	9
* Dry transfer lettering	1	3	0	0	0	0
* Having to hand letter	1	3	0	0	3	9
* Accumulation of eraser grit	1	3	0	0	0	0
* Torn and messed up paper	0	0	2	6	0	0
* Time consuming when space planning	0	0	1	3	0	0
* Drawings read conventional	0	0	1	3	0	0
* Expensive tools and materials	0	0	1	3	1	3
* Easy to make mistakes	0	0	1	3	1	3
* Tiring	0	0	0	0	2	6
* Paper comes untapped (tape sticks on to parallel bar)	0	0	0	0	2	6
* Can't WBLOCK drawing	0	0	0	0	1	3
* Keep drawings straight and elegant	0	0	0	0	1	3
* Hand drafting	0	0	0	0	1	3

F(1, 2, or 3)= Frequencies of the First, the Second, or the Third Thing Students Hated the Most About using Conventional Drafting Tools.

P(1, 2, or 3)= Percentages of the First, the Second, or the Third Thing Students Hated the Most About Using Conventional Drafting Tools.

(-X) = Number of the Messing Answers.

the smearing and smudges associated with using the conventional drafting tools in design problem solving. Another 22% of the students cited the time consuming aspect. Six percent mentioned their trouble in erasing, inability to move drawings and clutter on the drawing table. Since students' creativity, ideational fluency, was proven to be affected by problems related to the design and drafting tools, it is important to see which tool can stimulate students' creative ideas more than the other. The discussion of this subject is presented on the next section.

The Relationship Between Ideational Fluency and Using CADD in Creative Design Problem Solving.

As part of this study students were asked to reveal their feelings about whether CADD stimulated their creativity more than the conventional drafting tools or not. About 34% of the students voted for CADD, see Table (14), while 53% voted for conventional drafting tools, see Table (15).

Of the students who believed that CADD helped them generate new design ideas, seven students (64%) believed that CADD's flexibility made it easy for them to change, move, mirror, copy, and manipulate drawings. Another three students of the same group believed that, in general, CADD helped to generate ideas very quickly, and only one student selected CADD because it did not inhibit his or her creativity, see Table (14).

Table (14)

Item (32): Did You Feel That You Can Come Up With More or Different Ideas With CADD Than With Conventional Drafting Tools?

Respond	Frequency	Percentage
Yes	11	34
* CADD's flexibility made easy to change, move, insert, mirror, copy, and manipulate drawings without getting in a lot of mess.	7	64
* CADD helps generating ideas very quickly.	3	27
* CADD did not inhibit my creativity.	1	9
No	21	66

Table (15)

Item (33): Did You Feel That You Can Come Up With More or Different Ideas With Conventional Drafting Tools Than With CADD?

Responds	Frequency	Percentage
Yes	17	53
* Ideas generate easily because of the direct access to the drafting paper	6	35
* No feeling of limitation or inhibition	3	18
* Easy to sketch thumbnail drawings	2	12
* No need to zoom in/out when drawings can be seen in their actual size	2	12
* Easy to stimulate creativity	1	6
* Drawing can be done faster by hand	1	6
* No layer to turn on/of like in CADD	1	6
* Ideas come quickly when sketching with pencil	1	6
* Easy to think and draft at one time	1	6
* Trace of trash paper for quick sketches	1	6
* Long experience with conventional drafting tools	1	6
No	15	47

On the other hand, from Table (15), 35% of the students who agreed that working with conventional drafting tools stimulated their ideational fluency said that ideas were generated more easily with those tools because of having direct access to them. About 18% of the same group denied feeling any limitations when designing with conventional drafting tools and 12% of the students saw that those tools facilitated sketching and thumbnail drawing. Another 12% saw that there was no need to zoom in and out when drawing to see the whole drawing.

More than 78% of the population (25 students) did not feel intimidated by CADD in the semester studied. Hence, 57% of the students who felt intimidated by CADD said that this was true only at the beginning of the semester. Another 29% of them feared losing their drawing, and 14% of the students referred it to their lack of computer operating knowledge.

Students' Problem Using CADD in Design

Regardless of the problems that students had to deal with when designing with CADD, the majority of the students were very happy with their new CADD experience. However, it is very important to highlight those problems. It is true that some of the CADD problems may sound limited in their application because they were related to the "Gallery and Art" project that was designed and drafted with CADD. But, many of the other problems were of general application to CADD and computers.

Once again students were asked to identify their problems with

CADD. Problem were collected and ranked in order in Table (16) according to the frequency of problems. A sign of (-X) was used to represent the number of missing responses to each one of the three levels of frequency.

More than 28% of the population were unsatisfied with the performance of the plotters in the CADD lab. Plotters were responsible for consuming the students' time because of the slow plotting time, messing up plotted drawings and holding students back from working on the computer while drawings were being plotted. Another 19% of the students had diskette problems. Some students had disk error messages and others had disk full messages. In both cases students had developed some fear of using computers, especially when working on drive "A".

Lack of knowledge about CADD and DOS commands ranked third for CADD problems. More than 25% of the students were not comfortable with computers because they didn't know many of the CADD and DOS commands. Such lack of knowledge made some students feel controlled by computers where as they were expected to use and control computers.

Other problems occurred, such as failing to insert WBlocked drawings, previously saved drawing or symbol, in some files, having available a limited number of keys for the CADD lab, not connecting printers to all computers, and other minor problems which caused discomfort to many students.

Different problems arose when students started using CADD to design and draft the "Gallery and Art Center" project, see Table (17).

Thirteen design students sketched one part or more of their design solution by hand then drafted their final designs with CADD. More than 53% of this group explained they could sketch with conventional drafting tools faster than with CADD. Another 15% of the same group sketched their design solutions at home to save their CADD time for finished design solutions. Three other students of the same group explained they could not sketch with CADD. They said they could think and sketch by hand faster and more creatively than by using CADD, or that they were more used to sketching by hand than by sketching using CADD. However, 19 students (59%) designed and drafted all their rough and finished drawings for the "Gallery and Art Center" project using CADD.

On both the comment section in the survey and the two group discussions, students expressed other feelings about using CADD and conventional drafting tools in design in an informal manner. Many students showed their full awareness of using CADD in the professional field of interior design, yet, they hated to see themselves as only CADD operators inserting plans into the computer. Other students recommended more CADD courses to refine students' CADD skills before they go into the real world of interior design. One of the students said "I see CADD becoming strong, especially with the advent of colored laser printers on the market". The professor of the class, Dr. Joan McLain-Kark believes that when students CADD skills are brought to a professional level, their chances for good jobs and higher salaries

Table (16)

Problems That Students Had When Using CADD in the Semester Studied.

Item	F1	P1	F2	P2(-5)	F3	P3(-16)
* Plotting problems	9	28	6	19	2	6
* Disk error or disk full	6	19	5	16	1	3
* Lack of Knowledge about CADD and Dos commands	5	16	2	6	2	6
* Loosing files and drawings	3	9	1	3	2	6
* Fitting the lab time into students' schedules	1	3	1	3	0	0
* Moving layers while other some drawings are not on it	1	3	1	3	0	0
* Zooming in/out for details	1	3	1	3	0	0
* Inserting WBLOCK drawings in some files	1	3	0	0	2	6
* Getting in/out of CADD	1	3	0	0	0	0
* CADD slowed me down	1	3	0	0	0	0
* Erasing things	1	3	0	0	0	0
* Messing up drawings	1	3	1	3	0	0
* Being kicked out of CADD when working from the A drive	1	3	1	3	0	0
* Printers are not connected to all computers	0	0	2	6	1	3
* Can't change blocked drawings	0	0	1	3	0	0
* Connect lines correctly	0	0	1	3	1	3
* Copying files	0	0	1	3	0	0
* I had to check out the lab key quite frequently	0	0	1	3	0	0
* Using the 3-D commands	0	0	1	3	0	0
* Machine malfunction	0	0	1	3	1	3
* Transferring files from one computer to another	0	0	1	3	0	0
* Not enough keys for the lab	0	0	0	0	2	6
* Computers take a long time to regenerate drawings	0	0	0	0	1	3
* Wait in line for plotting	0	0	0	0	1	3

F(1,2, or 3) = The Frequencies of the First, the Second, or the Third Problem Students Had When Using CADD.

P(1,2, or 3) = The Percentages of the First, the Second, or the Third Problem Students Had When Using CADD.

(-X) = The Number of the Missing Answers.

Table (17)

Item: When Designing Project III-A (THE GALLERY AND ART CENTER) With CADD, Did You Sketch Any of Your Design Solutions by Hand Then Draw It With CADD?

Responds	Frequency	Percentage
Yes	13	41
* I can sketch faster with conventional drafting tools than with CADD	7	54
* I sketched my solutions at home to save my CADD time for drafting	2	15
* I can't sketch with CADD	1	8
* I can think and sketch by hand faster and more creatively than with CADD	1	8
* I am used to hand draft for the past 4 to 5 years	1	8
* Missing statements	1	8
No	19	59

increases.

In general, students were happy with their CADD experience. They believed that providing the CADD lab with ergonomic chairs, faster computers and plotters, and new lighting fixtures where glare is controlled would reduce many of the students' problems, save their time and affect their learning experience in a positive way.

CHAPTER FIVE

Summary and Discussion

This study was conducted to compare interior design students' attitudes and perceptions regarding creative design problem solving using CADD versus conventional drafting tools. Also it was carried out to determine whether interior design students believed that CADD fosters or stifles their creativity during the conceptual phase of the design process.

Such a study is needed because of the out-of-date responses from previous studies which addressed using CADD in interior design. Moreover, because CADD software has improved tremendously since these earlier studies, the present study on using CADD in interior design became important to update and re-evaluate the usage of CADD in creative design problem solving. AutoCAD Release 9.0 was used for this study because of its availability to the students and its prevalent usage in interior design.

The population of this study consisted of 32 interior design students from Virginia Tech with 17 juniors, 14 seniors, and one graduate student. All students were registered in the introductory course of computer-aided design for the Spring semester of 1989. At the last two weeks of that semester, each design student had to design and draft two design solutions using CADD for one problem and conventional drafting tools for the other. At the end of that period

students were asked to turn in their project, answer their survey questionnaires that were designed specifically for this study, and participate in a group discussion about their CADD experience.

By the time of the surveys, participating students reported an average of 124 hours of CADD experience and an average of 1,558 hours of experience of designing and drafting with conventional drafting tools. About 29 students (91%) had past experience with using computers. Only three students were familiar with CADD. Twenty six students (81%) rated their performance with conventional drafting tools to be above average while only 15 of them (47%) felt that way with CADD. This rating was very much affected by the length of the students' experience with both tools.

Most of the design students enjoyed their CADD experience and its challenge in problem solving. More than 70% of the students felt more comfortable in using CADD than conventional drafting tools in designing their future projects. In addition, the more students learned about CADD, the more they preferred it over the conventional drafting tools. The CADD short cuts that students learned when using the copy, array, mirror, rotate, move commands helped students to save time, improved students' productivity, and stimulated their creativity in design.

Still, more students felt that it was easier to generate ideas with conventional drafting tools than with CADD because of their long experience using those tools. While some students believed that the

convenience of the conventional drafting tools over CADD influenced their ideational fluency, factors such as easy hand sketching, absence of machine malfunctioning, and the unique personality of hand drafted drawings attracted other students to conventional drafting tools.

Despite the problems that many students had to deal with at the beginning of their CADD learning experience, only 12% of the students feared using CADD for their future projects. Thus, more than half of the students believed that CADD did not inhibit their creativity in design problem solving while fewer than one fourth of the population felt the opposite. Forty-one percent of the population said that it was easier to use CADD than conventional drafting tools for the initial design steps such as bubble diagramming, schematics, and thumbnail drawings to generate all kinds of new ideas.

Many of the students disliked the processes of zooming in and out when using CADD, however, only nine students (28%) saw that the small size of computers' monitor (12") in comparison with using 24"X 36" vellum paper inhibited their creativity in problem solving. Students who felt that creativity were not inhibited by using the (12") monitors might changed their minds if they had the chance to use larger monitors.

When testing the seven hypotheses of this study, the first, the second and the fourth hypotheses were not supported by any results from the surveys. The lack of support of the first hypothesis indicates that there was a little or no relationship between students' higher levels of CADD experience and their attitudes toward using CADD

more than conventional drafting tools for creative solutions to design problems.

The second hypothesis was also not upheld. Thus, for this case study it was not true that students with higher levels of CADD experience believed that they had more ideational fluency with CADD for design problem solving than students with lower levels of CADD experience.

Finally, the fourth hypothesis also failed to be supported by the data. Therefore, it is not true that design students with higher levels of CADD experience in this study had more favorable attitudes toward using CADD instead of conventional drafting tools in the conceptual design phase than students with lower levels of CADD experience.

In contrast to these results, the third, fifth, sixth and seventh hypotheses were supported by the results of a t-test of one item or more from the surveys. Those hypotheses that were supported are the following:

H3. Design students with a higher levels of CADD experience felt that CADD did not inhibit their creativity more than students with lower levels of CADD experience.

H5. Design students who had experience before the semester studied with CADD or any microcomputer software package had more favorable attitudes toward using CADD in design problem solving than students without such experience.

H6. Design students with many difficulties in using CADD had more favorable attitudes toward using conventional drafting tools than using CADD in creative designs.

H7. Design students with many difficulties in using CADD were more afraid to use CADD on future projects.

These results indicate that while higher levels of CADD experience did not mean more positive attitudes toward using CADD in design, negative CADD experience (i.e. problems with using computers) could actually reverse positive attitudes. It remains to be studied how severe a problem with CADD causes fear or negative attitudes toward CADD.

Major Findings

With respect to the four supported hypotheses of this study, there were 10 major findings that were generated:

1. While Tang (1985), Doubilet (1987), Thurston (1987), Plant (1988), and Lindsey (1988) found a relationship between CADD familiarity or experience and the positive attitude toward using CADD in design, this study suggests that there may be a plateau where after so many hours of CADD experience a design student becomes no more positive toward CADD.

2. Students with few difficulties when using CADD in design had favorable attitudes toward using CADD rather than conventional drafting tools in creative design problem solving especially for

future projects.

3. Design students with many difficulties when using CADD in design enjoyed using conventional drafting tools more than CADD in design problem solving.

4. Design students who had previous experience in using CADD or any other microcomputer software package enjoyed CADD more than conventional drafting tools.

5. Design students with few CADD problems felt that they had more ideational fluency when designing with CADD than when designing with conventional drafting tools.

6. Design students with many CADD problems felt that they could generate more different ideas when working with the conventional drafting tools than with CADD.

7. Design students with many difficulties with CADD and computers feared using CADD for their future projects.

8. Design students with few CADD problems did not believe that CADD inhibited their creativity in the design problem solving process.

9. Design students with higher levels of CADD experience were bothered and their creativity was distracted when they were limited with a time schedule to use CADD.

10. Design students with many CADD difficulties enjoyed designing and drafting with conventional drafting tools more than with CADD because they could use their conventional tools at any time and place they wanted.

The first objective of this study is to compare interior design students' attitudes and perceptions regarding creative design problem solving using CADD versus conventional drafting tools. Thus, it can be concluded that students attitudes and perceptions regarding that issue are highly affected by students past experience with both tools. The fewer problems students had when using CADD in design the least they liked using the conventional drafting tools in the design problem solving process and visa versa.

The second objective of this study was to determine wither interior design students believed that CADD fostered or stifled their creativity during the design process. When examining this objective against the findings of this study, it can be said that the number and quality of problems associated with using CADD in design had a create influence on students' creativity when practicing problem solving. Students who had few CADD problems felt that CADD did not inhibit their creativity in the design problem solving but it fostered their creativity. Other students who had many CADD problems during the semester studied preferred using the conventional drafting tools more than CADD because their fear of using CADD in design stifled their creativity in the problem solving process.

Recommendations

Most of the students' problems in using CADD for design problem solving seemed to be associated with the depth of students' experience

in using CADD in design. Such conclusions were drawn from the fact that many students brought up that issue either when answering the survey questionnaire or when discussing CADD problems in the group discussion activity that was held after answering the questionnaires. The researcher's recommendations of this study are divided into three different parts. The first part will discuss the general recommendations the researcher sees as especially important in improving the students' learning experience and reduce their CADD problems and discomfort. The second part will cover some specific recommendations that concern the computer-aided design lab at Virginia Tech. Finally, the third section will highlights suggestions for future research in the same stream.

General Recommendations

The following recommendations drawn from this study may help educators teach CADD with a minimum of CADD problems:

1. Improve students' CADD learning curve by:
   * teaching students more about computers hardware and software,
   * exposing students more to important DOS commands before having students learn about CADD,
   * improving the quality and variety of early CADD learning exercises by using interesting design problems to stimulate students' creativity.
   * introducing design students at the beginning of their CADD

experience to assignments where they have to use as many CADD commands as possible to learn CADD as quickly as possible before they get to the major design problem(s) of the course,

* helping students' to build their self confidence in using CADD in design problem solving by making them realize that CADD should never interfere with their creativity because it is just another design tool complementing the conventional drafting tools,
* and finally, helping students understand that the one-of-a-kind design drawing is not typical in the design profession. Moreover, students should realize that CADD drawings have a personality and can be as artistic as the ones drawn by hand with the conventional drafting tools.

2. Teach students how to sketch quickly and accurately with CADD to make it easy for them to generate ideas when solving any design problem. Such a goal can be achieved when students are given special exercises where they have to develop a number of abstract designs by using the basic CADD commands such as sketch, copy, move, mirror, array, change, and stretch. This action should stimulate students creativity and free their spirits to generate all kinds of new ideas without feeling intimidated by CADD.
3. Reduce student fears about using CADD by supplying them with a trouble shooting appendix. Such an appendix may cover the most

common CADD and DOS problems that students may get into.

4. Employ a full time lab assistant who has a professional background in CADD and interior design to assist students in the lab and minimize their fear from computers by helping students get over their problems that are related to computers or CADD.
5. Offer students an advanced CADD course in design along with the introductory one to maximize students experience in using CADD in design. That course could be a requirement for any student seeking a degree in interior design.
6. Finally, train students to think and design creatively when using and designing with the drafting tool. Results of this study have shown that most of the students were more concerned about drafting their design solutions than spending time to think about the different possible solutions. This finding is true for both the CADD's group and the conventional drafting tools' group.

Specific Recommendations

Although the computer-aided design laboratory at Virginia Tech has developed tremendously over the past two years, still there are few missing things. It is the researcher's belief that once the following missing items are added to the CADD lab, that lab will save the students' time and provide them with a very valuable learning experience. The following are recommended:

1. The ratio of the design students who were taking CADD to the computer work stations at the CADD lab during this study was about 3:1 respectively, while the recommended ratio between CADD users and computers should not accede 2:1. This was also found to be the typical ratio in Lindsey's (1988) study of CADD education in interior design. It was suggested that only two students should be assigned to one computer work station. By reaching this ratio each student with a semi personal working station will have more time to practice and design. Also this action will reduce the demand on each computer and reduce problems related to full hard disks.
2. Provide each design student in the CADD course with a personal set of keys one to the exterior doors of Wallace and the other to the CADD lab. All enrolled students should sign a time table schedule to use their computers during the week days and the weekends. Students should also sign a liability paper for any misuse of the keys or the CADD lab. Any violation of the agreement shall cause the student to lose his or her privilege of obtaining the keys during the course and limits the student to use the lab only during the school hours.
3. Use fast computer machines in the lab to help student invest their time in learning and designing with CADD rather than waiting for the computers to regenerate drawings.
4. Use the necessary program(s) or device(s) to speed up the slow

existing computers to eliminate the time spent on all zoom-related regenerations.

5. Use a minimum of one plotter and one printer to every four to five computers. All computers should be attached to plotters and printers.
6. Use the necessary program(s) or device(s) so that students can use their computers while plotting or printing their drawings.
7. Use the largest flat tension mask monitors that can be afforded to replace the existing (12") monitors in the CADD lab to reduce glare and students' eye strain.
8. Replace the existing chairs in the CADD lab with ergonomic ones for maximum user comfort.
9. Replace the acrylic prismatic lenses for the existing lighting in the CADD lab with parabolic wedge louvers to reduce glare on computers screens and to protect students from eye strain.

It is important to state that all the previous recommendations in the above section are concerned with the existing setting in the CADD lab at Virginia Tech. Therefore, some or all of the above may be considered for the new CADD lab that will replace the existing one two years from now.

Recommendations for Future Study

Due to the limitations of this study, the size of its population and the short CADD experience of the participating interior design

students, it is important to consider the following for any future follow-up study:

1. Since the population in this study was limited in size and choice to participating students, future researchers may want to consider a larger and random sample population. Such action may not be easy to obtain within one school; however, if future researchers consider other interior design students from other design schools across the nation with have similar design programs, they may come up with some valuable results.
2. A similar study with professional interior designers in the American Society of Interior Designers (ASID) who use CADD in design is highly recommended. Such a study is essential because the professional designers' CADD experience could be expected to be much richer than the design students' experience.
3. Assign the selected ASID members to two full scale actual design problems where one has to be done with CADD and the other one with conventional drafting tools. Such action is important because of its wide considerations of all factors of any design operation.
4. Use different CADD software other than AutoCAD for future studied. Comparing such software should enrich the study and help explore the influence of those packages on designers creativity during the design problem solving process.
5. Consider an experimental setting than rather a survey for future

studies in this field to examine designers' attitudes toward creativity in design problem solving using CADD versus conventional drafting tools to obtain more scientific results. Future researchers may want to examine the effects of computer speed and the size of computer monitors on designer creativity and attitudes toward CADD compared with the conventional drafting tools in interior design.

Conclusion

As an exploratory study, the researcher admits that this case study is not a very comprehensive one, yet, it may inspire future researchers to study the human-machine interface and its influence on designers creativity and attitudes toward replacing the conventional drafting tools with CADD. As a personal observation, the researcher noticed that even the best design students in this study were to some degree negatively affected by their early CADD problem. Although those students learned from their mistakes, however, they continued to psychologically fear computers.

Other students who liked using the conventional drafting tools and feared CADD were observed to be unfamiliar with many CADD commands and the different options of those commands. Maybe that lack of knowledge was related to the number and type of commands that students needed to draft their design solutions with. Thus it is very important that students learn all the CADD commands and their options to make the best

CADD and operate creatively.

Furthermore, CADD users should be psychologically as well as mentally prepared to use that tool in design. From a personal experience, the researcher believes that it is necessary for design students to have as many CADD demonstrations as needed by the class instructor or the professional assistant. Such demonstrations should focus on how to use CADD for brainstorming and how to stimulate students' ideational fluency and operate creatively. This effort may very well lead the design students to a successful start with using CADD in interior design.

From two years personal experience the researcher feels that using CADD in the conceptual design phase is more effective than using the conventional drafting tools. This judgement is based on the fact of knowing the advantage of using the copy, move, array, mirror, stretch, rotate, break and trim commands which enabled the researcher to quickly generate many ideas in a short period. Moreover, having the layer feature when using CADD in the conceptual design phase enabled the researcher in his previous practice to add and substitute drafted elements from his generated ideas and design. Layering was used to assign additional drawings or details to different layers. Later on, the researcher would turn on and off the

needed layers to compare ideas with each other. Thus the researcher believes that the issue of whether CADD stifles or fosters designers' creativity in the design problem solving process depends on how much the CADD user knows about his or her tool and how much creative is that person. Basically, CADD is only another design tool that can stimulate the designer's creativity and thoughts but it can not think for a designer.

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APPENDIX (A)

DESIGN PROBLEMS

Project #3

General Description:

Project #3 has two parts, A and B, each a small separate space planning project. As experienced CAD users now, I am interested in your opinions about using computer vs. using conventional drafting tools for various phases of the design process. Thus, I am requiring you to execute one project entirely with conventional drafting tools while the other must be executed entirely with CAD. Please think about the advantages and disadvantages of each design tool as you work on this project. Both projects will be a good addition to your design portfolio and integrate concepts learned throughout this semester.

Project Requirements:

Project #3 is worth 10% of your course grade. Any student not submitting Project #3 will automatically receive an F in the course. For the CAD part of the project, you will be given a DS, DD diskette (740K). This must be returned or a grade of I will be given for the course. Grading criteria is below:

Space Planning	40%
Drawings:	30%
Schematics	
Floor Plan	
Elevation	
Class Discussion and Survey	30%

DEADLINE: During the final examination period, you will be submitting your project and participating in a survey and discussion on the project. Attendance is required.

1:00 Class: 1:00, May 2, Tuesday

3:00 Class: 10:00, May 3, Wednesday

Project III - A

Gallery and Art Center

Mr. John Smith is a well known art dealer from Washington, D.C. He has just rented a new building to accommodate his needs for a large space for his fast growing art business. In the bidding process, you as an interior designer are given a 1/4" =1'-0" scale floor plan of the building to design the interior space and fulfill the following requirements:

1. use 40-50% of the interior space for the art gallery.
2. use 20-30% of the interior space for art supplies display.
3. design an open space office near the gallery with a desk, three chairs and file cabinet.
4. provide a storage with a minimum of 75 linear feet for shelving art supplies.
5. provide a personal rest room with a toilet and a sink for employees use only.
6. design a cashier counter.
7. provide a small working area with a 4' X 8' working surface.

To enter the bid you have 2 weeks to present your design to Mr. Smith. The design solution has to be presented in four different phases as the following:

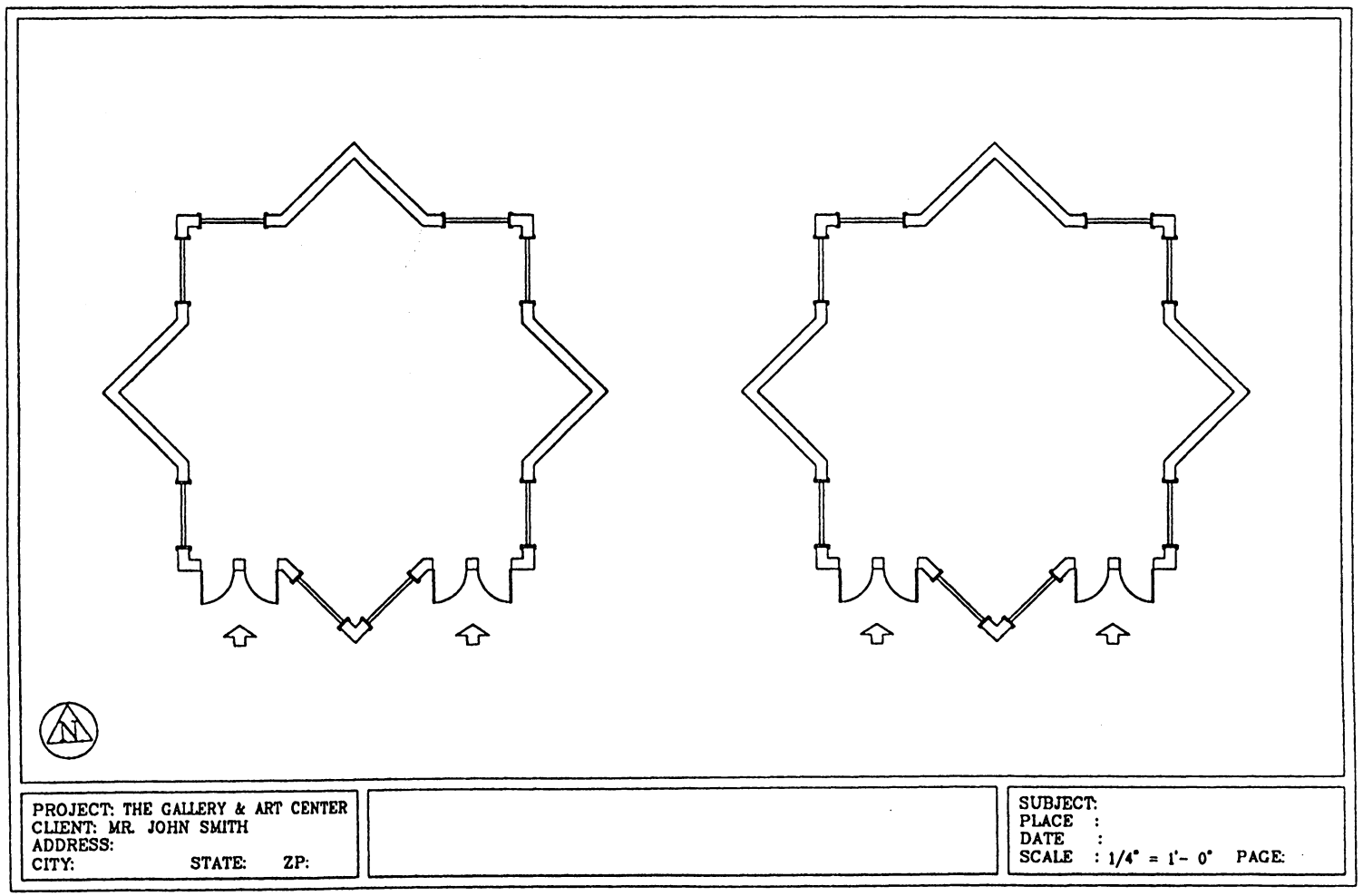
I. a graphic presentation of a bubble diagraming to show the relationships between all design requirements.

II. a graphic presentation of a conceptual drawing to identify the interior space for each design requirement in the project with respect to other requirements.

III. a floor plan with the design layout for the interior space and furnishing.

IV. a long section elevation for the Gallery and Art Center. Use 1/2" = 1'-0" scale for the elevation.

[USE CADD TO DESIGN AND DRAFT YOUR ENTIRE PROJECT]


PROJECT: THE GALLERY & ART CENTER
CLIENT: MR. JOHN SMITH
ADDRESS:
CITY: STATE: ZP:
SUBJECT:
PLACE :
DATE :
SCALE : 1/4" = 1'- 0" PAGE:

Project III - B

The Designer Touche Showroom-Office

After 10 years of hard work and long experience in interior design, you finally have all of what it takes to start your own design firm. As an owner of a 1044 sq. ft. showroom-office building in L.A. in California you need to design your interior space with the following features:

1. select 60-70% of the building to be a showroom with different display methods for accessories, fine pieces of furniture, small size oriental rugs, and collective art work.

2. provide a seating area in the showroom for 3-4 people to display sketches and sample boards of small scale projects.

3. design your open office with desk, three chairs, two file cabinets, and a computer work station.

4. provide a desk and a chair, a computer work station and a printer for your secretary.

5. provide a large reference and sample room with 200 linear feet for books, catalogs, and sample materials. A drafting table or a CADD work station and a plotter needs to be included along with a working surface and two plan stands or storage.

6. include a personal rest room with a sink and a toilet for employees use only.

In two weeks, you are asked to present the following phases:

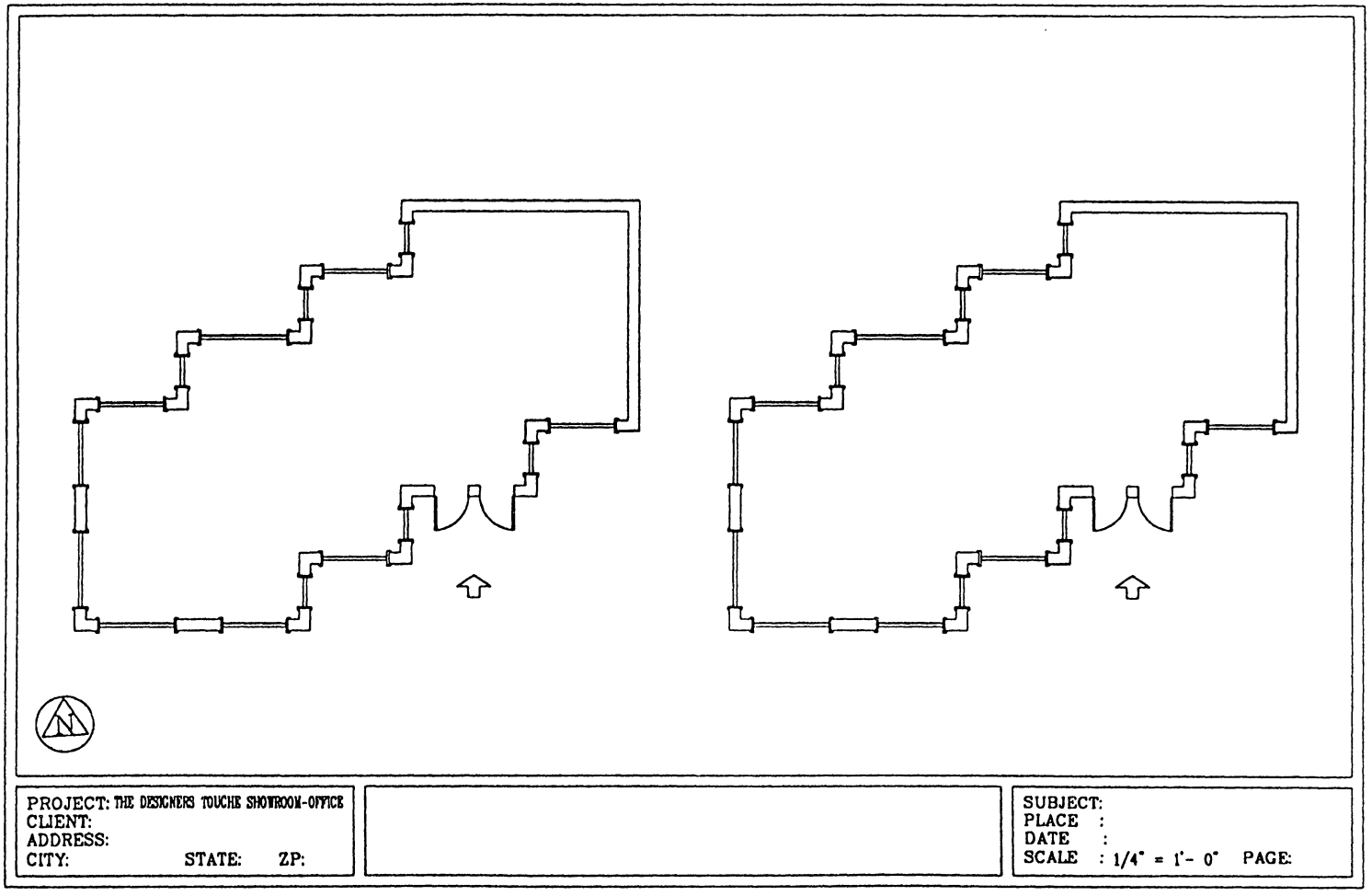
I. a graphic presentation of bubble diagraming to show the relationships between all design requirements.

II. a graphic presentation of conceptual drawing to identify the interior space for each design requirement in the project with respect to other design components.

III. a floor plan with the design layout for the interior space design and furnishings.

IV. a long section elevation for the showroom-office. Use 1/2"=1'-0" scale for the elevation.

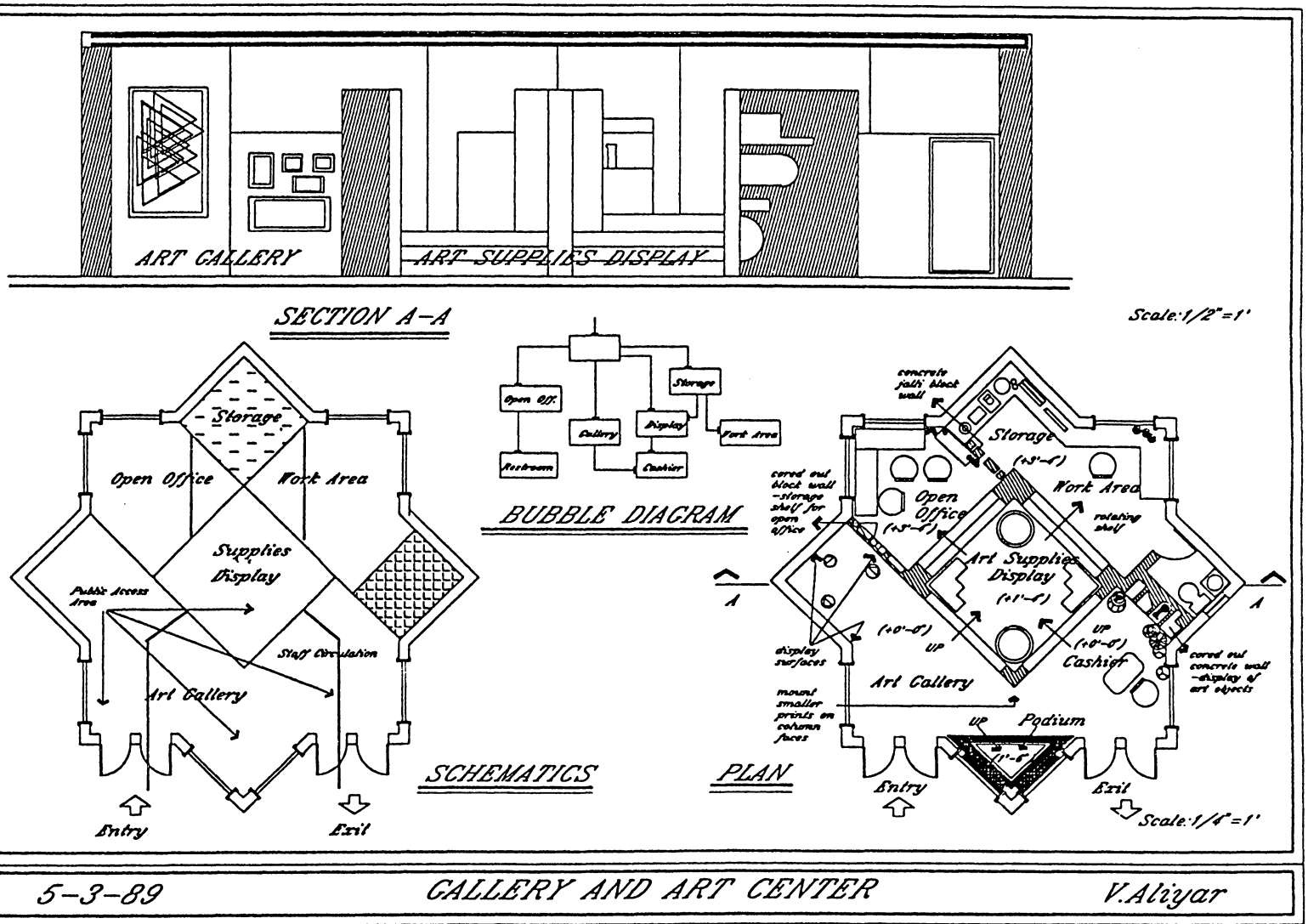
[USE YOUR CONVENTIONAL DRAFTING TOOLS TO HAND DRAFT YOUR ENTIRE PROJECT]

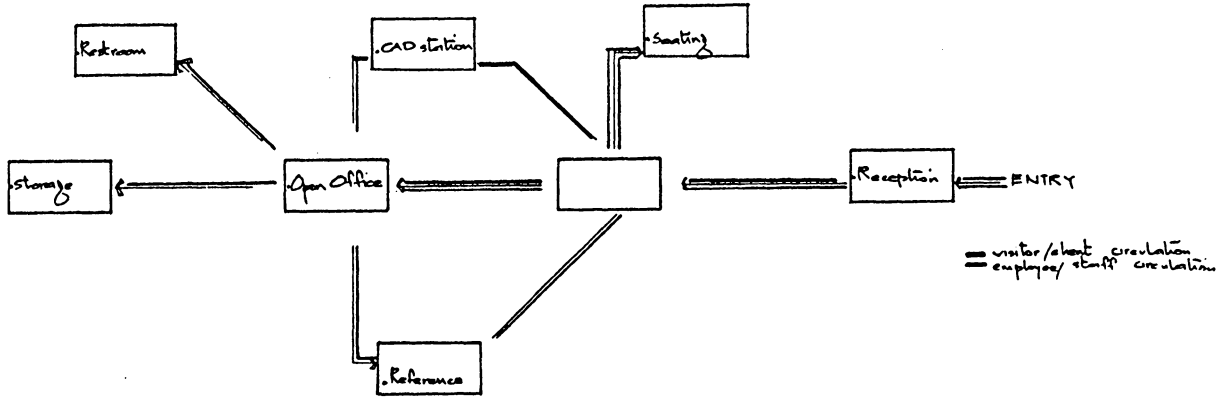

PROJECT: THE DESIGNERS TOUCHE SHOWROOM-OFFICE
CLIENT:
ADDRESS:
CITY: STATE: ZP:
SUBJECT:
PLACE :
DATE :
SCALE : 1/4" = 1'- 0" PAGE:

APPENDIX (B)

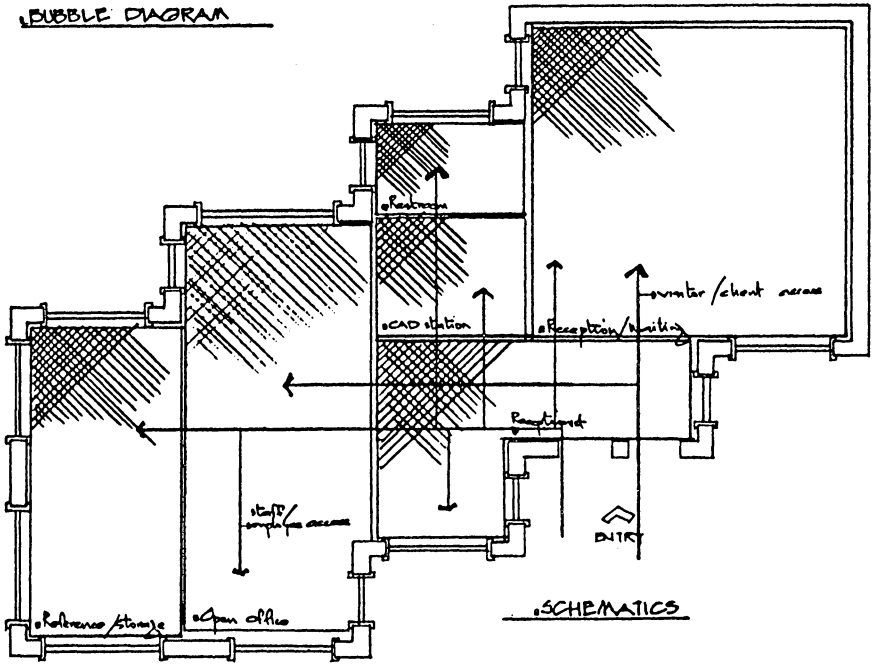
EXAMPLE OF A DESIGN PROJECT

DONE WITH CADD AND CONVENTIONAL DRAFTING TOOLS


ART GALLERY
ART SUPPLIES DISPLAY
SECTION A-A
Scale: 1/2" = 1'
Storage
Open Office
Work Area
Supplies Display
Public Access Area
Staff Circulation
Art Gallery
Entry
Exit
SCHEMATICS
Open Off.
Storage
Gallery
Display
Work Area
Restroom
Cashier
BUBBLE DIAGRAM
concrete jalli block wall
Storage
(+3'-0")
Work Area
Open Office
(+3'-0")
rotating shelf
carved out block wall - storage shelf for open office
Art Supplies Display
(+1'-0")
A
A
(+0'-0")
UP
UP
(+0'-0")
Cashier
display surfaces
Art Gallery
carved out concrete wall - display of art objects
mount smaller prints on column faces
UP
Podium
(1'-0")
Entry
Exit
PLAN
Scale: 1/4" = 1'
5-3-89
GALLERY AND ART CENTER
V. Aliyar



BUBBLE DIAGRAM



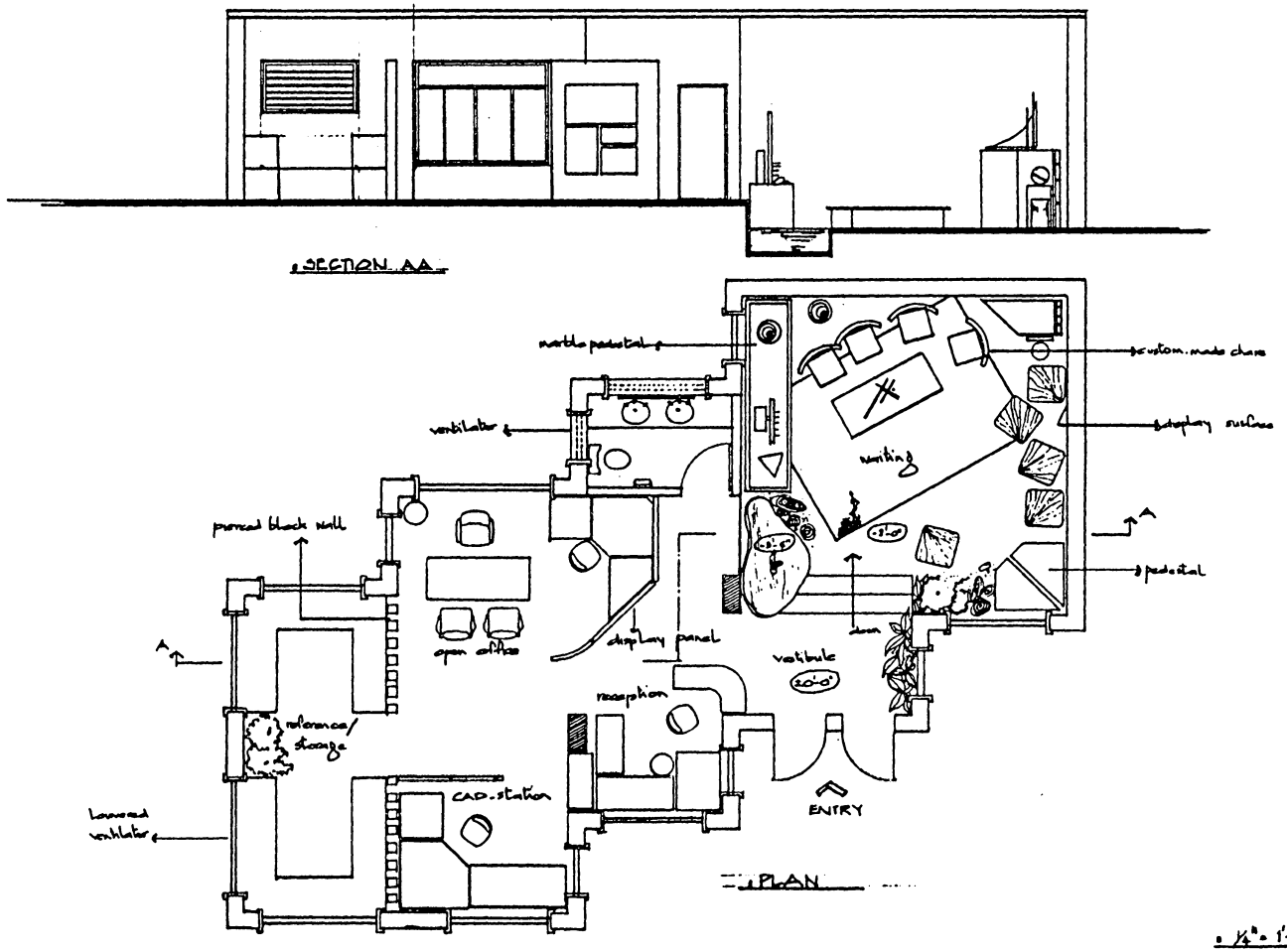
SCHEMATICS

1/4" = 1'-0"

9-3-89

THE DESIGNER TOUCHE SHOWROOM OFFICE

V. Alyar



29.3.89

THE DESIGNER TOUCHE SHOWROOM OFFICE

V. Alwar

APPENDIX (C)

QUESTIONNAIRE

SURVEY QUESTIONNAIRE ON
ATTITUDES OF INTERIOR DESIGN STUDENTS
TOWARD CREATIVITY IN DESIGN PROBLEM SOLVING
USING CADD VERSUS CONVENTIONAL DRAFTING TOOLS

SSN#.....

Please answer the following questions about the factors that may have influenced your attitudes toward creativity in design problem solving using CADD versus conventional drafting tools. ALL ANSWERS WILL BE KEPT CONFIDENTIAL.

****

PLEASE CIRCLE THE LETTER OF YOUR SELECTED ANSWER.

1. Are you
   A. male
   B. female

2. What is your current college level?
   A. junior C. graduate
   B. senior

3. If interior design has not been your only major, what was your previous major?

   A. computer science
   B. others (please specify).....

4. Do you or did you have a minor?
   A. yes
   B. no

4a. If yes, what is or was your minor?
   A. computer science C. none
   B. others (please specify).....

5. Have you used computers before this semester?
   A. yes
   B. no

5a. If yes, what did you use computer for? (please rank your answer in order, 5 for use the most and 1 for use the least)

5. .....
4. .....
3. .....
2. .....
1. .....

6. Have you taken CADD or practice working with CADD before this semester?
   A. yes
   B. no

7. To the best of your knowledge, please estimate the total number of hours that you have spent so far working with CADD (..... hours)

8. I rate my performance in using CADD for design problem solving to be
   5. excellent
   4. very good
   3. good
   2. fair
   1. unsatisfactory

9. To the best of your knowledge, please estimate the total number of hours that you have spent so far working with conventional drafting tools (..... hours)

10. I rate my performance in using conventional drafting tools in design problem solving to be
    5. excellent
    4. very good
    3. good
    2. fair
    1. unsatisfactory

On the rating scale from 1 to 10, please draw a circle around your selected answer on the questions from 11 to 23. Use number (1) on the scale for STRONGLY DISAGREE and number (10) for STRONGLY AGREE.

11. I feel more comfortable using CADD now than using conventional drafting tools for doing my future projects

(Strongly Disagree)									(Strongly Agree)
1	2	3	4	5	6	7	8	9	10

12. I enjoy the challenge of using CADD in design problem solving

(Strongly Disagree)									(Strongly Agree)
1	2	3	4	5	6	7	8	9	10

13. I enjoy using conventional drafting tools more than using CADD in design problem solving

(Strongly Disagree)									(Strongly Agree)
1	2	3	4	5	6	7	8	9	10

14. The more I learn about CADD the more I enjoy designing my projects with conventional drafting tools

(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

15. I can come with more different design ideas when I'm working with CADD than with conventional drafting tools
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

16. I can come up with more different design ideas when I am working with conventional drafting tools than with CADD
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

17. I had a lot of problems working with CADD
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

18. I am afraid of using CADD for my future projects
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

19. It was easier to use CADD than conventional drafting tools for the initial design steps such as bubble diagrams, schematics, sketches,

thumbnail drawings etc. to generate all kinds of new ideas
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

20. I don't believe that CADD inhibits my creativity in the design problem solving process
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

21. Having to use CADD only at the school lab at certain times bothers me and distract my creativity in design
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

22. I enjoy designing and drafting with conventional drafting tools more than with CADD because I can use them at any time and place I want.
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

23. The small size of computers' monitor in comparison with using 24"X36" vellum paper inhibits my creativity in design
(Strongly Disagree) (Strongly Agree)
1 2 3 4 5 6 7 8 9 10

24. Which tool were you more comfortable with when you were designing "The Gallery and Art Center" and " The Designers' Touche Showroom - Office"
    A. CADD
    B. conventional drafting tools

25. Why were you comfortable with your selected design tools? (If more than one answer, please rank your selections to be 1 for most comfortable and 5 for least comfortable.)
    ( ) A. total familiarity with the design tool(s)
    ( ) B. easy access to the design tool(s)
    ( ) C. it was the best tool(s) to serve my purpose
    ( ) D. I felt more creative in using it
    ( ) E. others (please specify).....
    .....

26. Over all, how do you rate your understanding of design problem III-A (The Gallery and Art Center)
    A. fully understood it
    B. partially understood it
    C. did not understand it

26a. If your answer to Q#26 was B or C, please explain the cause of your of your misunderstanding
    A. lack of background in such design problem
    B. poor instructions
    C. unfamiliarity with CADD
    D. others (please explain).....
    .....

27. Over all, how so you rate your understanding of design problem III-B (The designers' Touche Showroom - Office)
    A. fully understood it
    B. partially understood it
    C. did not under stand it

27a. If your answer to Q#27 was B or C, please explain the cause of your misunderstanding
    A. lack of background with such design problem
    B. poor instructions
    C. unfamiliarity with conventional drafting tools
    D. others (please explain).....
    .....

28. Please, list in rank order minimum or three things that you LIKE THE MOST about using CADD in design (5 = you like the most and 1 = you like the least.)
    5.....
    4.....

3.....
2.....
1.....

29. Please, list in rank order a minimum of three things that you HATE THE MOST about using CADD in design (5 = you hate the most and 1 = you hate the least.)
5.....
4.....
3.....
2.....
1.....

30. Please, list in rank order a minimum of three things that you LIKE THE MOST about using conventional drafting tools in design (5 = you like the most and 1 = you like the least.)
5.....
4.....
3.....
2.....
1.....

31. Please. list in rank order a minimum of three things that you HATE THE MOST about using conventional drafting tools in design (5 = you hate the most and 1 = you hate the least.)
5.....
4.....
3.....
2.....
1.....

32. Did you feel that you can come up more or different ideas with CADD than with conventional drafting tools?
A. yes
B. no

32a. If your answer to Q#32 was yes, please explain why
.....
.....
.....

33. Did you feel that you can come up with more or different ideas with conventional drafting tools than with CADD?
A. yes
B. no

33a. If your answer to Q#33 was yes, please explain why
.....
.....

34. Did you feel intimidated by CADD this semester?
    A. yes
    B. no

34a. If your answer to Q#34 was yes, please explain why
    .....
    .....
    .....

35. What kind of problems did you have when using CADD 109 during this semester
    1.....
    2.....
    3.....
    4.....
    5.....

36. When designing the Gallery and Art Center with CADD, did you sketch any of your design solutions by hand then draw it with CADD?
    A. yes
    B. no

36a. If your answer to Q#36 was yes, please specify why you did it that way
    .....
    .....
    .....
    .....
    .....

37. OTHER COMMENTS:

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