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A COMPARATIVE ANALYSIS OF GENERIC
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A COMPARATIVE ANALYSIS OF GENERIC VERSUS DISCIPLINE-SPECIFIC INSTRUCTIONAL MATERIALS FOR AUTOCAD USE IN INTERIOR DESIGN

By

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ABSTRACT

A COMPARATIVE ANALYSIS OF GENERIC VERSUS DISCIPLINE-SPECIFIC INSTRUCTIONAL MATERIALS FOR AUTOCAD USE IN INTERIOR DESIGN

By

Tami Lyn Schultz

The increase in the use of computer-aided design (CAD) in interior design and architecture has necessitated the incorporation of CAD classes into the academic curricula of these professions. The software program acknowledged as the industry standard is AutoCAD. The lack of AutoCAD reference materials directed to design professions makes it difficult to learn the program in the shortest time possible.

This study identified and tested a new AutoCAD textbook aimed at the interior design audience. An experimental design utilizing stratified random sampling manipulated the independent variable of instructional materials. The dependent variable, achievement, was evaluated through analysis of students' grades. Surveys were used to collect qualitative data on the effectiveness of the instructional materials.

Descriptive and non-parametric inferential statistics identified computer usage trends indicating discipline-specific materials appeared effective for improving student achievement. Significance was found for Kendall's Concordance values but not for Mann-Whitney results. Using discipline-specific materials resulted in achievement levels no worse than those obtained by using generic materials. Students preferred discipline-specific over generic materials.

This work is dedicated to my family, to Phil, and to Clair for their unswerving belief that I had the ability and motivation to achieve this goal, and to Phil and Clair for nurturing latent ability and providing the inspiration to embark on a career as a fellow design educator.

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CHAPTER I. DEFINITION OF THE PROBLEM

Introduction

As the presence of computers makes itself felt in architecture and design, many employers in the design field now look for computer drafting expertise as well as the host of more traditional design skills in their potential employees. According to Interior Design magazine's poll of 100 leading design firms, over 95% utilize Computer-Aided Design (CAD) or Computer-Aided Design and Drafting (CADD) on a daily basis (Loebelson, 1990). Since drafting is considered a component of design, the terms CAD and CADD are synonymous and will be used interchangeably throughout this report. Considering it is not often cost effective to utilize on-the-job training for this skill, it is very beneficial to the employer to be presented with a potential employee already somewhat proficient in this area.

Studies have shown productivity gains ranging from 10% to 23% over a five year period when CADD is used by a firm. Even more impressive is an increase of 50% to 100% if the principal project designer uses CADD directly rather than having a junior designer/draftsman execute the drawing (Jones, 1989). What is abundantly clear is that Fortune 1000 companies now consider CAD a serious tool (MicroCAD News, 1989; Hoyt, February 1989, April 1989, June 1989; Loebelson, 1989; Thatcher, 1990). Thus, lack of CAD experience may be costly, both to the design firm and to the person seeking a design position. Familiarity with computer drafting software is an enormous asset.

Statement of Problem and Justification

Although there exist some specific regional preferences for particular CAD software programs (MicroCAD News, June 1989), AutoCAD is presently recognized as holding the coveted position of industry standard among the leading drafting software packages on the market used by interior designers/architects for project development. Started in April, 1982 with a capital investment of $59,030 and the technical expertise and entrepreneurial ambitions of 13 system programmers, Autodesk, Inc. quickly established a foothold for its premier product, AutoCAD.

From 1983 sales figures of $14,733 to $80 million dollars in 1989, Autodesk director of marketing and sales Malcolm Davies has witnessed, as of March 1989, sales figures representing in excess of 200,000 copies of the AutoCAD program (MicroCAD News, June 1989; Witte, 1989). At a retail price of ±$3000, the potential generation of over $600,000,000 in revenue by this product alone represents a staggering entry on Autodesk's corporate reports through 1989. These figures represent a market share of approximately 49%. This percentage is confirmed by a survey conducted by MicroCAD News of 250 randomly selected members of the 30,000 plus members of the American Institute of Architects (AIA); the survey revealed CAD usage by 47.6 % of its sample, of which AutoCAD usage accounted for 47%. The next most frequently used software program, DataCAD, trailed AutoCAD quite significantly, being used by only 13% of the sample (MicroCAD News, June 1989). In fairness, it must be said, however, that DataCAD is a very recent player in the CAD software market and was designed by architects especially for the architectural/interior design market. As such, it would not be expected to appeal as much to the broader CAD market of engineers, landscape designers, and other similar design oriented professionals (Payne, 1989).

The flexibility and power of AutoCAD, as well as a plethora of compatible third party software packages, have helped establish it as the industry leader in software. This flexibility, though, has precipitated reference manuals that are generically oriented in their explanation of the command menus. This is understandable since AutoCAD is designed and marketed to fulfill the drafting needs of several disciplines including among them architecture, interior design, engineering, surveying, facility management and geology (MicroCAD News, June 1989). AutoCAD's power and complexity make learning the entire program a lengthy process, often requiring several hundred hours of practice to become proficient with the entire program (Dubbs, 1990). However, AutoCAD may be efficiently utilized without understanding every command or option the program offers.

Purpose of the Study

Since it appears plausible that people learn most effectively when they understand the applications of what they are learning, it could be hypothesized that learning AutoCAD would take place more effectively and perhaps more quickly if a tutorial utilizing interior design and architectural learning applications were used in lieu of the more general references frequently utilized. This exploratory study's purpose is threefold:

1) to implement a field test of recently developed CAD educational materials utilized by the study's experimental group to provide baseline data for future reasearch while making (and providing the author with) a qualitative assessment of the materials.

2) to make a comparison of the effectiveness of two different sets of reference materials used in teaching AutoCAD.

3) to measure preference for the two types of materials used.

One set of materials will utilize learning exercises and text information of a generic nature; the other set of materials will utilize interior application learning exercises and an additional, supplemental text directed primarily toward interior applications.

This study addresses the learning of basic competencies needed to use AutoCAD in a professional setting. As such, it is an analysis of a beginning CAD course and focuses primarily on the two-dimensional portion of the AutoCAD software package. Course material presents commands necessary for drawing, editing, dimensioning, and plotting (producing a "hard copy" of the drawing). A brief exposure to three-dimensional AutoCAD is also given, time permitting. CAD courses are often viewed as "luxury" courses in many universities due to the large number of technical and support courses many interior design programs require. Substantial increases (10% to 50%) in entry level salaries have been predicted for architecture students with CAD skill; if this prediction is extended to design students as well, the need for CAD courses is self-evident (McLain-Kark, 1986).

Thus, the analysis of results provided by this study will prove helpful in determining the most effective type of course instructional reference materials for CAD classes offered to interior design/ architecture students. Identification and utilization of such materials by faculty will benefit the student, university, and potential employer by identifying an effective means for obtaining this desired and increasingly demanded skill in both a cost effective, time efficient manner.

Research Questions

Analysis of the results of implementation of a tutorial developed by Joan McLain-Kark at Virginia Polytechnic Institute and State University utilizing interior design exercises for learning AutoCAD will explore the relationships of issues stated in the following research questions:

1. When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts do students:

   A) learn more effectively as measured by the students' scores on individual assignments, quizzes, tests and projects as well as the composite grades obtained for the course?

   B) learn more quickly as measured by comparing scores on individual assignments, quizzes, tests and projects to assess whether better scores are obtained at an earlier point in the term?

   C) indicate a preference for discipline-specific texts or learning exercises as measured by 1) the percentage of students who chose to use the discipline-specific supplemental text in addition to the one they were assigned and 2) the percentage of students which indicate on the post-course survey the desire for the utilization of such materials?

2. What effect, if any, does a student's computer background appear to have on his/her ability and desire to learn AutoCAD as measured 1) by the amount of time spent in the lab versus the scores obtained on the various measures and 2) by students' responses on both the pre- and post-course surveys?

Terms and Definitions

Discipline-specific: information and/or reference/learning materials directed toward a particular profession's subject matter; in this study the profession(s) referred to by this term are interior design and architecture.

Internal conditions: "those states within the learner that are involved in learning. Examples of internal conditions are motivational states and mechanisms involved in processing, storing, and retrieving information." (Aronson & Briggs, 1983, p. 98).

External conditions: "those events outside the learner that activate and support the internal processes of learning. The appropriate provision of the external events is the framework for planning instruction." (Aronson & Briggs, 1983, p. 98).

Instructional event: any activity associated with learning which provides the external conditions required for information transfer to occur (Aronson & Briggs, 1983).

Outcome: the end result of the learning transfer process. The learned capability is physically exhibited through and measured by the learner's performance during evaluation of the knowledge in a specific observable fashion (Aronson & Briggs, 1983).

Interference: knowledge or experience which interrupts the process of transfer of new information (learning) due to its similarity in content with the material in acquisition (Yelon, 1989).

Positive transfer: the acquisition of new information without the interference of prior information during the transfer process as evidenced by the learner showing correct application of the information, without difficulty, in a testing or practical application (Yelon, 1989).

Negative transfer: the acquisition of new information which has been affected by interference of prior knowledge as evidenced by the learner providing erroneous solutions based on prior knowledge or exhibiting difficulty or confusion when applying the new information (Yelon, 1989).

Learning curve: the rate at which an individual acquires information as evidenced by instructor's assessment of assignments, quizzes and tests, and application projects.

Command: an instruction to define or invoke a set of conditions for a task within the computer software environment.

Command sequence: a set of commands used to accomplish a specific drawing, editing, dimensioning, or plotting task within the computer software environment.

CAD Concept(s): an idea or tool unique to using CAD versus traditional drafting methods; a partial list of such concepts includes:

1) the use of layers and color to organize a drawing file
2) differentiation of colors on a plotted document
3) drawing in full-scale (life size) rather than in a reduced size
4) the use of windows to focus in on a specific location within a drawing to create a view
5) panning (scrolling) within the drawing to see different parts of the drawing
6) saving views for later reference
7) setting up drawing parameters (paper size, reference units)
8) the creation and use of symbol libraries
9) editing commands such as mirror and array which allow reverse and multiple imaging of parts of the drawing
10) grouping tasks to facilitate their implementation by taking advantage of properties such as color, name, location by layer, linetype, or other associated values
11) menus (list of commands and/or tools and settings available to use)
12) the use of tools and coordinates to locate and precisely draft a drawing
13) the use of an input device such as a keyboard, digitizer, or mouse for entering coordinates and commands
14) plotting a drawing

Potential Limitations Inherent to Educational Research

Hawthorne Effect: improvement in subjects' performance due to their awareness of: 1) knowledge of the study's hypotheses', 2) receiving special attention, or 3) their participation as research subjects (Borg & Gall, 1989).

John Henry Effect: improvement in control group subjects' performance due to a perceived threat of replacement of control group procedures/materials with new materials or with those being used by an experimental group (Borg & Gall, 1989).

Pygmalion Effect: manipulation of the subjects' behavior(s) brought about by conveyance of researcher expectations to subjects through the use of intentional or unintentional cues (Borg & Gall, 1989).

List of Assumptions

1) The students in the study, as a group, exhibit no unusually low or high levels of motivation for the disciplines under study.

2) The amount of effort exhibited and achievement gained by the students in this class is indicative of their normal quantity and quality. The study is providing neither an unusually positive nor negative motivating factor in the learning process.

3) The students have not been affected by the Hawthorne, Pygmalion, or John Henry Effects sometimes encountered in educational research. This assumption is based on the use of this study's methodology designed to minimize or eliminate these effects.

4) Differences in achievement are not based upon gender or ethnicity. This is based on the course's position as an entry level class which neither expects nor requires any computer background skills, merely the appropriate drafting skills taught in the course prerequisite.

5) The students have either taken the course's prerequisite or its equivalent, or displayed a sufficient understanding of the material to waive the prerequisite course.

6) The learning materials utilized in the course are appropriate in terms of relevancy of subject content and correctness of the information presented for learning the AutoCAD software program.

7) The instructor's scoring of course assignments is reliable and valid.

8) The type of material covered by both groups is the same and is presented in approximately the same sequential order.

CHAPTER II. REVIEW OF LITERATURE

The Role of Computers in Design Professions

The Use of CAD in Industry

When computers are mentioned in connection with the design professions, it is often assumed that the primary use is for computer-aided design. The true role of computers is, however, much more diverse. A study conducted by Joan McLain-Kark and Ruey Tang (1986) indicated that design firms are using computers for activities including accounting, billing, specifications, business correspondence, scheduling, cost estimation, and facilities management as well as for CAD functions. Even within the design functions, diversity is seen, as some designers in the study reported using the computer to perform analysis of lighting/acoustical, structural, and energy concerns in addition to the familiar drafting applications of creating elevations, details, plans, and perspectives. A 1989 study of 250 randomly selected AIA members showed 99% of the sample used CAD for 2D drafting, 57% for 3D drafting, 20% for facilities management, 15% for technical illustration/rendering, and 7% for desktop publishing (MicroCAD News, June 1989).

A recent (1988) worldwide survey, directed by Wolfgang Preiser and cosponsored by the AIA/ACSA Council on Architectural Research and the School of Architecture and Planning at the University of New Mexico, revealed several research topics related to computers and architectural design. Returned questionnaires resulted in a response rate of approximately 9% (73/822). Analysis of responses with regard to country revealed that domestic responses comprised 61.6% of the total number of responses, as compared to 38.4% foreign responses. A low response rate was anticipated from foreign countries due to either lack of research or a desire not to disclose research information. Surprisingly, Japanese universities declined to return any survey information although they were expected to be engaged in research.

Eighteen universities reported research on computer applications resulting in this topic's rank as the 6th most frequently researched subject area. Following closely in 7th place was research on CAD systems, with 17 universities indicating studies in this category. Research is being conducted in the USA, United Kingdom, Turkey (Istanbul), Singapore, Australia (Sydney), and Isreal. The variety of responses within this relatively small sample prominently displays the global impact of computers and CAD in the professional design community, and the need for acquisition of CAD skills. Specific projects included: development or use of computer programs for CPM scheduling, learning of basic design skills, providing a 3D "tour" through a space, development of expert systems or Intelligent Computer-Aided Design Systems (ICADS), learning CAD software, intelligent building systems, simulation of egress behavior in fire situations, databases, passive solar building design, and other building system concerns. Those projects which indicated use of a CAD program principally mentioned AutoCAD or the use of its programming language, Autolisp.

These results support the findings of an earlier pilot study done by Dr. Preiser, reported in the April 1989 issue of <u>Progressive</u>

Architecture. Pilot study results showed 80% of the responding institutions reported research on CAD or other computer applications. This poll indicated research was being conducted at 21 schools in the area of CAD systems, with 19 schools reporting research in computer applications. This is significant, as the largest number of schools reporting research in any category was 22. This preliminary study ranked the popularity of research in CAD and computer applications as second and third, respectively (Ladestro, 1989).

The Use of CAD in Management

Clearly, the computer is finding use in industry beyond drafting and business administrative functions. The emerging field of facilities management (FM) makes extensive use of this tool. The International Facilities Management Association (IFMA) is cited as the source of information in an article which states (Cortes, 1989, p. 20):

> "...a full quarter of a corporation's budget is spent on the tracking of information, equipment, and people as they move about. The same report states that the use of CAFM (computer aided facilities management) systems enables managers to realize significant cost savings and increased productivity in this area."

A recent (1988) IFMA report indicated that 36% of the firms surveyed use computers for facilities management. FM is emerging as a separate profession apart from business management, commercial design or architecture, due to the increased use of computers for managing information (Becker, 1990). Closely inter-linked with increased computer usage are four factors which stimulated the growth of FM. These factors include: 1) increased global competition, 2) the high cost of space and the need to attract and retain quality personnel,

3) changing employee expectations of the work environment, and 4) the increasingly high cost of mistakes.

Noted facilities manager and Cornell educator Franklin Becker summarizes the profession of FM in this manner (Becker, 1990, p. 7):

> Facility management is responsible for coordinating all efforts related to planning, designing, and managing buildings and their systems, equipment and furniture to enhance the organization's ability to compete successfully in a rapidly changing world.

FM is resource management; a firm's definition of its total physical resources package must now be expanded beyond the traditional "plant" or "building" assets to encompass human resources—personnel—as well. In fact, management of the latter asset is by far the more important aspect of FM since 90% of a firm's long range costs are due to its personnel (Becker, 1990). The goal, then, of FM "...is organizational effectiveness: helping the organization allocate its physical resources in a way that allows it to flourish in competitive and dynamic markets." (Becker, 1990, p. 8). Within the highly competitive business marketplace, the time saved by computerization drastically increases the ability of companies to provide goods and services to the consumer and still maintain a reasonable profit margin. At a time when competition for market share is fierce, the prevailing attitude is toward streamlining corporate costs; this strategy has colloquially become known as being "lean and mean" (Becker, 1990).

The use of computers, and CAD in particular, can be appreciated for their internal (corporate) use as well as for external (client) use. One such internal use is the generation of new floor plans necessitated by high churn rates. Churn is defined by Becker (1990, p. 153) as "...the number of offices that are reconfigured each year as a percentage of the total number of offices." The 1988 IFMA survey and Becker indicated an annual churn rate of 30%. Becker further cites instances which showed annual churn rates of 70% or higher. The industry average percentage (30%) is significantly higher in firms which systematically measure their churn rate (43%) as compared with an estimated 26% churn rate reported by firms with no specific measurement methods (IFMA, 1988). Reasons cited for high churn include the effectiveness of project workgroups, corporate growth requiring additional personnel, and restructuring of corporate operational practices and procedures (Becker, 1990).

Clearly, the time needed for designing spatial reconfigurations and the drafting of new space plans is much less if plans are on computer. The time required is limited to the time it takes to plan the new layout on screen and send it to the plotter. Traditional drafting would include not only design time, but also several hours of manual drafting. When one considers the billable time and revenue lost to in-house use of draftspeople or designers, allowing for an average of $40/hr. for drafting and $50/hr. for design (Loebelson, 1990), the choice between CAD and traditional drafting methods appears to be clear. Further, many CAD programs are capable of automatically determining and printing out a listing of new materials required to accomplish the new layout, saving design or facilities management personnel laborious hours of checking stock in inventory available for use.

The Use of CAD in Education

An effective approach to computer use in design is to integrate the learning of computer programs and skills into the educational process in design curricula. This strategy has been used in the following case studies.

A course in interior design professional practices and business procedures (Case & Rabun, 1985) was designed to integrate word processing and database activities into the course assignments. When the course was implemented, the students found learning word processing by applying it to the types of business documents they would produce as design professionals a beneficial experience. They experienced difficulty when using word processing to create business forms requiring extensive use of tabs and margin settings and many students were not proficient enough with basic computer skills to execute documents requiring the use of database functions. The course assignments were altered to allow a few students who were concurrently taking a general university-wide computer class to complete the course assignments as intended using database functions, while the remaining students learned through lecture of the types of documents useful to the design field. At the end of the course, the assignments of those students actually using a database were viewed by the entire class to recognize the options available for design documents through the use of computers. Students acknowledged the potential for the broader use of computers, beyond CAD, in the working design field.

Another usage of computers in the academic sector of design is reported by Dumesnil in a 1988 study on the effectiveness of using computer-assisted instruction (CAI) in two courses offered at the University of Utah during Winter quarter, 1986. The courses utilized a software program developed to help students learn to recognize furniture from various periods in history and to be able to learn how not to make mistakes in recognition of the items. The software was used by students in a history of interiors course in the interior design department and by students in a liberal arts course who were initially unaware that the course focus involved interior environments.

Although the limitations of the study prevented extensive generalization on the ability of the software program as to its effectiveness as a vehicle for learning, the study did validate previous educational research as to the effectiveness of CAI as a well received, effective method for learning. This is due to the interactive nature of many software programs which allows the student immediate feedback and reinforcement of material being presented. Both the interior design students and the liberal arts students improved significantly by using the software program. The use of the computer to learn to avoid mistakes was beneficial for both groups as well. The interior design students obtained higher scores overall since their computer exercises counted toward their course grade. Liberal arts students used the software as their only text reference, and scores on the computer exercises did not affect their grade. The design students' computer exposure was supplemented by the use of traditional teaching methods such as lecture, a reference textbook, slides of furniture, and museum field trips. Regardless of the study's limitations, it points out the use of computers in a design capacity other than CAD.

Actual usage of computers as a tool for classroom instruction is not the only way in which computers are integrated into design. As computer usage becomes more prevalent in the design field, there is a continuing debate as to whether it is necessary to offer actual computer courses within a design curriculum. Accreditation teams entrusted to evaluate the competency of various universities' interior design and architecture curricula, facilities, and faculty, now assess whether applied computer courses exist in the design curricula (FIDER Guidelines; Gelernter citing NAAB criteria, 1988). Although practical courses are desirable for providing specific CAD skills, actual implementation of such courses need not occur to acclimatize the design student to some of the implications of computer use. The computer itself may be used as the object of instruction.

Radford and Stevens (1988) report on an entry level architecture course offered to architecture students at the University of Sidney which uses role playing and games theory to sensitize architecture students to the issues involved when considering integrating CAD into a firm's practice. The class's students are assigned to play the role of an employee in an architecture firm and required to research the use of CAD and the pros and cons of its use.

The roles include those of CAD vendor/salesperson, senior partner, associate, junior and senior draftspersons, architect, or office manager. The students are presented with a game scenario which states that they will be assigned to teams representing architectural design firms and be assigned a role/persona within that firm. They are provided with a personality/professional profile of the character role they have been assigned and are required to play out the game from their persona's point of view regardless of whether it coincides with their own. They are told that their firm is competing with five other mid-sized architectural firms for an attractive resort project whose bidding conditions and specifications indicate that the client is known to be extremely favorable to CAD. The game concludes with a panel presentation made by each firm's "staff" to the firm's "senior partners" and to the rest of the class. Senior management then decides whether to purchase a CAD system based on the views of the firm's staff, and if so, in which hardware and software packages to invest.

Initially, some students are skeptical of the game approach and reluctant to engage in it fully, but soon come to recognize its value and the broader concerns created by CAD use. CAD usage is viewed not only from a positive approach as a time saving tool, but is also considered for its potential as a threat to the elimination of draftspersons. Senior management views are also explored, especially the long-range implications for the firm's assets and operations of the effect of the large expenditure required to make the capital investment if the contract was not to be awarded to them.

Students found the experience extremely valuable and were intrigued by the changes in their views toward CAD based on the role playing experience. The role playing forced them to consider CAD from different viewpoints, rather than from only their own perhaps pre-conceived views. The situation was so realistic students found themselves emulating the actual behavior of their persona; vendors resorted to slandering other vendors, junior draftspeople felt threatened if they didn't learn CAD and expressed many of the familiar fears of those design professionals faced with the job requirement of actually learning a CAD package. It also elicited the opinion that the experience was instrumental in creating the motivation needed to maximize learning the skill content in future CAD courses prior to actually taking the course.

This scenario provides one non-threatening way of acclimatizing students to CAD and alleviating potential fears before they become serious obstacles to professional advancement. It also provides a firm with a potential employee sensitive to several issues encountered if and when CAD is used and allows that person to help the firm's apprehensive personnel make the transition to CAD more easily.

One further application of computers in design education is reported by Zavotka in a 1985 study done at Ohio State University. The hypotheses advanced suggested the use of filmed animated computer generated images would increase interior design students' learning of orthographic drafting skills. A series of programs were written to display two-dimensional and three-dimensional views of three items in both solid and wireframe form. Two-dimensional images transformed into the three-dimensional forms; three-dimensional forms were shown changing into their two-dimensional component views. Each film segment showed the three-dimensional forms in both wireframe and solid views.

Findings indicated the use of computer views significantly increased students' ability to learn orthographics more easily than control group students who did not view the computer sequences. The one exception to this was in the group of students shown the sequence which started the viewing process with the three-dimensional object views shown in wireframe mode. Students shown this sequence of views did significantly worse than students in the control group, who did not view any of the sequences of computer generated views. The study empirically verified Piaget learning theory by finding the sequence of views most beneficial for learning was one which showed the object in question in three-dimensional solid form first, changing to 2D solid, then to 3D wireframe and finishing with 2D wireframe which is the form associated with orthographic views. Such a sequence relies on the association with prior similar knowledge to find a solution when presented with new problems requiring resolution.

New Directions in Computer Use

An exciting and growing concept in computer usage is that of hypermedia. This involves the access and use of multiple types of information within a single computer file. For example, in interior design, one might create a file with a CAD floor plan, a copy of the furniture specifications used in the plan and line drawings of each item, the pricing for the complete project, and illustrations showing handicapped access clearance requirements. Hypermedia allows this diversity of information types to be accessed and integrated from within a single file. Hypermedia further allows the use of sound and animation within a file.

Hypermedia is an excellent medium for use with design due to the inherently non-linear nature of design information. Design requires access to different types of reference material, including building/ safety code stipulations, product knowledge, and graphic concepts such as adjacency matrices and bubble diagrams. This information is often accessed in a parallel fashion; it is not usually critical or even necessarily desirable to access a particular category prior to working on a different one. Access to the various types of information is accomplished by the selection of an on-screen key word or graphic symbol. The designated information appears on screen, often enclosed within a window which is superimposed over the current screen view.

Hypermedia has the capabilities of analyzing diverse information sets and creating interdependent relationships.

The type and amount of hypermedia use is difficult to ascertain due to limited journal coverage of any type of computer usage in design. However, the great potential for hypermedia use in interior design and architecture has already been acknowledged by Autodesk, the manufacturer of AutoCAD, through its purchase of the rights to Ted Nelson's Xanadu project. Nelson has authored what some computer industry personnel consider to be the definitive HyperText program (Case, 1990).

A recent (1990) Indiana University study conducted by Dr. Duncan Case explored the use of hypermedia via the programs HyperText and HyperCard, in a junior level interior design class on programming methodology. The study reports results of the use of hypermedia in two successive offerings (1988, 1989) of the Fall semester class. The objectives of the course were to learn programming techniques and to learn the value of using hypermedia for interior design information retrieval. These objectives were structured to be met through the creation of a design programming notebook using hypermedia. Since the course did not require computer experience as a prerequisite, Case used HyperText to create a template form for each of the categories of information being incorporated. It was expected that students could spend their time on information gathering and incorporation, rather than on computer programming. Students would be exposed to the specifics of hypermedia programming part way through the semester, so they would understand the concepts and general applications for other uses.

This approach, used in 1988, resulted in students neither clearly understanding the use of the templates nor fully grasping the concepts involved with hypermedia. Consequently, Case's objective of having students realize the advantages of using this media for interior design applications was not initially met. Case suspended the use of the templates, oriented the students to hypermedia programming concepts while they continued creating the notebook using traditional notecards, and then had them convert the notebooks into electronic media using HyperCard. The HyperCard program was chosen because of its use of a notecard type format. It was felt the similar format would facilitate learning program applications. Due to the time lost to resequencing the course while in progress, the resulting notebooks did not take full advantage of the capabilities of hypermedia. Students found HyperCard versatile; the primary problem once the hypermedia concepts were understood was to create a way in which to incorporate the various types of information available for access into a unified, smooth flowing product. Case reported subsequent changes made in the sequencing of course content which provided hypermedia programming concepts to students at the beginning of the course resulted in the Fall 1989 students gaining a deeper understanding of both hypermedia concepts in general and their usefulness for interior design.

Justification for CAD Use

Trends in Design

Trend analysis for the years 1984 through 1990 of computer usage by the top 100 interior design firms in the United States reveals the magnitude of the computer's impact on the design industry. These figures, (see Tables 1 and 2) reported by Interior Design magazine (Loebelson, January 1985-1991) represent a substantial growth in the use of computers for a variety of purposes, and in particular, the increasing use of computers for computer generated drawings.

CAD usage has increased significantly from 76% of the top 100 firms reporting CAD use to 95% reporting its use (see Table 1); as of 1986, Interior Design magazine has allocated a separate employee category to specifically track CAD personnel. It is significant to note that CAD personnel, as a percentage of a firm's employees, has risen from 4% (1986) to over 8% (1989), doubling its ranks (see Table 2).

The percentage of firms which utilize any type of spatial standard (fixed or flexible) has ranged from 50% to 58% (see Table 1). This percentage has remained relatively constant since 1987, apparently stabilizing around 57%. Standards affect the amount of time designers and draftspeople need to plan and draft new plans (reconfigurations). The more standards that exist, the less time it takes to reconfigure. Considering the industry reconfiguration or churn rate is 30% (IFMA, 1988), it is evident that a significant amount of time is spent by design personnel in this activity. CAD allows the design and generation of reconfigured plans to be accomplished more quickly due to its ability to handle repetitious tasks in a time efficient manner.

With the increasing trend toward eliminating designated CAD personnel in favor of training design staff to use CAD directly, the potential total percentage of a firm's employees using CAD increases dramatically to an average of 50% (see Table 2). Corporate revenue can be enhanced by greater use of CAD. Approximately 50% of any

Table 1

Corporate Characteristics affected by CAD Usage from 1985 to 1990

	Year					
Characteristic	1985	1986	1987	1988	1989	1990
$ volume of services[a]	9	9.1	10.5	10.6	11.3	11.2
% firms using CAD	76[b]	67	84	92	95	94
$ revenue/employee[c]	.95[d]	1.15[e]	1.79	1.86	2.1	2.3
% firms with office spatial standards						
fixed stds.[f]	25	27	30	28	27	---
flexible stds.[f]	25	27	28	28	30	---
total %	50	54	58	56	57	---

Note. Estimated table values based on annual ranking of the top 100 United States interior design firms (Loebelson, January 1986-1991).

[a]Dollar value given in millions.

[b]Usage not devoted exclusively to CAD.

[c]Dollar value given in millions.

[d]Figure estimated from percentage of change reported in 1986.

[e]Figure estimated from percentage of change reported in 1987.

[f]Stds. refers to standards.

Table 2

Allocation of Design Personnel by Professional Title[a]

	Professional Title within Firm					
Year	Jr Draft	Jr Dsn	CAD	Sr Draft	Sr Dsn	Total %
1985	---	---	---	---	---	---
1986	11	13	4	11	12	51
1987	8	14	5.5	11	11	49.5
1988	---	---	6.5	---	---	---
1989	---	---	8+	---	---	---
1990[b]	---	---	---	---	---	---

Note. Figures represent composite percentages reported by the top 100 United States interior design firms (Loebelson, January 1986-1991).

[a]Figures given as a percentage of firms' total personnel.

[b]Figures reported as being approximately the same percentages as those reported in 1989.

given firm's total personnel is comprised of design staff. Analysis of the percentage of design personnel using CAD to the total percentage of design personnel in 1986 and 1987 reveals that only 8% (4/51) of the potential CAD users definitely made use of CAD in 1986; in 1987 this figure increased slightly to 11% (5.5/49.5). Therefore, CAD is a largely untapped source for the generation of potential revenue. By using this information with other factors affecting corporate operations (see Table 3), it is possible to see the impact of this lack of CAD use.

The billing rate for draftspeople as well as designers may be allowed to increase; billing rates for CAD personnel are consistently higher (±25%) than for either category of junior level employees (see Tables 3 and 4). This will allow an increase in the revenue generated by staff that are often entry level personnel, increasing their value to the company. The differential in hourly billing rates is evident when specific rates are compared. For example, in 1989 the hourly billing rates for junior level draftspersons and designers were $42 and $44 respectively; CAD rates were billed out at $54/hr., and senior level draftspersons and designers at $56/hr. and $64/hr. respectively. This shows an increase in revenue of at least 22% (54/44) by using CAD. From the employees' point of view, CAD skills are desirable since they garner approximately 19% (27.5/23) higher employee salaries (see Table 4) at the junior staff level, and provide personnel with more professional latitude.

Analyzing the ratio between corporate revenue and corporate expenses with regard to the factors of employee salaries and the revenue generated through each category of billing rates, it is clearly seen

Table 3

Corporate Characteristics affected by CAD Usage by Professional Title

	Professional Title within Firm				
Characteristic	Jr Draft	Jr Dsn	CAD	Sr Draft	Sr Dsn
$ Annual Salary[a]					
1985	—	—	—	—	—
1986	20	21	24–25	29	29
1987	21	21–22	25	30	33–34
1988	23	24	29	34	39–41
1989	24	25	29	33	43
1990	25	26	30	37	40
$ Billing Rate[b]					
1985	—	—	—	—	—
1986	35	37–38	45	50	55
1987	28	39	49	41	56–57
1988	43	43	51	57	64
1989	42	44	54	56	64
1990	47	46	54	63	68
Revenue/Expense Ratio[c]					
1985	—	—	—	—	—
1986	2.80	2.86	2.94	2.76	3.03
1987	2.13	3.40	3.14	2.19	2.68
1988	2.99	2.86	2.81	2.68	2.56
1989	2.80	2.82	2.98	2.72	2.38
1990	3.00	2.83	2.88	2.72	2.72

Note. Estimated table values are based on annual ranking of the top 100 United States interior design firms (Loebelson, January 1986–1991).

[a]Annual salary figures are reported in thousands of dollars.

[b]Hourly billing rates.

[c]This ratio is a crude estimate of the firms' return on investment (ROI). It was calculated by determining the revenue generated by each type of employee (allowing 80% of time as billable and multiplying by the hourly billing rate of the employee) and then dividing by the employees' annual salary. This ratio, when multiplied by 100, yields a rough percentage of ROI for each category of employee.

Table 4

Corporate Characteristics affected by CAD Usage:

Composite Mean Values 1985 to 1990

	Professional Title within Firm				
Characteristic	Jr Draft	Jr Dsn	CAD	Sr Draft	Sr Dsn
\$ Annual Salary[a]	22.6	23.5	27.5	32.6	37.1
\$ Billing Rate[b]	39	42	51	53	62
Revenue/Expense Ratio[c]	2.76	2.86	2.97	2.60	2.67

Note. Computed mean figures are based on estimated table values given in Table 3. See the general note in Table 3.

[a]Annual mean salary figures reported in thousands of dollars.

[b]Mean hourly billing rates.

[c]This ratio is a crude estimate of the firms' return on investment (ROI). It was calculated by determining the revenue generated by each type of employee (allowing 80% of time as billable and multiplying by the hourly billing rate of the employee) and then dividing by the employees' annual mean salary. This ratio, when multiplied by 100, yields a rough percentage of ROI for each category of employee.

that this ratio for the category of CAD personnel is consistently among the highest reported ratio's of all categories (see Table 3). The CAD personnel category has ranked either first or second for 4 out of the 5 years for which data was reported; it ranked third in 1988. In comparison, the senior level job categories consistently ranked among the lowest ratios reported. The only time a senior level ratio was ranked as first or second for any given year was in 1985 in the senior designer category. The low ratios at the senior levels show room for improvement of revenue generation by this group of personnel.

By reviewing the five years worth of annual figures shown in Table 3 and computing their average values, it is possible to see the impact of these overall trends. These average values are reported in Table 4. Clearly, CAD allows a firm to charger higher hourly billing rates; the average CAD rate of $51 is much closer to the senior level hourly rates of $53 and $62 than to the junior level hourly rates of $39 and $42. This $51 billing rate, in conjunction with the annual average CAD salary of $27,500 creates the highest average revenue to expense ratio of 2.97. The lowest ratios of 2.60 and 2.67 are found at the senior levels. By allowing the billing rates of all job categories to rise while holding the salary levels relatively constant, the ratios, and thus the return on investment (ROI) will be greater and more profitable for firms. When this conclusion is viewed in light of the minimal 8%-11% of design personnel using CAD, it is evident that a large base of resources exist whose potential for generating revenue demands exploration.

A 1988 study done by the International Facilities Management Association (IFMA) surveyed 1,940 IFMA members. A 46% response rate yielded a total of 886 usable responses. This sample represents 60 industries. Subgroups consisted of government and educational institutions (13%), manufacturing and production industries (31%) and financial and other service companies (55%). The members were asked about a variety of facilities management concerns, one of them being the amount and type of computer usage in FM. Respondents were categorized by the size of their organization due to the variety of uses and differing percentages reported. A smaller organization consisted of a firm under 250,000 square feet, a medium organization was comprised of 250,000-550,000 square feet, and a large organization was defined as having over 550,000 square feet. The representation within the total sample by organizational size consisted of 34%, 25%, and 41%, respectively.

Analysis of the portion of the survey addressing computer usage revealed that within the total sample, 36% of the firms presently use CAD/CAM (computer-aided manufacturing) within the facilities management department, and 76% of the firms' FM personnel use microcomputers in some capacity. Forty-five percent indicated the use of computer data supplied by other departments, while 29% reported the use of an on-line computer network linking the FM department with other departments. Eight percent of the sample listed the use of designated FM automation specialists.

The larger organizations consistently showed heavier usage of computers for the different types of tasks, although the differential between larger and smaller firms' percentage of computer use for inventory and listing purposes (77% and 62%, respectively) was relatively small (15%). Differentials based on design or drafting tasks was 31%, while a 27% difference was found when comparing computer use for decision support or project management functions such as forecasting, business graphics, or cost-benefit analysis. An overview of the total sample shows 69% of the corporations reporting use of the computer for inventories and listings, 38% indicating CAD usage, and 53% utilizing automation for decision support or project management (IFMA, 1988). These figures should not be surprising since the use of computers for carrying out database management predates their use for design and managerial forecasting functions.

Given the consistent growth of computer usage and the fact that 95% of the top 100 firms use CAD, it is clear that design students and professionals need to obtain CAD training if they are to secure positions and continue to advance within a company. The burden of training falls in the realm of the academic setting for students' acquisition of these skills, and within industry for those design personnel presently working as professional practitioners.

Indoctrination procedures are more easily accomplished in the academic environment where time frames are frequently less demanding and the cost of CAD mistakes is insignificant compared to those found in industry. Considering time equals money in a design firm, the pressures brought to bear on personnel to produce quality work in the shortest possible time can be enormous. As a result, there may be a greater tendency toward resistance to learning new procedures and fear of making mistakes. This is only one of several obstacles which must be overcome for the successful implementation of CAD. Students introduced to CAD while in school experience less difficulty with assimilating changes in office procedures due to CAD implementation

(Gelernter, 1988), making the academic setting the preferred learning environment.

Benefits and Drawbacks of CAD Use

Several benefits of CAD use have already been enumerated in the prior section on the role of CAD in management, but a few additional advantages should be noted. One of the most important advantages of CAD is its flexibility to change designs during design development. As one architect noted, "'I was more willing to change ideas, explore things I think about. With ink and Mylar I'd be reluctant to make the change.'" (Ross, 1990, p. 171). With more design options being evaluated, it is possible for a better design to be the end product, benefiting both the client and the designer.

Another benefit is that CAD increases client participation in the design process by allowing the designer to show the client the changes during a presentation. The client can see directly how the suggested changes affect a project. Thus, clients may "sell themselves" on the final plan and are less apt to be dissatisfied with the final product as a direct result of seeing the design process in action. This practice further results in fewer change orders during the implementation phase of design. CAD allows for standardization of projects worked on by several people, including projects across the country. One such application is to use CAD to develop modualized housing plans (Ross, 1990).

As mentioned previously, it is reported that the use of CAD has both the potential for achieving, and of having actually achieved, increases in the productivity level of employees (Cortes, 1989; Jones, 1989; Kramer 1990), particularly when designers use CAD directly rather than having a CAD operator do the work. One architect noted the cost of a CAD system using the Macintosh computer was justified solely on the basis of its ability to draft architectural details. "'There's a 5 to 1 advantage over manual methods,....'" (Ross, 1990, p. 173). The computer frees up time lost to doing repetitive tasks. As another architect noted, "'I'm not a corporate person...I do not like computers. But it can do the things I hate, so I can do the things I like.'" (Ross, 1990, p. 173). Turn-around time is reduced by using CAD since plotters draw faster than people. As Thatcher and Thatcher stated in Interior Design magazine (January 1990, p. 122), "CAD-trained designers and drafters look for work with firms that provide the tools they have come to expect. If a design firm wants to attract or retain the best available talent, it will have to provide a CAD environment."

Despite the evidence which argues for CAD use, CAD is not a panacea. The choice to use it must be one supported by everyone involved. Although the system itself represents a relatively high capitol expenditure for some firms in the short run, the primary cost of a firm is its long term costs involving personnel. If the personnel are not supportive of CAD, they will resist using it and their general productivity will suffer. Implementation procedures must be handled carefully to educate everyone to CAD. All design and management personnel must have familiarity with CAD, regardless of whether they draft of not. Management must be familiar with CAD to be able to 1) evaluate a software program's ability to do a task to their satisfaction, 2) tell whether the firm's staff are able to perform their CAD-related job tasks at the desired level of competency, and

3) to determine when told by a person using CAD that some task can't be done whether the problem is due to software limitations, or if the problem stems from an employee's lack of CAD skills and/or an employee attitude/motivation problem (Thatcher & Thatcher, 1990).

As with any tool, there are various ways CAD can be used and misused. The most effective use of CAD is dependent on three main elements: the users, the software, and the hardware. It is up to the user to tap the potential of the computer. Merely implementing a computer into a firm will not guarantee increases in employee productivity or a firm's gross profit. CAD often requires the retraining of many employees' methods of thinking. A few tips to help utilize CAD effectively include the development of office standards for the identification of files and the stage each is at, the development and use of standard symbol libraries, having frequent CAD users set up default settings for items that have variable settings, having users back up their files at least once a day, and indoctrinating all personnel as to the time frame required for CAD. As noted by one architect, "'The hardest thing to find is an efficient way for the people who do not input work to communicate information to those who do. To what extent can you mark up drawings during the day and slip them under the door for someone to enter that night?'" (Hoyt, April 1989, p. 135). Another potential problem can be that of accepting the initial solution that is formulated; CAD allows alternate options to be explored. If such options are not evaluated, the system is not being utilized to its fullest potential. As discussion moderator Chuck Eastman stated at the outset of a roundtable discussion on CAD usage (Hoyt, February 1989), "'There are many horror stories of failures in the use of CAD in architectural offices. Often, it is used for drafting with no change in design development.'"

The second element mentioned, CAD software, must be carefully chosen. A firm must evaluate the purposes for which it expects to use CAD. The majority of software presently available has chosen to concentrate primarily on 2D drafting applications. While this is beneficial for interior design uses, various architects have pointed out the need to think in 3D (Hoyt, February 1989). This requires software to have sophisticated modeling capabilities. While future directions in software development address this issue (Sanders, 1989), the level of detail required of a 3D model for producing complete and accurate 2D working drawings is formidable.

Donald Fullenwider, president of Fullenwider CAD Services, stated in a roundtable discussion "'What's interesting in advising architects and engineers buying PC systems,'...'is that there's almost no interest in 3-D. They've seen it and found out they can't make hard copy.' Not even cost was considered a factor." (Hoyt, February 1989, p. 161). Versacad, Inc. president Tom Lazear, in the same forum, added "'At first'...'nobody asked for it.' When they did, his company made it. But they still didn't buy it." (Hoyt, February 1989, p. 161). Perhaps the results of future research and development will reverse this position. An interview done by MicroCAD News staff with Autodesk's director of marketing and sales, Malcolm Davies, indicates that by 1995 future releases of AutoCAD will have the following features (MicroCAD News, June 1989, p. 30.):

> ...fully integrated drafting and modeling capabilities that include wireframe, surface, and solids modeling. Support for multi-tasking operating systems will allow concurrent updating of relational databases and AutoCAD drawings. New display hardware will allow

zooming, panning, and rotation of complex, shaded models in real time.

Another direction taken by research and development in CAD is the development of product databases which can be integrated within CAD software. This is presently being undertaken by providing the architectural design community with its primary building product resource, Sweet's Catalogue, on computer (Hoyt, June, 1989). The presence of product information in electronic form has sparked discussion as to whether the best products are being chosen for use in projects. Some architects have expressed concern (Hoyt, June 1989) that the design professional needs to look at and/or physically test the product being specified. One concern is that merely viewing product information selected by the computer to fit certain criteria may result in the designer overlooking new products or being lulled into a false sense of security about the worth of certain products. Another issue is whether using electronic specification will put specification department personnel out of a job. As with CAD, computer-aided specification is only a tool of the job. It's value is in doing a more accurate job in less time. Those individuals who specify manually will be able to save time through the use of computer specification programs. The job won't disappear, it will adapt to encompass new tools (Hoyt, June 1989).

Problems may be the result of hardware, as well. At some point in time, it is inevitable that the computer will "crash" or go down. According to Murphy's Law, that time will be at a critical moment! It is therefore imperative for large offices to have backup hardware to accommodate this contingency. One alternative to additional hardware is to have access to another company's or the vendor's equipment when this situation occurs. Regardless of the method chosen, it will be useless unless personnel are indoctrinated with the awareness of how critical it is to save their workfiles frequently (Thatcher & Thatcher, 1990).

Another concern with CAD pertains to legal ownership of electronic files. Some firms retain the right to keep the design, and provide the client with a finished product. Other firms may choose to provide the client with the design documents as well. The issue of ownership of design generally refers to the master set of documents involved. With the advent of electronic media, the question of whether the master set of documents are the ones on computer files or the ones which exist as printed hard copy is raised. Such an issue is of paramount importance should the client decide to change design firms during the design process. Understanding of the ownership issue needs to be addressed in the firm's contract with the client (Thatcher & Thatcher, 1990).

Another issue for consideration in the choice whether or not to use to CAD is the type of work a firm executes. A firm which performs highly customized design may not find it cost effective to use CAD, since one of CAD's principle advantages is its ability to quickly perform repetitive tasks and to quickly and easily modify existing items for a similar situation. If such situations are less frequent, the use of CAD software may require the use of its specification programming to justify the initial investment in the system rather than reliance on reducing design/drafting time. Some firms will find CAD simply isn't necessary for their needs. Each firm must evaluate its needs individually. Thatcher and Thatcher (1990) note that if the percentage of repetitive elements within or across projects approaches or exceeds 25%, the use of CAD should be given serious consideration.

Should a firm wish to use CAD but are unsure if they can justify its cost, it might consider leasing the hardware. This cost is relatively minimal, often being only a few hundred dollars a month (Hoyt, April 1989). Hoyt reports that firms frequently discover they are able to afford the cost of equipment after observing the amount of use the leased system receives. A note of caution is necessary when evaluating the productivity and potential of any CAD system; taking the view that CAD expenditures can be recovered in the short run is erroneous. It may lead to employee resistance to use the equipment because their productivity and billable time will likely be lower for the time it takes to learn the software itself, as well as during the time after that as they reorient themselves to designing in a CAD environment (Dubbs, 1990). This time frame may potentially be shortened by using personnel familiar with other CAD systems. Architect Kenneth Sanders, Director of computer services at Leason Pomeroy Associates, reveals "'Deeper understanding is gained only after you've learned your second or third system. Then you see the big picture and not just the specifics of the system you've learned.'" (Hoyt, April 1989, p. 135).

Debate over the amount of time required per day in using CAD to make it cost effective abounds; Thatcher advocates using CAD if 25% of the work performed is repetitive. Other firms indicate employees should spend no more than four to six hours per day to avoid employee burnout (Dubbs, 1990). Still others suggest letting employees use

CAD as much or as little as they desire (Hoyt, February, 1989). Architect Donald Gibbs, principal partner of Hugh Gibbs and Donald Gibbs Architects, states "'One of the things we've discovered'...'is that you only have to use a computer five or six hours a day to make it pay.'" (Hoyt, April 1989, p. 137). Gibbs' firm is noted for being one of the most efficient in its CAD usage (Hoyt, April 1989).

Obstacles to Acceptance of CAD

Educational Concerns

Concern has risen in some sectors that CAD may not be an appropriate media for interior design. McLain-Kark & Rawls (1988) indicate that this view stems from some educators' firm belief that interior design is primarily a right brain (intuitive/creatively oriented) activity as described by the split-brain theory in psychology, and that computer operation requires left brain (rational/sequentially oriented) activity. The rigidity of acceptance of data in a specific, structured format, found in some software programs, may be a contributing factor in helping substantiate such a conviction. This has led some designers and educators to speculate on whether creativity is being curtailed (McLain-Kark & Rawls, 1988).

The validity of this view must be addressed since "...creativity is included as one of the Foundation for Interior Design Education Research (FIDER) guidelines for program objectives. (FIDER, 1988)" (McLain-Kark & Rawls, 1988). Considering FIDER is the sole regulatory agency for evaluation of academic interior design curricula, the resolution of this issue is certainly of paramount importance to design educators. McLain-Kark concluded the computer has both strengths and weaknesses for design application; proper application of CAD, for example as a drafting tool, would not endanger the creative energies utilized during other stages of project management such as conceptualization and design development (McLain-Kark & Rawls, 1988). Some studies indicate that design personnel find CAD allows them to consider additional design solutions they might not have time to develop beyond preliminary stages based on CAD's ability to easily and quickly modify existing solutions (Ross, 1990).

Corporate Implementation Concerns and Strategies

Parallel to the problems of CAD implementation and user attitude in the academic setting are their counterparts in the professional design environment. User attitude tends to be more variable in the professional setting based upon the corporate employer's attitude about and commitment to CAD. Employee acceptance of CAD is critical, since a firm's employees account for the vast majority (92%) of the long term costs incurred by a firm, while only 8% of a firm's expenses are due to operational and maintenance factors. As noted facilities manager Franklin Becker states, "...it is the staff who ultimately determine the success or failure of any enterprise." (Becker, 1990, p. 13).

Firms such as Heery International and RMW utilize computer support groups and buddy systems for CAD instruction. The commitment to CAD must start at the senior echelons of management since CAD programs are complex and take time to learn proficiently. A frequent estimate of the amount of time necessary for acquisition of and full utilization of CAD program commands and skills is 450 hours beyond completion of training (Dubbs, 1990). This estimate varies from person to person and is also partially dependent on the specific software program's complexity and degree of user friendliness. The attitude at Heery is obvious: "'We're going to buy a system and make it effective.' There's got to be someone who's not afraid to tell staff that if they don't learn the system, they'll be replaced." (Dubbs, 1989, p. 52). While this authoritarian view may cause stress, user apprehension is tempered through the use of the buddy system. In this system, a more experienced CAD user is paired with a new operator. "'Being a buddy is an honor....It's the firm's way of letting a CADD user know that he's reached a certain level of proficiency.'" (Dubbs, 1989, p. 62).

At RMW, CAD use strategies are similar; training costs are absorbed by the firm in the expectation of greater productivity and future return on investment. RMW uses CAD as an incentive, enticing employees to learn CAD to help them gain raises and promotions. "By including CADD as an overall job requirement, RMW provides the strongest motivation of all to learn the system." (Dubbs, 1989, p. 62).

Los Angeles based firm Skidmore, Owings & Merrill (SOM) starts a new employee learning CAD immediately. At SOM, new personnel spend two hours a day in a CAD course for two weeks. Because of SOM's high percentage of CAD use (70%-75% of all drawings are done via CAD), CAD skills become ingrained in all employees (Hoyt, February, 1989). SOM's CAD specialists are all architects and account for only 14% of the Los Angeles branch's personnel. These individuals are distributed among the various project teams, allowing a project team easy access to a highly knowledgeable CAD user.

An approach used by the architectural firm of Hugh Gibbs and Donald Gibbs is to have two types of CAD users. One type of user is a CAD specialist who does nothing but CAD. The other type of user is an architect who will typically spend between two and four hours a day on CAD. The amount of time spent in CAD is up to the individual. This firm also uses flexible time shifts, allowing personnel to set their own hours, thus increasing each employee's productivity (Hoyt, February 1989). These practices work very well for this particular firm; 95% of their work is done by CAD methods.

A somewhat innovative method of acquiring CAD skills is used by Vincent Association + Architects, a Dallas, Texas based firm. After learning basics of the computer's disc operating system (DOS) including how to prepare the computer itself for physical transportation, a computer is sent home with the employee for two weeks. The employee learns the program at his/her leisure by playing around with it. Computer games software is also loaded on the unit to make sure the tendency to feel learning is a chore is lessened. The games software is designed to increase the user's familiarity with the keyboard as well as providing relief from the "work" mode of CAD. Vincent Association reports this strategy has proven very effective and makes learning CAD very enjoyable. Skills not learned in the home environment are quickly mastered back in the office (Payne, 1989).

Another problem facing CAD users is that of burn-out. Since the number of CAD users in an individual firm is often relatively small, the employees who know CAD frequently spend more of their time as computer draftspersons than as designers, managers, or performing whatever tasks their job position entails (Dubbs, 1990).

Several steps may be taken to minimize burnout. Perhaps one of the easiest ways to do this is to assess the personalities of employees for their suitability to using CAD and then provide CAD training to those personnel whose interest level and personality are most suited to CAD. For example, it has been observed that personnel who exhibit a tendency to restlessness or disorganization are often less efficient at using CAD. Those personnel who are more systematic in their work are more effective when using CAD. This is attributed to the sequential nature of CAD functions and command structure. "With rare exception, a firm's best workers also work best on CADD." (Dubbs, 1990, p. 22).

While it helps to train people in CAD whom are more apt to be receptive to the idiosyncrasies and nature of CAD functions, it is also important to avoid dedicating specific design personnel to be CAD operators. This can lead to designers perceiving themselves solely as draftspersons rather than as part of the project staff. One way to control this is to train as many people as possible in CAD from all levels of the design staff. Another way to lessen this problem is to limit the amount of time spent on-screen to between four and six hours per day per person, allowing the designer to spend the remainder of the day on other project tasks. As such, personnel tend to feel less like CAD drones whose professional goals have been set aside (Dubbs, 1990). This latter time frame is recommended by David A. Jordani, an American Institute of Architects (AIA) architect who heads his own office automation and management consultation firm. The firm's services includes a variety of automatization techniques including the implementation of CAD systems and CAD training (Dubbs, 1990).

Symptoms of CAD burn-out are similar to signs of general work burn-out. These signs often include an increase in the quantity of errors, less work being produced by CAD than would be expected given the firm's workload, neglect of file back-up and other standard maintenance safeguards, and a lower quality of work (Dubbs, 1990).

Overall, one of the best ways to reduce the problem of CAD burn-out is to have management understand the problems involved with using CAD and to set reasonable, achievable goals for its personnel using CAD. This includes understanding the stresses caused by software use problems and time schedules, physical and mental fatigue caused by intense CAD use, and the potential for employee job dissatisfaction if personnel feel diverted away from their intended career paths by intensive use as CAD operators (Dubbs, 1990; Hoyt, April 1989; Jordani, 1989).

Additional benefits of CAD skill diversification in personnel include a minimization of disruption to project production schedules should a firm lose an employee trained in CAD, as well as the reduction in the quantity of errors in CAD documents created through fatigue. One fallibility with the use of CAD is a tendency to unquestioningly accept an expected higher degree of accuracy of computer generated reports and drawings. This greater degree of accuracy is a valid assumption as long as user fatigue does not cause error to occur (Dubbs, 1990). One must guard against this by reviewing CAD drawings and documents as carefully as manually generated documents.

CAD opinions held by designers in small residential design firms, which often consist of four or fewer designers, were explored by McLain-Kark and Ruey Tang in a 1986 investigatory study of computer use attitudes among professional members of the American Society of Interior Designers (ASID). The sample size (n = 150) consisted of 57 (38%) residential designers and 93 (62%) non-residential designers.

The study analyzed data on designers' background and type of computer experience (if any), as well as the applications for which each designer utilizes computers. Additionally, the intention of the designer to purchase a computer was explored. Results showed both residential and non-residential designers felt CAD was not cost effective in small design firms. Computer uses most often cited included billing (57%), business management functions (53%), and correspondence (50%). CAD functions were utilized only 7% of the time (McLain-Kark & Tang, 1986).

Software Application Issues: Concepts which make CAD Difficult

Technical problems specific to CAD software often are encountered when CAD is first introduced. One such stumbling block which frequently arises is the concept of using Cartesian coordinates for positioning the cursor to draw (Thatcher & Thatcher, 1990). Cartesian coordinates may be considered analogous to geometry's use of grid coordinates or the designer's use of graph paper to indicate the relative location of points in space. Another concept often difficult for some users to master is the creation of drawings using full scale. The computer is not aware of size until the drawing file is sent to the plotter to be drawn on hard media. Therefore, the designer selects a unit of measurement appropriate to the nature of the drawing (such as feet and inches for architectural work) and then indicates the scale at which the drawing is to be plotted (such as ¼" = 1' - 0"). On screen, scale is meaningless due to the ability to "zoom in" or magnify a portion of a drawing to fill the entire screen. Scale, on screen, is changeable (Thatcher & Thatcher, 1990).

Other concepts unique to CAD include "panning" and "windowing"; the "pan" command allows the user to move around within the drawing by indicating which direction to move the view on the screen. An adjacent section of the drawing appears on the screen. The "window" command allows the user to define within a rectangular "window" or box the portion of the drawing he or she desires to fill the screen. This window may be an enlargement of part of the screen view visible at that moment, or the user may recall the entire drawing or another partial view which has been saved as a window. The new window selected will then replace the screen's current view. Since many drawings are large, when viewed in their entirety, details become indistinguishable. Commands such as zoom, pan, and window are necessary to work effectively in a CAD environment, but do constitute some of the major conceptual differences between drafting on a board and via computer.

The use of layers may also be new to some CAD users. Layers can be thought of as separate transparent film sheets of a given drawing file. This is the same concept used by the overlay drafting system used in many firms. Each layer represents a single sheet or page of the drawing. A layer may be turned on (visible) or off (invisible). If a layer is on, it is as if the page were placed on the overlay equipment; if a layer is off, the page would not be there. A floor plan might be one layer, an electrical plan a second layer, a furniture layout a third layer, dimensions a fourth layer, and notes or labels a fifth layer. The advantage of CAD over manual drafting is that layers are instantly accessible by simply turning a layer on or off; with manual drafting, one must turn unwieldy pages in a bulky set of drawings or physically retrieve them from plan storage.

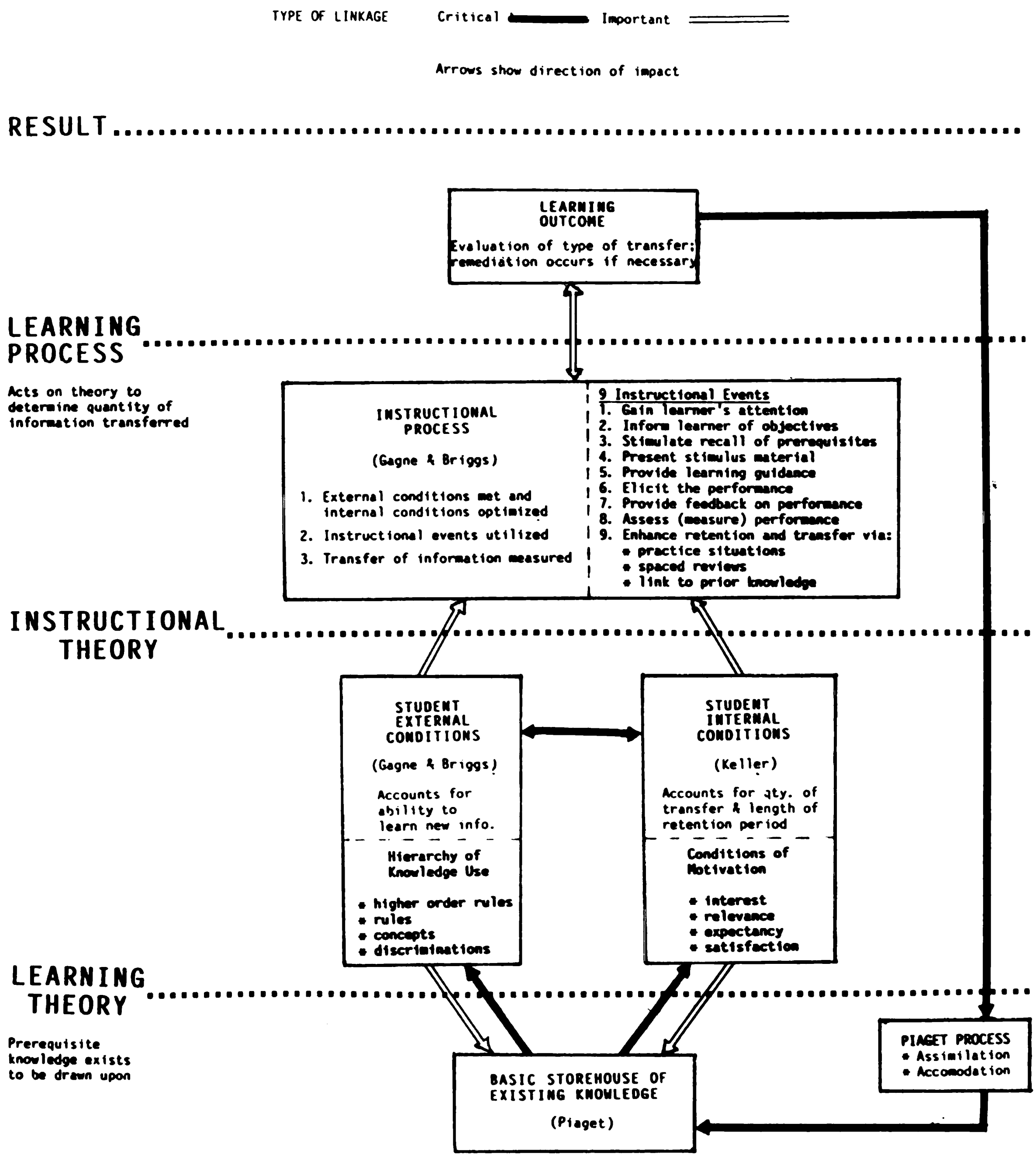
Educational Learning Theory

The Theorists: Gagné, Briggs, and Keller

Learning theorists have quantitatively and qualitatively analyzed learning and instructional theory strategies for learning which are demonstrated empirically on a daily basis in real learning situations. Basic issues discussed include defining what learning is, how to measure it, and perhaps most importantly, what conditions and environment are necessary to foster its growth. It is critical for educators to have a basic understanding of these issues in order to be able to continue adapting course materials to the changing learning environment and to provide students with high quality educational experiences.

The model set forth in this study (see Figure 1) is a synthesis of those presented primarily by instructional theorists and designers Robert Gagné, Leslie Briggs, and John Keller. The instructional theory work of Gagné and Briggs is directed toward determining the conditions necessary for increasing the quantity and improving the quality of transfer in the learning process. They state specific instructional actions (see Figure 1) which should be undertaken by the educator to improve the outcome of the learning process (Aronson & Briggs, 1983). Keller's domain explores the role motivation plays in the learning process and provides an explanation on why the retention period varies for different types of information. His work presents suggestions on how to lengthen the retention period of the information in the learner (Keller, 1983).

These three facets of the learning process and its outcome are interactive in nature. As seen in this study's model (see Figure 1), transfer is dependent on the type of instructional events occurring



Model adapted from the theories of Piaget, Gagne, Briggs, and Keller

Figure 1

Relationship between Instructional and Learning Theories, Educational Process, and Learning Outcomes with respect to the Conditions of Learning and the nature of the external and internal conditions surrounding the learner. Fundamental to this model is the premise that the learner acquires new knowledge by drawing upon an existing body of knowledge (Hilgard & Bower, 1981). A learner's response to a new situation may be affected by the degree of similarity between the newly encountered situation and a previously learned situation. Bower and Hilgard (1981, p. 28), describing Thorndike's transfer theory, state:

> ...the theory proposes that transfer depends upon the presence of identical elements in the original task and in the transfer task which it facilitates. Either the stimulus elements of two situations or the response-components of two similar skills may be identical.

Thorndike's view is supported by Gage & Berliner (1988); they indicate that transfer may be improved by substantive transfer. Substantive transfer is the concept of directly teaching a learner what they need to know in a relevant direct application. The larger the number of identical elements which are used, the greater the transfer will be. The instructor should watch out for and correct negative transfer; this frequently results from the misapplication of rules and principles. Transfer may also be aided by the use of procedural transfer (Gage & Berliner, 1988). This type of transfer occurs when a wide variety of examples and applications are presented to the learner in order that the learner may learn to identify and distinguish the similarities that exist between them. Transfer of attitudes occurs, as well as transfer of knowledge. Thus, expectancy is a learned condition.

Gagné & Briggs: External Conditions needed for Transfer

According to Thorndike, successful learning outcomes are based on the learner's ability to correctly apply this former knowledge base to new situations (see Figure 1). To be able to maximize the amount and optimize the type of transfer, the learner must draw on a hierarchy of types of learning. For new information to be integrated into the existing knowledge, the learner must be able to correctly apply higher order rules. To do this, the learner must recognize and understand the relationships between a variety of rules used for higher order, more complex applications. Rules in turn are dependent on the learner's ability to recognize and apply basic concepts of the subject matter. These concepts, in turn, are grasped by drawing upon existing knowledge for comparison and discrimination purposes. Piaget's theory regarding the method (assimilation or accommodation) by which information is incorporated into the existing knowledge base describes the overall physical process against which are set the specific mechanics of instruction. These mechanics are operationalized by Gagne and Briggs as instructional events and influenced by the learner's internal conditions as defined by Keller.

Gagné and Briggs suggest nine instructional events or steps for increasing the effectiveness of the teaching strategy employed (see instructional process, Figure 1). Of these nine steps, three of the most critical are (Aronson & Briggs, 1983):

1) the instructor's actions which require the learner to recall prerequisite information,

2) the need for the instructor to próvide cues to channel the learner's energies in the correct direction, and

3) the need for the instructor to enhance the retention and transfer of information through the use of practice exercises, periodic review, and by having learners make connections between new information and what they already know.

Guidelines suggested by Gage and Berliner (1988) parallel those of Gagne and Briggs which are presented in Figure 1. Gage & Berliner suggest:

1) maximizing the use of real world settings,

2) providing many varieties of practice opportunities,

3) using several different types of examples when presenting information,

4) watching for the occurrence of negative transfer when stimuli are similar but require different responses,

5) making sure learners understand the prerequisite information and sequencing it into the instruction at an early stage,

6) using discovery learning, allowing students to create their own applications and

7) having the learner verbalize the thought process which is gone through to act as check on the correctness of the procedure being followed.

Keller: Internal Conditions needed for Transfer

Internal conditions of the learner affect how the learner perceives and chooses to approach the learning task. Keller's work addresses the impact motivation has on the learning outcome. Motivation is affected by four conditions:

1) the learner's degree of interest in the material,

2) the degree of relevancy the material has to the learner's personal interests,

3) expectations by the learner and by others regarding the degree of success achievable, as well as the level of control the learner has over the instructional process, and

4) the degree of satisfaction the learner achieves from the instructional process.

An increase in any of these conditions will generally exert a positive influence on the transfer process. It should be noted, however, that detrimental effects on the level of motivation may occur if the learner has high expectations which are not met (Keller, 1983).

The combination of internal and external conditions comprises the instructional theory accounting for why learning occurs, and sets the stage for instructional events to take place during the physical learning process.

Motivation is responsible for which goals a person will strive toward as well as the amount of effort an individual is willing to expend toward the accomplishment of any given goal (Keller, 1983). It has been shown that a direct relationship exists between the amount of time spent in an activity, and the strength of motivation for performing the activity (Gage & Berliner, 1988). Ability refers to the capacity of an individual to competently fulfill or execute any given task or function. Generally, ability is a more stable, consistent indication of success than is motivation; motivation varies greatly from individual to individual and is affected by both internal and external factors (Keller, 1983).

A study done by Nenniger (1987) addresses the issue of stability of student motivation. Nenniger explored how content-oriented motives pertaining to subject-matter oriented interest contribute to an individual's interest in learning. He raised the question of whether or not these motives are constant or if they could be influenced by manipulating the instructional conditions. It was found that the key factor in increasing the level of motivation was to develop interest in the learner for the subject matter. It was concluded that learners' perceptions of their own competency were an outgrowth of the level of interest generated and sustained by the instructional conditions throughout the course of instruction. As meaningfulness/degree of relevance was increased, learner competencies were found to increase.

Space does not allow a detailed accounting of how to optimize the four conditions of motivation; interested readers are directed to several articles by Keller or Keller's chapter on the motivational design of instruction in C. M. Reigeluth's Instructional-design theories and models: An overview of their current status.

To maximize learning, the desired state of each of motivation's four components is as follows (Keller, 1983):

> 1) INTEREST: the learner's attention must be gained, and the threshold level of curiosity must be achieved; if these conditions are not met, the potential for transfer is highly limited. The student should be encouraged to learn by the discovery techniques of exploring and manipulating the subject content.
>
> 2) RELEVANCE: Students should be made to see that the knowledge being presented fulfills "a basic need, motive, or value" (Keller, 1983, p. 407). Values can include those associated with personal desires achievable as an end to themselves; instrumental values of which attainment acts to allow the learner access to a future goal; and cultural values associated with the approval of the learner's peer group or family. The critical factor with relevance is to induce learners to perceive the relevance of the information so that they generate their ability to motivate themselves to work toward the achievement of their goals. This may be partially accomplished by providing learners with at least some of the responsibility for and degree of control over specific actions necessary to achieve those goals.
>
> 3) EXPECTANCY: Critical to maximizing motivation with regard to expectancy involves the concepts of self-efficacy or "mind over matter", and learned helplessness. Learners come to expect certain outcomes based on their past experiences in similar situations. If these outcomes have been unsuccessful, the learner often becomes discouraged and expects to fail in subsequent similar situations. If students have been successful, they build confidence in their abilities and bring a positive attitude or expectancy to new situations. The instructor's task is to reverse a negative expectancy in less successful students in order that they realize that they too are capable of learning and so that they start building confidence in their own abilities. With success comes increased motivation. Keller states (1983, p. 421) "...positive expectancies lead to improved performance and success rates. A key factor in this principle is that the positive expectancies are not necessarily consistent with actual, or objective, predictions of success. Believing something can, apparently, help make it happen."

4) SATISFACTION/OUTCOMES: Learners' motivations are affected not only by their own specific internal assessment of the quality of learning which has transpired, but by the external response of others to the visible outcome itself. Feedback is critical in order for improvement to occur; however, it is necessary that care be taken by the instructor to deliver the appropriate type of feedback at the appropriate point in time. The two types of feedback are motivational and formative. "Motivational feedback should be given immediately after a performance, and should refer to those aspects of the performance criteria that were acceptable. In contrast, formative feedback should relate to those aspects of performance that are less than standard, and should be delivered when it is immediately useful (i.e., just before the next performance)." (Keller, 1983, p. 428). If feedback is not provided at the appropriate time, the positive motivational impact is severely compromised if not altogether negated by the formative or corrective feedback.

A word of caution is in order. Although educators desire to optimize the motivation level of the learner, it is critical that the correct amount of motivation is generated. As Keller states (1983, p. 400) "Too low a level of motivation results in less than optimal performance. On the other hand, excessive motivation also results in suboptimal performance due to anxiety and other sources of distortion and disorganization."

Due to the interactive nature and codependency of the instructional process, conditions, and outcome/results, a deficiency in one segment often affects the effort necessary for a successful outcome in another one. Depending on the type of transfer which has occurred, the learner may advance on to encounter new learning situations, or may continue to process the same information until a correct transfer occurs. It is likely that if the latter situation transpires, negative transfer has occurred, causing confusion in the learner. This condition does not preclude, however, the learner simultaneously encountering new learning situations. Thus, the learning process is cyclical and interactive in nature.

The Gelernter article, describing Piaget's learning theory, uses this theorist's approach to argue for the need to change from the common practice in architecture schools of separating lecture information and studio application of that information to a more integrated approach as postulated by Piaget. Gelernter states the existent approach to architectural education does not allow the integration of theory with practice to occur thereby reducing the opportunity for application to be experienced. Without the practical implementation of testing new situations against existing experience, less change and accommodation occur, limiting the amount of knowledge transferred, thus providing a smaller knowledge base for future learning experiences to access.

Gagné's, Briggs' and Keller's theories account for the structuring of the course selected for the purposes of this study. This study's sequencing for the course's assignments and final application projects allows students to first experience learning the material in a practical manner, then initially applying it to a relevant, familiar application followed by a less relevant, unfamiliar application. Learning theory supports such a sequencing as the optimum one to facilitate and maximize positive learning transfer (Keller, 1983). It accounts for the belief held by this study's investigator that comprehension of material will occur faster and/or more thoroughly if familiar, relevant material is presented to the learner during the learning process.

Interior Design Studies Validating Gagné's Conditions of Instruction

Several of the case studies mentioned earlier (Case & Rabun, 1985; Dumesnil, 1988; Case, 1990) have found actual conditions for effective learning parallel to those proposed by Piaget, Gagné, Briggs, and Keller. These cases support the need for correct sequencing of information within a course and document the need for prerequisite skills/knowledge to be in place for the learner to access in order that transfer may be optimized.

The Case and Rabun (1985) study on incorporating word processing and database usage into a course on interior design business practice found that prior or concurrently acquired computer skills were necessary to effectively apply the basic computer skills to the intended interior design applications. The students without these skills became frustrated by not achieving the type of documents they desired, and spent more time learning computer skills than in applying the skills to a relevant professional design usage. A computer lab time slot dedicated to learning computer skills separated from the design content was found to alleviate some of the problems.

Recommendations suggested by the study included having students take a general computer use course prior to taking the interior design business practices course, or at least to concurrently enroll in a general computer course. This was tempered by the comment that the course time frame may have been a factor in this recommendation. It was suggested that a semester length course might allow students enough time to learn computer skills integrated with their practical design applications.

The Dumesnil study utilizing computerized programmed learning for recognizing styles of furniture reported similar findings to Case and Rabun; in this instance computer skills were not the issue, but rather prior knowledge of interior design. Dumesnil cites a 1986 Department of Education reference on research on learning which states:

> "regulating learning activities [include]: sequencing course content so knowledge builds on itself, pacing instruction so students are prepared for the next step, monitoring success rates so all stay productively engaged regardless of how quickly they learn, and running an orderly, academically focused classroom." (Dumesnil, 1988, p. 46).

Although students both with and without prior interior design knowledge were found to increase their post-test scores through the use of the computer program, students with prior knowledge increased their knowledge to a significantly higher degree (54% vs 34%) than did those without such information. These results may be questionable due to the lack of a balanced research design and differing grading practices between the two groups. The post-test and exercise scores for students without prior design information did not count toward their course grade; the post-test score and exercises for interior design students did count toward their final grade.

While the study did not appear to determine the specific degree of desirability of the use of the computer as the sole means of instruction, it does point out that motivation may be considered a significant factor in the learning process. The study concluded that its findings would be stronger if parallel groups had been used.

The Hypermedia study (Case, 1990) provides further empirical confirmation of the need for providing students with an understanding of the basic concepts and principles involved in learning a specific set of skills of a subject prior to applying those concepts to a relevant application. As in the 1985 study by Case and Rabun, students experienced problems when given only rudimentary knowledge or guided instructions on the use of specific computer related skills. When the course on design programming was taught for the second time in 1989, students gained a much deeper understanding of both the process of using hypermedia, as well as its application potential for their own professional use. This more effective teaching approach was accomplished by sequence changes, as well as content changes.

Students were oriented to hypermedia's ability to present diverse types of information and presented with specific knowledge on how to create a hypermedia program. Students were shown three good examples of the use of hypermedia, and then were asked to consider how its capabilities could be applied to interior design information. Students were required not only to create their own programming notebook for the entire project, but to create their own HyperCard notecard format as well. The project was completed in two stages; the initial stage was to create the program format and incorporate the design project information into a notecard format. Stage two involved refining the initial product to incorporate characteristics specific to hypermedia into the notebook and to simplify the means of accessing the various types of information.

Case stated this latter (1989) sequencing worked much better for creating an understanding of hypermedia and its applications. Although this approach resulted in less extensive notebooks, the time spent initially teaching computer concepts resulted in more effective projects and applications of hypermedia. The high degree of similarity between the use of standard notecards for presenting information and the notecard format used by HyperCard allowed students to grasp the applications more easily once they understood the hypermedia concepts and capabilities. Further, by requiring students to create original formats, rather than to simply use a pre-existing format, students gained a deeper understanding of hypermedia programming.

This study was of further interest, as the 1988 (and presumably the 1989) course used simulation as an apparently effective teaching strategy. The students were asked to assume the role of a designer who had been asked by their firm to compile, for presentation purposes, a programming information document in notebook format. The project took the place of traditional assignments. The study did not report on how well this approach was received by the students. Although the study doesn't either confirm or deny the use of simulation as a valid teaching strategy, it does vindicate Gagné's and Briggs', as well as Piaget's contentions on instructional design and learning theory.

The Use of Simulation to Elicit Real World Performance

Although it is generally agreed that computers play an integral part in design project management and drafting (Sherman, 1984), various concerns have been raised specifically over how to implement CAD into interior design curricula. The practicalities of this problem have not been researched thoroughly, nor has much attention been given to the students' perception of the need to acquire CAD skills (Sherman, 1984). This latter issue has been addressed by a 1984 study conducted at the University of Illinois (Sherman, 1984).

The University of Illinois investigation studied the effectiveness of CAD instruction utilizing two different instructional techniques. One technique was to present the information only through lecture without allowing students hands-on computer applications of the material. The second technique was a combination of lecture and on screen application of the material. The study also addressed another major area of concern prevalent in using computers: attitude toward and anxiety about using computers. In both groups, findings showed interest and curiosity about CAD combined with a receptive attitude toward learning these skills. Anxiety, however, increased as students became aware of the complexity and power of the CAD programs; the group not receiving reinforcement of lecture material via actual program application practice registered the highest anxiety level. This tends to suggest CAD lectures must be accompanied by practical on-screen exercises or it may be detrimental to the students' future CAD experiences (Sherman, 1984).

The Radford and Stevens case study cited earlier dramatically portrays the effectiveness of the methodology of teaching material through the use of role playing or simulation. Simulation provides the set of relevant conditions closest situation to the "real world" situation a student is likely to encounter. Several architects and designers have commented on the fact that they learned more their first few years in the working field than they ever did in school. While school may have given them the technical knowledge base required to practice their discipline, it didn't teach them what to do on a daily, practical operational basis. As such, the need to utilize role playing should be noted. To be effective, however, students must have a comparable stake in participating in a game scenario to simulate an equivalent level of motivation in the real work situation. This may be accomplished, in part, through the use of grades being equated with the level of job performance and retention status.

Summary and Conclusions

The low cost of microcomputers and increasing user friendliness of CAD software programs has created a meteoric rise in their use by firms of all sizes. Several small design firms feel they may have to purchase and learn microcomputer CAD programs in order to attract clients to be able to stay competitive in the present design marketplace. Many clients are aware of the accuracy and timesaving advantages offered by computers; they are beginning to hold designers to a state-of-the-art level of professional performance, including the use of technology as represented by computers (McLain-Kark, 1986). This trend argues for an increase, not a decrease in the level of CAD skills taught to design students and professional design practitioners.

Such critical skills demand the utilization of the most relevant materials available in order that learning may occur in the shortest time possible and be of maximum quality. The use of such materials may also help alleviate the resistance and apprehension exhibited by many students and professional designers when first presented with either the opportunity or requirement of learning CAD. Given AutoCAD's 50% to 60% market share and position as industry standard, as well as its position as the most frequently taught CAD program in FIDER accredited interior design programs (Lindsey, 1988), the analysis of material which teaches AutoCAD basics to interior design students and professionals in an applied, relevant manner is essential.

Of the commercially available references on AutoCAD, Inside AutoCAD is the one chosen most often for class use; instructors report, however, that they prefer to use materials they have created and tailored specifically for their own courses and subject area (Lindsey, 1988).

The evaluation of McLain-Kark's Designer's AutoCAD Tutor is critical; this new (and as yet unpublished) reference is structured specifically for interior design applications.

AutoCAD references presently available to the general public or academic community, such as Raker and Rice's frequently used Inside AutoCAD, take a generic approach to learning AutoCAD commands and potential applications. Such a reference is often unable to provide the learner with suggestions on how to maximize the software for their own purposes; this could be due to a host of factors including cost, a lack of space, or lack of knowledge of the specific drafting/design needs of the various disciplines. As such, according to educational psychology and instructional theory, a reference of this nature does not appear to be the most effective vehicle for learning due to its less relevant subject content. Therefore, the outcome of this study will provide additional information to aid interior design-oriented CAD instructors in their evaluation and selection of academic reference materials.

CHAPTER III. METHODOLOGY

Selection of Subjects

Subjects were those students enrolled at Northern Arizona University in Flagstaff, Arizona for the Fall 1990 semester of a beginning Computer Aided Design (CAD) course, IS 230: Fundamentals of Computer Graphics. This course is offered through the department of Industrial Supervision within the School of Art and Design; the degree of Interior Design, under the administrative supervision of the School of Art and Design, is one of several degrees awarded through the College of Creative and Communication Arts. The number of students anticipated in the study was dependent on the final number of sections of the course offered (one) and the number of students willing to be included in this study (fifteen). Prior years' class enrollments have varied between approximately 20 and 60 students; Fall 1990 enrollment was 21 students.

This particular sample was chosen for a variety of reasons, primary among them being the cross-disciplinary mixture of students which typically register for the class. A sample consisting of students from a variety of academic backgrounds increased the population validity of the research study by allowing results to be generalized to a wider group of students. The specific population to which this study generalized is made up of those students in the design sciences of architecture, interior design, and engineering who frequently find the acquisition of CAD skills necessary. This study addressed the subjects' level of success in acquiring CAD skills through the learning of the leading CAD software program, AutoCAD.

Selection and Control of Educational Variables

Educational research is frequently subject to a host of extraneous variables outside of the direct control of the researchers. Utilization of this sample accorded the researcher a much higher degree of control over the manipulation of independent variables than would the use of a different sample. Specifically, using only one class at one university for this sample allowed the researcher to control for the amount of variance in results which could have arisen due to the use of multiple locations and classes. The following independent variables were controlled by the use of a single section of this beginning CAD course:

1. differences between instructors teaching the course
2. time of day the course was taught
3. laboratory conditions
4. degrees of access to computer facilities
5. types of computer hardware used
6. degrees of attitude toward CAD of the instructors and department offering the course
7. grading techniques and degree of "toughness" the instructors utilize when grading

This study did not need to control for the effect of students' prior degree of computer experience since only one student had knowledge with another CAD program. This student was also the only graduate student in the class (see Chapter 4 under description of the study).

Two primary influences affecting learning include the instructor and the textbook/teaching materials utilized. These two influences are responsible for the amount of material taught and the manner in which it is presented. Differences in these two influences need to be held to a minimum for educational researchers to be able to evaluate research results effectively. This is particularly true in situations where new materials are being evaluated for their effectiveness in teaching classroom material.

In a pilot study and field test of materials such as this one, it is essential to control major independent variables as tightly as possible. Slight differences in results of analysis of the dependent variable, degree of learning occurring, based on differences in independent variables, may often be obscured if extraneous variables are not controlled in some fashion. While the independent variables listed above are worthy of study, an exploratory study of this nature must evaluate the effectiveness of the treatment being applied without the influence of extraneous variables affecting the resultant data. For this reason, replication studies are needed in educational research; this research project does not provide an exception to this line of reasoning.

Choice of Instructional Learning Materials

The course utilized two different reference texts. All students used a generically oriented reference text, Using AutoCAD, by James Fuller. This text was chosen for its broad range of subject matter used for the instructional exercises, allowing students from a variety of academic disciplines exposure to different applications of AutoCAD. Additionally, the use of exercises from a different discipline allowed the instructor to evaluate the ability of each student to assimilate the material and apply it to unfamiliar applications. This facilitated the analysis of the amount of information learned by each student by allowing the researchers to determine whether the reason behind a score's value was due to the student's ability to learn AutoCAD or to his or her degree of familiarity with any given assignment's subject content.

Approximately half of this sample, the experimental group, used a supplemental discipline-specific text, Designer's AutoCAD Tutor (DAT), by Joan McLain-Kark, which is directed toward the field of interior design. The control group used Using AutoCAD (UA) as their sole reference, and supplemented this text's guided learning exercises with a multi-disciplinary set of non-guided exercises supplied by the instructor. The experimental group used Designer's AutoCAD Tutor as well as Using AutoCAD for reference and DAT as the source of guided learning exercises, supplemented, as necessary, by researcher provided non-guided discipline-specific CAD exercises. The use of non-guided exercises allowed students the chance for reinforcing skills covered in their reference text(s). All efforts were made to maintain a comparable level of difficulty for both sets of exercises.

The degree of content validity of DAT, although not yet quantified, may reasonably be assumed to be high. The tutorial has been developed and tested during its preliminary stages of development by the author on her CAD students at Virginia Polytechnic Institute. During the past five years, the author has been in contact with editors at Autodesk, Inc., the manufacturer of AutoCAD software. She has periodically received their assessment of the tutorial as it was being developed and incorporated materials into the text in response to these evaluations. The tutorial is expected to be published during the Fall of 1990. The experimental subjects of this study used Xeroxed copies of the final manuscript as their tutorial with the written permission of the author and publishing company (see Appendices). As such, results obtained may not be as true an indicator of the tutorial's effectiveness as an instructional tool due to the use of a final manuscript rather than a "polished", high quality published product.

Procedures Governing the Use of Human Subjects

Permission of the instructor was received to use the class IS 230: Fundamentals of Computer Graphics for research purposes. The instructor reviewed and gave approval of the choice of text materials selected and of the structuring of the course itself. The instructor participated in the planning stages of the research study and was aware of the intended use of the data which was generated. Permission to implement this research was jointly sought and received from the Northern Arizona University (NAU) Institutional Review Board (IRB) which is governed by the Office of Sponsored Research, and from the Michigan State University Committee on Research Involving Human Subjects (UCRIHS).

Research Design

This study used a combination of experimental, correlational and descriptive research designs, though it was primarily experimental in nature and principally utilized surveys as instruments for data collection. Data was collected from the following sources: the instructor's grading record, student pre and post-course surveys, an instructor post-course survey, and both student and instructor project evaluation surveys.

Research Procedures

Student Consent and Confidentiality

Students were given a cover letter the first week of class explaining the nature of this study along with a participation consent form. The consent form and cover letter both indicated the study had been reviewed by the appropriate personnel at both Northern Arizona University and Michigan State University. Students completed the form, indicating their identity only by their student number. The form was collected by university personnel other than the instructor and sent to the researchers for tabulation of the determination of research participants.

All students' identities were kept confidential by having students identify themselves to the researchers on all data collection forms only by the last portion of their university student number. No direct link to any particular student was available to either the researchers or the instructor. The instructor did not know which students had given consent for their data to be used, and the researchers did not have a list of students' names. Only data collected from students indicating a willingness to participate in this study are reported in the research report.

All data of research participants was pre-coded for statistical analysis prior to inclusion in the research report. All students' data was available to the course instructor for academic purposes of improving future sections of this course. Students choosing not to be included in this study did not incur risk, such as a grading penalty, since confidentiality of student participation status records was maintained by the Michigan State University researchers.

Implementation of Research Design

All students, regardless of participation status, were held responsible for completing class assignments associated with whichever group, control or experimental, to which he or she is assigned. All students were assigned to these groups through the use of stratified random sampling. The stratification was based on the students' academic major. Two classification designations were used: "interior design majors" and "non-majors"; all majors other than interior design were be collapsed into the category of "non-majors".

Both groups were given a combined computer/general academic background survey and an AutoCAD skills pre-test exercise to establish each student's baseline level of computer familiarity in general and with AutoCAD software in particular. Each group then completed the same number and general content type of weekly learning exercises up through the tenth week of the semester. The control group used exercises from a broad variety of applications; the experimental group used exercises specifically tailored for interior design/architectural applications. For the remainder of the semester, each student completed the same two assigned projects of three weeks duration each. The projects were completed using a partial counterbalanced sequencing to detect the existence of a potential practice effect.

One project was of a generic nature; the other project was specifically based on an interior design application. No specific knowledge of interior design was necessary beyond the understanding of basic interior design documents and drafting principles. The students was be provided with "target" drawings for both projects; the projects consisted of the creation of these target drawings using AutoCAD commands. The projects were to be assigned by stratification category in both the experimental and control groups, but rather were assigned by group designation.

All interior design majors and experimental group non-majors drafted the design based project as their first project, followed by the more general applications mechanical drawing project. The control group non-majors completed the more general project first and then did the design based project. A comparison was made between the references used for each of the two projects. The use of a counter-balanced design using this sequencing allowed potential increases in scores for a given project to be attributed to the text used rather than to a "practice effect" since the second project for both design majors and control group non-majors represented a less familiar application of the material they had learned.

Thus, researchers were partially able to explore whether a score on the second project equal to or higher than the score obtained on the first project might have been an indication that a greater degree of information transfer has occurred. The potential for the occurrence of a practice effect on scores for the second project was explored through student self-reports of their ease with using the software on the second project in relation to their ease with using the software on the first project. Thus, all other factors being held constant, differences between students in the experimental and control groups of scores on the second project could be partially attributed to a varying degree of transfer of information from the text(s).

The degree of transfer is partially dependent on the ease of assimilation of CAD commands from the texts. Students obtaining higher scores on a project whose content they are less familiar with could reasonably be expected to achieve a greater degree of information transfer, regardless of the level of difficulty experienced in completing the work. It might be anticipated, however, that students reporting a low level of difficulty for the completion of unfamiliar work could be expected to achieve higher scores in general, regardless of a text(s) ability to explain the skills. Analysis and interpretation of data of this nature will help instructors in their future selection of course textbooks and materials.

Description of Instruments

Student Background Profile Survey

Students completed a background information survey addressing their degree of computer experience, attitude toward computers based on prior experiences, academic status, reasons for taking the course, and whether they were working. The survey provided a basis for comparison of change in computer attitude and achievement between the beginning and the end of the course.

Student and Instructor Assignment Evaluations

Although a survey assessing each learning assignment was created by the researcher, this survey was not utilized due to unanticipated time problems. This asked the student to evaluate the text(s) they were using on its (their) ability to present the information being covered on the assignment. The instructor was to complete a similar survey for each assignment indicating what additional resources were utilized and the degree of use of those resources for the preparation of lecture material as well as the ability of the two references under study, Using AutoCAD and Designer's AutoCAD Tutor, to clearly explain that assignment's material.

Student and Instructor Project Evaluations

Both the students and the instructor completed an evaluation form comparing the two applications projects. Students indicated their degree of enjoyment, degree of difficulty experienced, level of appropriateness for demonstrating CAD skills, and the resources used for completion of each project. They were additionally asked how, if at all, they would like to see each project modified, and which specific parts of each project were the easiest and most difficult for them and why.

The instructor was similarly asked about the perceived versus actual experienced difficulty of each project as well as the appropriateness of each in demonstrating an understanding of basic AutoCAD skills. The instructor was then requested to indicate whether either of the projects required modification, and if so, what modifications would be made for future use of the materials.

Student and Instructor Post-Course Surveys

At the end of the semester, both the students and instructor completed a post-course survey. The students' surveys were collected by university personnel other than the instructor to reduce the likelihood of students erroneously perceiving a potential detrimental effect on their grade should they answer the survey in a negative manner. Questions on the student survey evaluated the course in general on: its usefulness, the effectiveness of the texts, assignments and projects used, the difficulty of the course and factors affecting the quality of students' work, and other types of CAD courses students would like to see taught.

The instructor's post-course survey addressed concerns on the content of exercises and projects and whether either the content or the pacing of the course needs modification. The instructor was requested to evaluate each student-used text on its overall ability to function as the sole student text reference for a course of this nature, as well as the quality of the text in general. Additionally, the instructor was asked whether each of the texts would be recommended to other instructors of similar courses, and what other texts would be suggested for student and/or faculty use. Finally, specific to this particular group of students, the instructor was asked to evaluate which students, the interior design majors or non-majors, appeared to have a higher interest level and ease of learning on the two sets of learning exercises and the two projects.

Statistical Analysis Procedures

Analysis of Measures

The nature of the statistical tests to be utilized was non-parametric due to the small number of research subjects. The unit of measure was the individual student's scores (as a percentage value) on a variety of weighted measures. The measures include weekly learning exercises, performance tests, written quizzes, application projects, and a written final examination. Scores obtained on these assignments were analyzed to identify any relationships which might exist between the variables under study. Students' scores were assessed in relation to their computer background (a covariate of the study) to determine what effect, if any, their prior experience may have had on their scores. Analysis was also done on a self-reported student analysis of the text(s) they had been assigned to use and their own assessment of their competency with the software program on each assignment. The instructor filled out a similar text assessment form for each assignment, which additionally addressed specific instructional technique concerns. Finally, an overall assessment of the students, based on their stratification category and designation within the control or experimental group, was made to give readers a tool to judge for themselves the effectiveness of utilizing Designer's AutoCAD Tutor in the classroom as instructional material.

Choice of Statistical Tests

Descriptive and inferential statistical techniques were used for analyzing and reporting the data. The following tests were used for analysis: Chi Square (X^2), the Mann-Whitney U Test, and Effect Size (E.S.) were used to detect degrees of difference between the experimental and control groups, while Contingency Coefficients (C), and Kendall's Concordance (W) were used to evaluate degrees of association between the two groups.

Implications of Analysis

The basic practical question this study addresses is whether the supplemental tutorial, Designer's AutoCAD Tutor, helps students achieve the ability to use the program for their own applications in a more effective manner than do general texts. Effectiveness was measured by the degree of depth of understanding exhibited by the student. It is additionally hoped that 1) this tutorial will help all students, and that 2) it will help design students in particular to gain an appreciation of the power of AutoCAD as a tool they may utilize in their professional careers.

Limitations of the Study

The results obtained from this study may not be a true indicator of the effectiveness as in instructional tool for a variety of reasons. Due to the pilot nature of this study, several independent variables were tightly controlled in order not to obscure statistical significance of the resultant data. Furthermore, information regarding the reliability coefficients and validity of course materials and tests was unavailable. It is necessary to note, however, that statistical significance differs from practical significance. Results which are statistically insignificant may still have great relevance when applied to practical applications. Borg & Gall (1989) state that in educational research, correlation values as low as .2 to .4 may be all that can reasonably be expected, since many uncontrollable factors may influence study results. This points out the necessity for careful deliberation and interpretation of study results before dismissing what may appear to be insignificant values; such values may have practical application value despite their low degree of statistical importance.

Format of Supplemental Text

One extraneous variable not under researcher control was the quality of publication of the tutorial. It was necessary to utilize Xeroxed copies of the author's final manuscript prior to publication, since at the time this study was implemented, the manual was not yet published. As such, the quality of the drawings and typeface used was not optimum and may have depressed the level of significance obtained in comparison with the material used by the control group. This depression of significance may be expected to be minimal due to the use of this reference as a supplemental source of information.

Sample Size

The use of a small sample size limited the generalizability of the results; the sample size also required the use of non-parametric tests rather than their more powerful parametric equivalents. A larger sample size could additionally facilitate a more in-depth analysis of relationships within sub-groups. Future studies should be modified to adapt this study for implementation in a similar university setting which utilizes the quarter system. This will help determine if the tutorial is of help in a more quickly paced course.

Non-Use of the 3-Dimensional Portion of Software

Although this course did give students a limited exposure to the three-dimensional capabilities of AutoCAD, the primary focus of this study was the acquisition of two-dimensional AutoCAD commands. The software also contains three-dimensional drafting capabilities. The supplemental tutorial, Designer's AutoCAD Tutor, addresses this material as well as the material this study focused on. This portion of the tutorial should also be evaluated prior to acceptance of this reference as a text for the acquisition of AutoCAD skills. The acquisition of the complete three-dimensional portion of the AutoCAD program was beyond the scope of subject content of this beginning CAD course. The learning of three-dimensional AutoCAD skills should be the focus of a second course in AutoCAD.

External Conditions Encountered During the Study

During the actual gathering of information from the students in the course, conditions were encountered which had some negative impact on the results of the study. The students were forced during the initial weeks of the study to spend less time on the computer due to hardware problems experienced with the operation of the computers themselves. As a result, some of the later assignments had to be left out of the coursework. The time frame for the two application projects had to be shortened, causing students difficulty in completing them to their satisfaction. Inadvertent misinterpretation of instructions regarding counterbalancing of projects resulted in the sequencing of the final projects being partially compromised. Weekly student feedback regarding the specific abilities of the reference texts used did not occur. None of these complications was deemed critical due to the exploratory nature of this study, whose primary purpose is to provide preliminary baseline data on which to build future research of a similar nature.

CHAPTER IV. RESULTS AND ANALYSIS OF FINDINGS

General Description of the Study

Subjects of the study (N = 15) included a total of 71% (15/21) of the students enrolled in IS 230: Fundamentals of Computer Graphics. Six out of twenty-one students chose not to participate in the study or withdrew from the class during the course of the semester. Data collected from student and instructor surveys comprise the qualitative portion of this study. The dependent variable, students' level of CAD skill achievement, was measured through the instructor's grade record and comprises the quantitative portion of this study. The sampling frame used stratified random sampling; stratification was by academic major. Students were randomly assigned into experimental (n = 7) and control (n = 8) groups. The independent variable, instructional materials utilized, consisted of a generically oriented text used by both groups. The control group completed exercises of a general nature while the experimental group used an additional discipline-specific text and exercises appropriate to an architectural/ interior design major.

Qualitative information was gathered by pre-course and post-course surveys. Pre-course survey results provided baseline measures on students' general academic abilities, attitude towards computers, and the nature of other computer experiences. Post-course survey results assessed both student and instructor opinions regarding CAD's effectiveness, the effectiveness of the instructional materials used, and student wishes for specific types of future CAD course offerings. The results reported represent a student response rate of 60% (9/15) on the project assessment survey, while the post-course survey represents a 100% response rate. The instructor's views were conveyed by these two surveys and through post-study telephone discussions.

All assumptions of the study (see pp. 8-9) were found to be met with the partial exception of assumption number one. One student was found to be a graduate student pursuing a Master of Arts degree with a minor in computer studies. It was discovered that the intention of this student was to teach interior design in general, and computer-aided design specifically, in a university environment. This student also reported having a 3.5 - 4.0 cumulative grade point average.

Rationale for Measures used in Statistical Analysis

Results are reported principally through descriptive statistics, with inferential values used to indicate the degree of difference found between the experimental and control groups on student background characteristics. Non-parametric inferential statistics were utilized due to the exploratory nature of the study and past history of the course selected for analysis. Specific study conditions included: 1) an experimental research design, 2) a small sample size (N = 15), 3) a highly skewed (negatively) grade distribution, 4) first time usage of the AutoCAD software program, and 5) field testing of an unpublished text, currently in press.

Generalizations pertaining to research questions are based on the use of Yate's corrected values of Chi Square (X^2), and Mann-Whitney

U tests for the significance of differences. The Contingency Coefficient (C), a non-parametric value based on Chi Square and parallel to Pearson's r value was used to assess correlation (Sprinthall, 1990), as was Kendall's Coefficient of Concordance (W), (Siegal, 1956). Effect size (E.S.), a measure of magnitude of differences between groups (Fraenkel & Wallen, 1990) was used to assess the magnitude of differences between groups. This value does not give a measure of statistical significance, rather a practical one. Levels of student achievement were evaluated for their practical significance in relation to students' individual characteristics and beginning competencies, as well as in an absolute fashion for statistical significance. An overview of course results by group composition is shown in Table 5 and is graphically portrayed in Figures 6 through 9 (see pp. 94-97).

Course Description and External Limiting Factors

Students were assessed periodically throughout the semester. Each student took a CAD skills pre-test the first day of class, and a parallel form of the test was administered as a post-test at the end of the course. These measures did not count toward their final semester grade, but allowed researchers a baseline measure of student skills. The course was divided into two phases: 1) learning phase: weeks 1 through 10, and 2) application phase: weeks 11 through 15. The learning phase entailed a series of ten drawing assignments, interspersed with two written quizzes and three in-class performance drawing tests. The second phase consisted of two in depth application projects and a written final examination. The interior design (ID) based project involved the replication of drawings required for a revision to a portion of a residential dwelling. The other project,

Table 5

Mean Composite Achievement (in percent) within groups by Academic Major

Phase/Measure	Experimental Group $\bar{X}$[a]	SD	SD^2	Control Group $\bar{X}$	SD	SD^2
LEARNING PHASE MEASURES						
1. Weekly Drawings						
ID Majors	96.10	3.47	12.05	91.94	2.68	7.18
Non-Majors	92.91	6.82	46.56	91.16	6.84	46.75
2. Written Quizzes						
ID Majors	79.73	19.49	379.89	70.27	2.34	5.47
Non-Majors	70.95	11.50	132.14	68.92	8.17	66.68
3. Performance Tests						
ID Majors	86.22	7.34	53.88	75.33	4.66	21.75
Non-Majors	82.16	7.35	54.05	81.73	3.61	13.01
LEARNING PHASE COMPOSITE SCORES						
ID Majors	89.51	7.37	54.32	81.97	3.27	10.70
Non-Majors	84.66	6.53	42.70	83.57	4.68	21.95
APPLICATION PHASE MEASURES						
1. Interiors Project						
ID Majors	86.66	9.87	97.33	84.33	5.13	26.33
Non-Majors	89.75	5.06	25.58	85.80	5.54	30.70
2. Mechanical Project						
ID Majors	88.00	3.61	13.00	78.66	8.08	65.33
Non-Majors	87.25	5.20	27.00	90.80	4.60	21.20
3. Written Final Exam						
ID Majors	81.33	11.93	142.33	78.66	3.21	10.33
Non-Majors	81.50	4.04	16.33	82.80	6.38	40.70
APPLICATION PHASE COMPOSITE SCORES						
ID Majors	85.99	7.28	52.96	80.86	1.58	2.49
Non-Majors	84.31	3.92	15.37	87.07	4.47	20.01
FINAL GRADE WEIGHTED SCORES						
ID Majors	87.60	7.24	52.39	81.38	0.60	0.36
Non-Majors	86.01	3.35	11.23	85.47	4.30	18.45

Note. N = 15; experimental group n = 7; control group n = 8.

[a]Statistical notation: $\bar{X}$ = mean; SD = standard deviation; SD^2 = variance.

based on content required for construction management (CM), required reproduction of mechanical drawings involved in the design of machine parts. Each project was weighted equally. The course culminated with the written final examination.

Composition of a student's final course grade (see Figure 2) consisted of the following components: weekly assignments (20%), two written quizzes (8.5%), three in-class performance skill tests (15%), two extended length projects (20% each), and a written final examination (11.5%). An additional 5% of the grade was attributed to attendance and effort; this portion was factored out of the study's results in order to obtain a "pure" objective assessment of the level of computer drafting skill achievement. This left the relative percentages of each measure within the two phases and on the final course grade as shown in Figure 3. Composite raw scores for each component of the final grade were computed, changed to a percentage score, and then multiplied by the weight allocated to each component. These values were then summed, arriving at each student's weighted final course grade.

With the exception of weekly learning assignments, all students completed the same coursework. The order of the completion of the two extended length projects was reversed for half of the students. The interior design students were asked to complete the interiors project first while the other students were asked to complete the mechanical crane project first.

Even though it was the intent to have only the interior design students, regardless of their group classification, complete the interiors project first, it was completed by the entire experimental

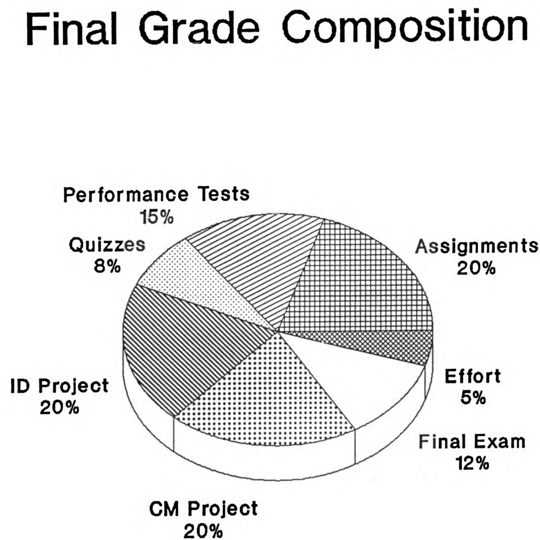


Figure 2. Composition of Course Final Grade

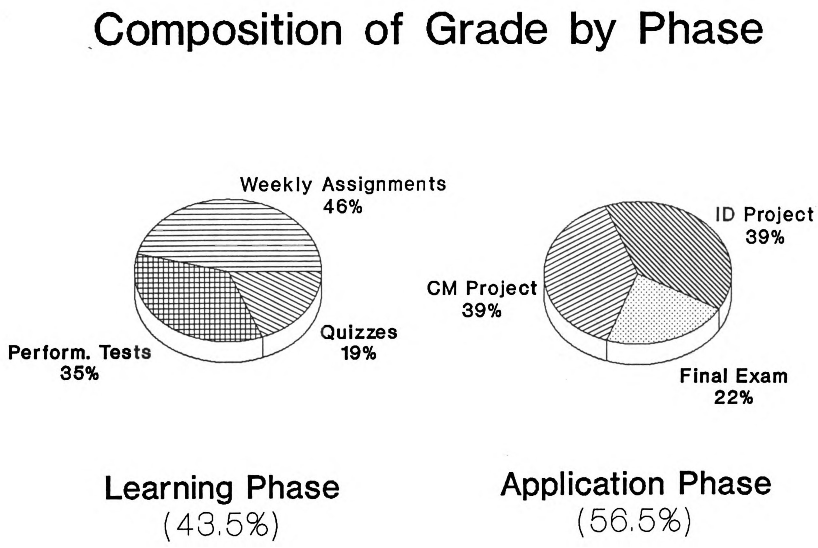


Figure 3. Composition of Course Grade by Phase

group as well as the interior design students in the control group. Furthermore, the construction management project required the structural design of the mechanical items drawn, rather than the simple reproduction of pre-existing drawings. This provided an additional content burden for the interior design students. The fact that the form which measured time spent in the computer lab was not used necessitated a slight reduction in the level of specificity when reporting results pertaining to the relationship between student CAD skill achievement and the effort required by the course. This relationship has been reported by analysis of ordinal versus interval data; post-course survey questions were used which asked students to indicate whether the amount of effort required by this particular course represented their normal amount, a greater than normal amount, or less than their normal amount.

Effect of Potential Covariates

The study anticipated the potential influence of the covariates of prior computer experience and academic success as evidenced by student Grade Point Average (GPA). Since students were not matched on these factors, it was necessary to evaluate the degree of difference in these factors between control and experimental groups in order to have a practical base against which to evaluate the students' final CAD achievement level.

Student Computer Experience Characteristics

Students were asked through a background survey about their general level of computer experience and whether they had ever formally taken any other CAD courses. Prior to Fall 1990, the CAD software taught in this course was VersaCad. It was found that only the graduate student (randomly assigned to the experimental group) had previously taken this course, although one student did report familiarity with another CAD program, Fastdraft. Many students (66%) reported being introduced to VersaCad during a course in the fundamentals of drafting (the CAD course's prerequisite). Exposure included explicit instructions for producing one drafting assignment using VersaCad. As such, this experience cannot be counted as significant CAD experience since students were not required to understand how to use the program but merely to follow directions. Therefore, the expected principal covariate of the study, CAD computer experience, was negligible and did not obscure the data or interfere with statistical analysis of the results.

General computer experiences included courses in or self teaching of application programs on word processing, spreadsheets, desktop publishing, and computer programming. The actual breakdown of the percentage of primary courses/experiences with the various types of computer programs can be seen in Figure 4. Analysis shows the total number of courses (n = 19) taken is the same for both the experimental group and control groups, but with differing content distributions between groups.

The experimental subjects share an equal division between the percentage of word processing and spreadsheet courses taken, as compared to a ratio of nearly 3 to 1 for the same type of courses taken by control group subjects. Both groups reported the use (albeit limited) of CAD, although the number of courses taken in this area reported

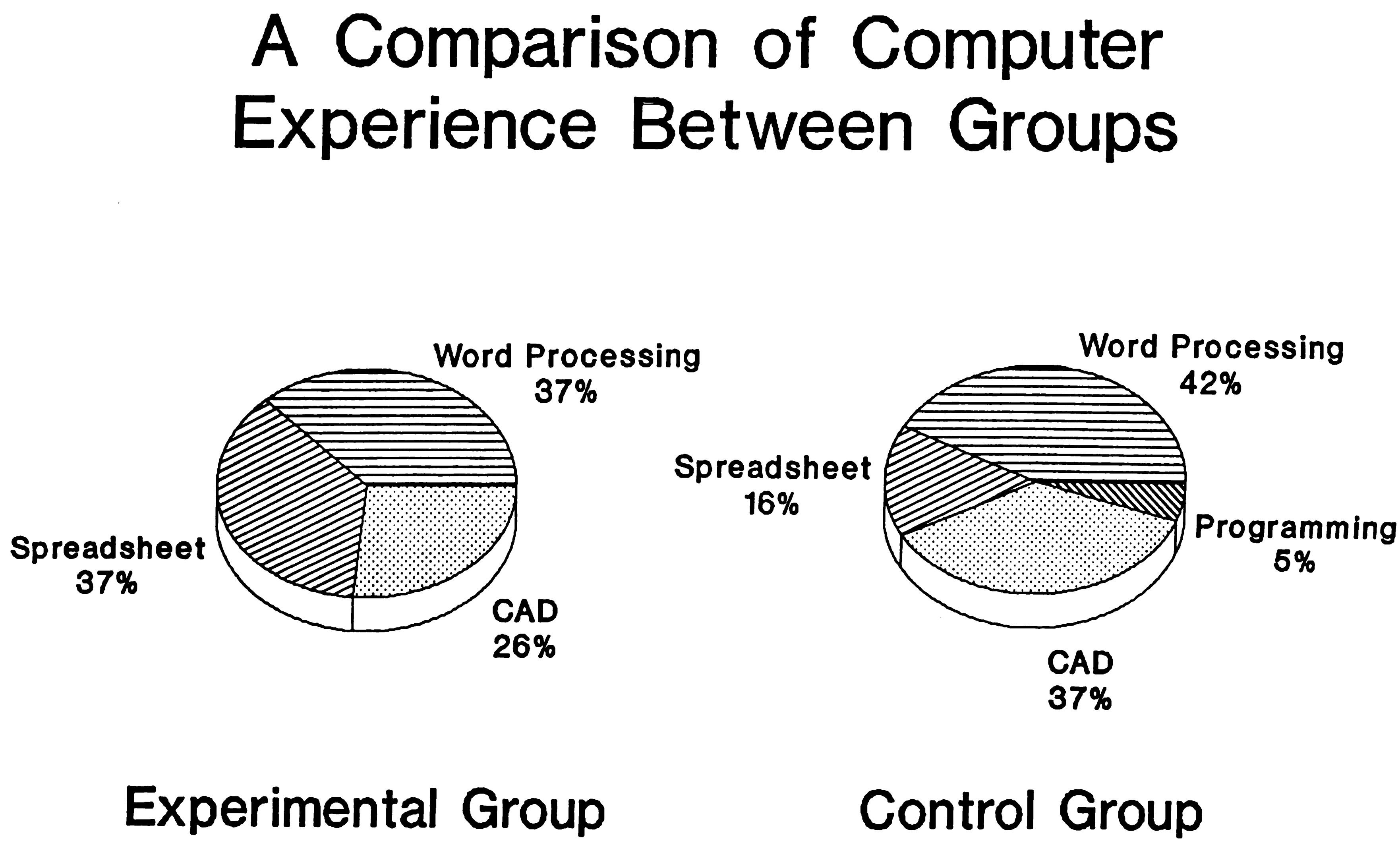


Figure 4. Group Composition by Type of Prior Computer Experience

by control group subjects was approximately one-third of that reported by students in the experimental group. Other minor differences between groups include one student in the control group who reported taking a computer programming class, and one student in the experimental group who indicated being self-taught in a desktop publishing program.

Student Academic Characteristics

Students were requested to report which grade point average (GPA) category they were classified in based on their academic GPA within their major. Categories were listed as: 1) Not yet determined (first term in college), 2) less than 2.0, 3) 2.0-2.49, 4) 2.5-2.99, 5) 3.0-3.49, and 6) 3.5-4.0. It was believed that a GPA based on classes comprising a student's academic major would represent a more accurate indicator of their level of motivation since the academic content represented is deemed as being more relevant to a student's future professional aspirations.

Group composition by GPA and major, shown in Figure 5, revealed the control group (n = 8) to have an overall slightly higher average GPA than the experimental group (n = 7). Within the control group, interior design majors (n = 3) appeared to have slightly higher GPA's as compared to the other students (n = 5). Other control group subjects consisted of one media arts student and four industrial supervision students. The GPA of control group students included three GPA's classified as 2.5-2.99, three as 3.0-3.49, and two as 3.5-4.0, with a group average of 2.94. The experimental group consisted of three interior design students (including the graduate student) and four industrial supervision students. Again, the interior design students

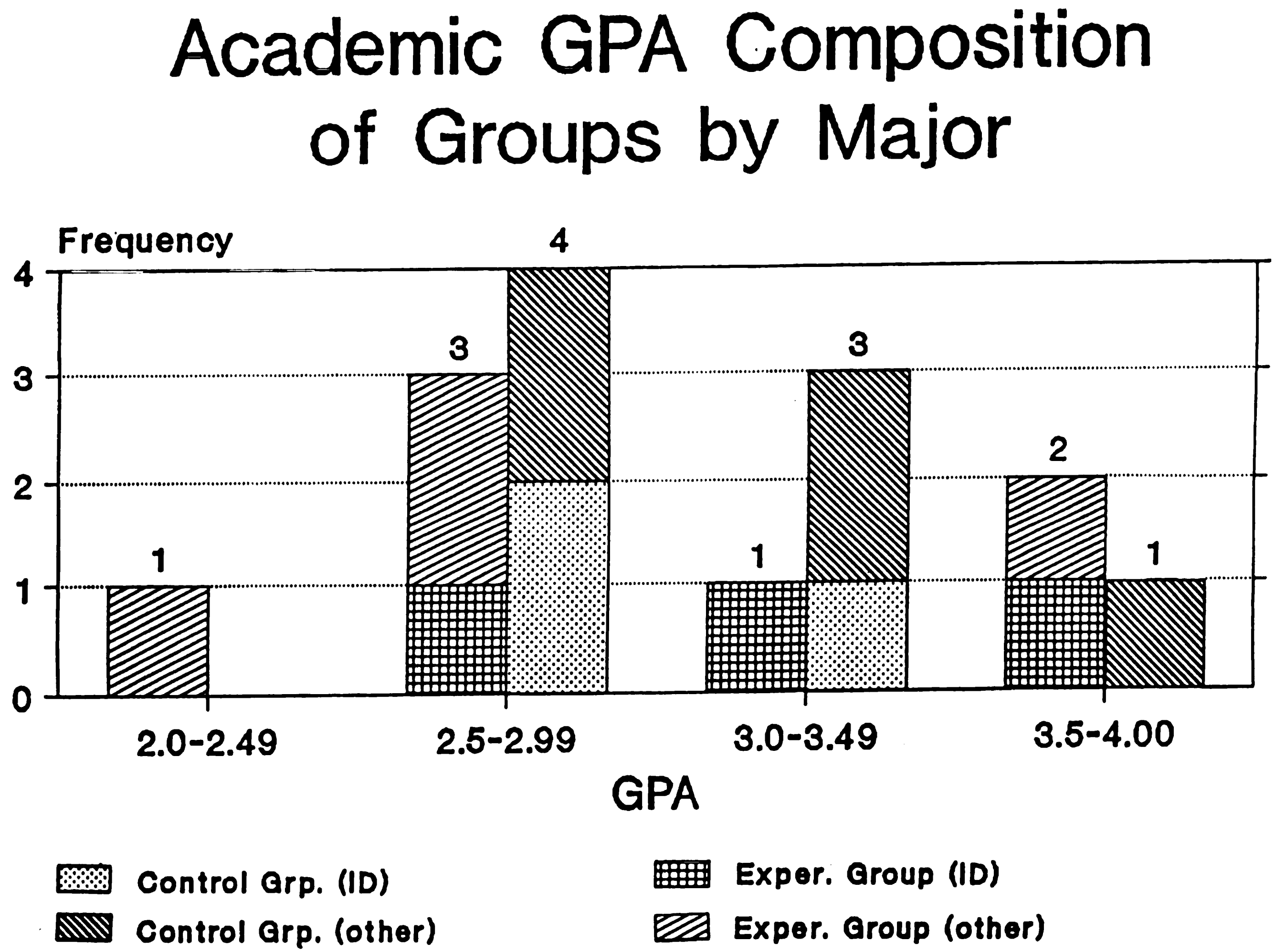


Figure 5. Group Composition within GPA Categories by Academic Major

held a slightly higher GPA average than the industrial supervision students. The GPA composition of this group included one student in the 2.0-2.49 range, three who were classified as 2.5-2.99, and two as 3.5-4.0. The average GPA for the experimental group subjects was 2.79.

Analysis showed no significant differences between distribution of experimental and control group subjects' GPA's ($X^2 = .98$ with 3 degrees of freedom, $.80 < p < .90$; Contingency Coefficient (C) value of .29) or the amount of effort either group of students indicated the course required ($X^2 = .10$ with 1 degree of freedom (d.f.), $.70 < p < .80$; $C = .08$). Neither did analysis reveal significance when comparing the groups' distribution of GPA levels against the amount of effort required by the course ($X^2 = 2.61$; d.f. = 3; $.30 < p < .50$) although a moderate level of correlation is shown by the related Contingency Coefficient of .44. Thus, differences in final grade outcome may reasonably be attributed to the type of instructional materials used, everything else being held constant.

Analysis between an individual subject's GPA and final grade rank order in the course, however, revealed a strong relationship ($X^2 = 8.36$; d.f. = 3; $0.025 < p < 0.05$; $C = .60$). It must be remembered that the Coefficient of Contingency is a less powerful indicator of association than Pearson's r, reaching a maximum value of .87 as compared to 1.0 (Sprinthall, 1990). This appears to indicate that student GPA is an effective predictor of achievement and may be masking the true degree of effectiveness of the experimental group treatment reported in the results of this study, despite the similarity of the GPA distributions between groups. The final ranking of students of both groups and major classification by their self-reported GPA category is shown in Figure 10 (see p. 100).

Analysis of Student Background Surveys

Reasons for Taking the Course

Discrepancies discovered during survey analysis required further investigation for clarification regarding the status of this particular course as a requirement within a given academic major. Faculty reported that this particular course is not required in either the academic majors of interior design or industrial supervision, and that the course represents either a departmental elective or a university general studies elective course. Interior design and construction management students typically account for the majority of students enrolled.

The top three responses reported by students on the pre-course background survey to the question of why the course was chosen were 1) students felt the course would help them in their professional careers, 2) a faculty member or their academic advisor had recommended it, and 3) it fills in a content area deficiency in their major or minor studies. Other reasons included the recommendations of friends who had taken it, the student had enjoyed other courses taught by the same instructor, substitution of this course for a discontinued course, and the use of the course in a Master's degree program area of emphasis by a graduate student intending to teach interior design.

Attitude towards CAD

Analysis of subjects' attitudes toward CAD based on prior knowledge of or experiences with CAD show strong support for the usefulness and applicability of CAD in professional situations, and indicates an overall positive attitude toward CAD in general. These attitudes did not appear to change due to experiences encountered during this course.

Study Results within the Context of the Research Questions

1. **When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:**

   A) learn more effectively as measured by the students' scores on individual assignments, quizzes, tests and projects as well as the composite grades obtained for the course?

The Mann-Whitney test for significance between groups was used to analyze the significance of the effectiveness of the experimental group materials in relation to those used by the control group. According to Siegal (1956), the null hypothesis (H_0) may be rejected indicating significance has been attained if the probability (p) associated with a U value less than or equal to the observed U value is less than or equal to the designated alpha level. Conceptually, rejecting the null hypothesis of no difference is interpreted as the percentage of time the null hypothesis has erroneously been rejected (a type I error) for any given U value (Siegal, 1956; Williams, 1986). Siegal states the Mann-Whitney test is one of the most powerful of those applicable for non-parametric studies, as its power efficiency approaches 95% of that of Student's _t_ test even for moderately sized samples.

Significance at the 0.10 alpha level was not found using a one-tailed test on any of the measures. Probabilities found on the composite measures are as follows: weekly assignments: $U = 19$, $p = .168$; written quizzes: $U = 25.5$, $p = .411$; performance test scores $U = 24$, $p = .140$; interior design project: $U = 20.5$, $p = .215$;

construction management project: $U = 27.5$, $p = .50$; final exam: $U = 25.5$, $p = .411$; and final grade: $U = 21$, $p = .232$. Values on the composite scores of each of the learning and application phases allows the null hypothesis of no difference to be rejected only for the learning phase. Values for these phases are: learning phase: $U = 16$, $p = .095$; application phase: $U = 25$, $p = .389$. All probability values reported for fractional U values were interpolated mathematically. Analyzing Table 5 (see p. 81) and Figures 6 through 9 allows these statistical values to be understood conceptually.

Effect size (E.S.) is a measure which is used to evaluate the magnitude of difference in standard deviations of the comparison group between the means of two groups (Fraenkel & Wallen, 1990). The presence or absence of statistical significance is irrelevant; the value obtained indicates how far away the two groups are from each other in comparison to the standard deviation of the comparison group. Although some educators (Mehrens & Lehmann, 1984) believe the interpretation of difference scores to be of questionable importance unless the difference between groups is greater than one standard deviation, Fraenkel and Wallen (1990) state that an E.S. greater than or equal to .5 is considered to be important. Effect size for the groups in this study was computed by taking the difference between the mean composite scores (in percent) of the experimental and control groups, and dividing by the standard deviation of the control group.

Using the scores reported in Table 5 (see p. 81) yields E.S. values for interior design majors ranging from 0.45 to 4.04 on the measures with an E.S. of 10.37 associated with the final grade weighted score. This indicates that the difference created through the use of the

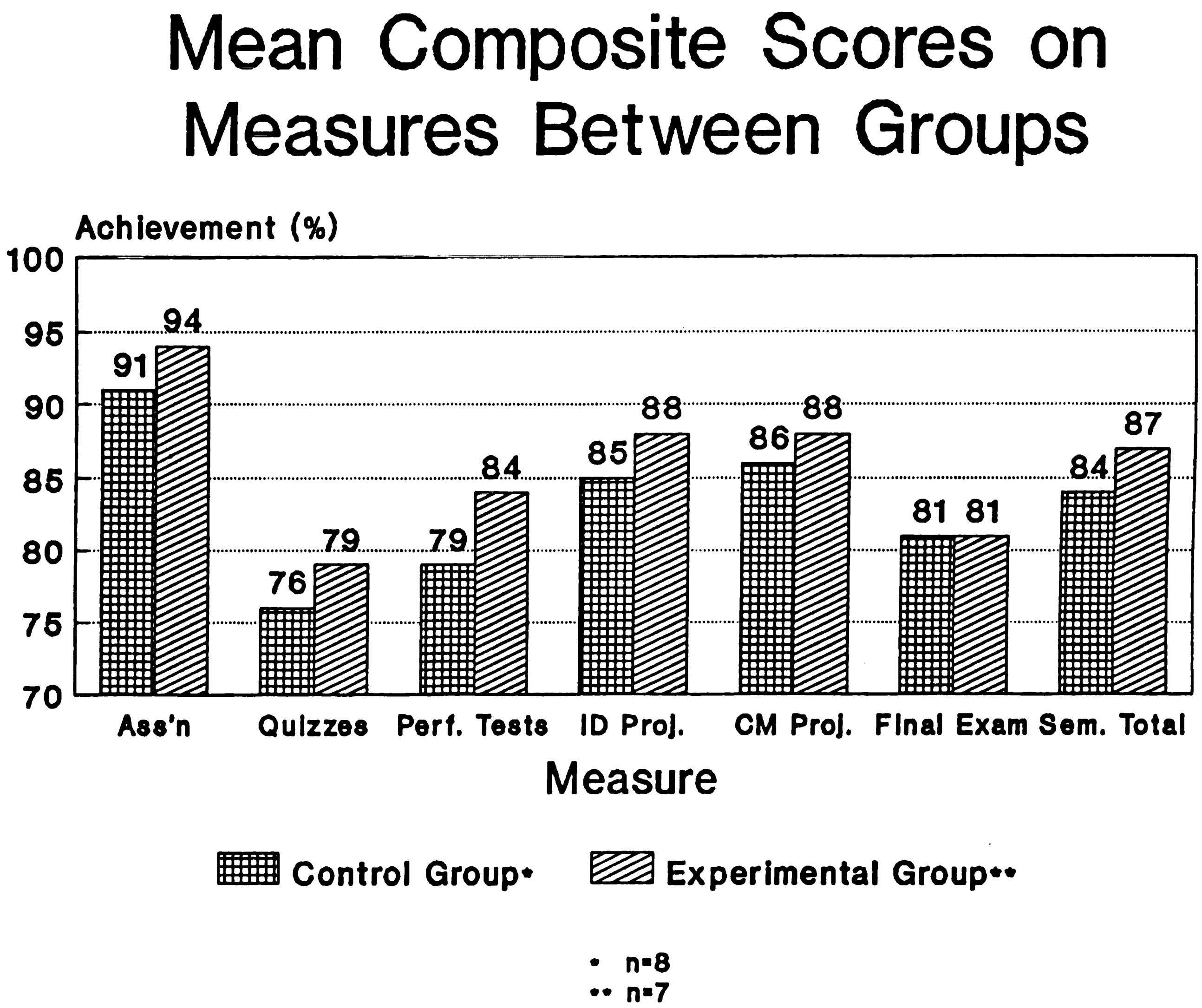


Figure 6. Mean Composite Scores on Measures between Groups

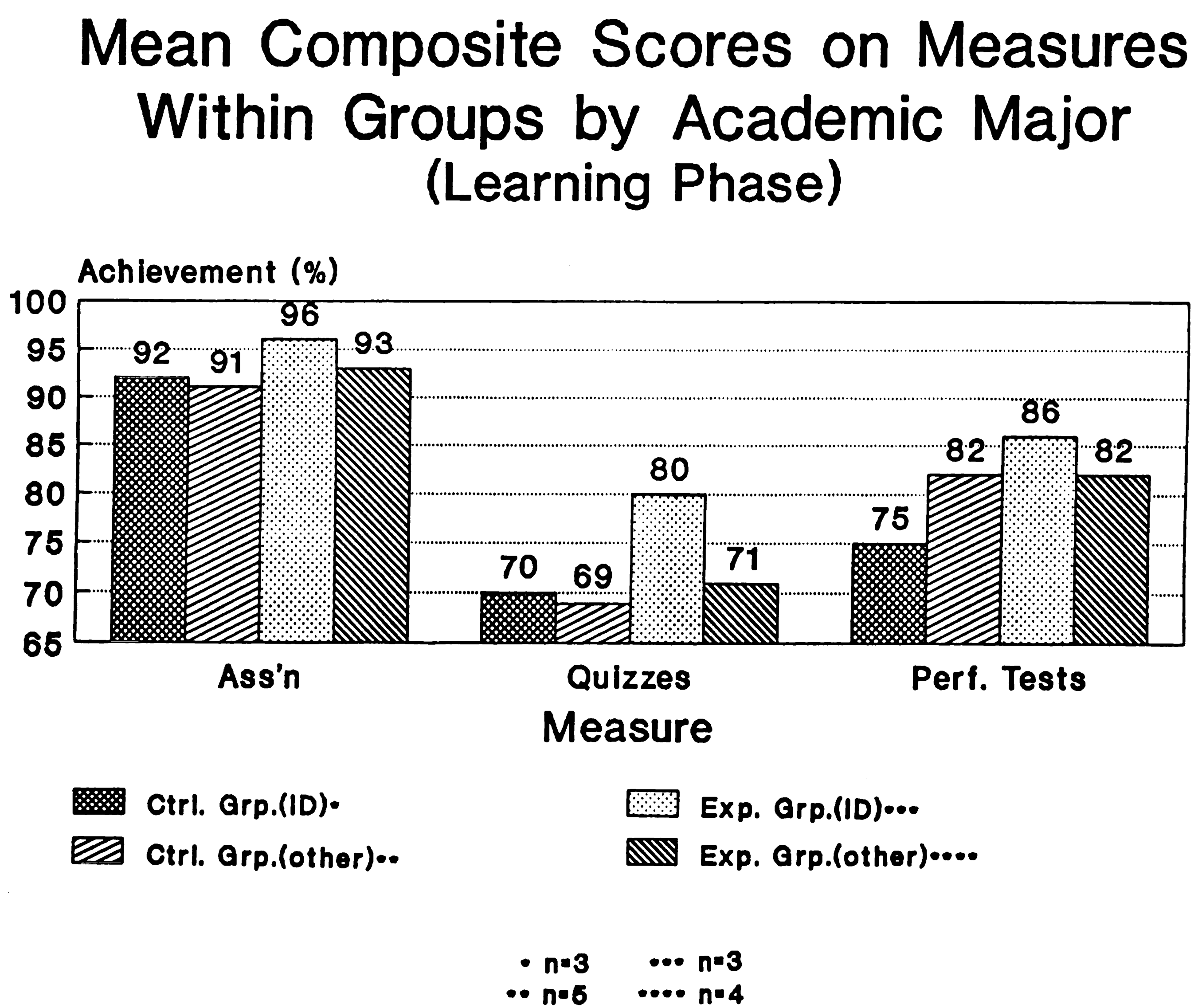


Figure 7. Mean Composite Scores on Learning Phase Measures within Group by Major

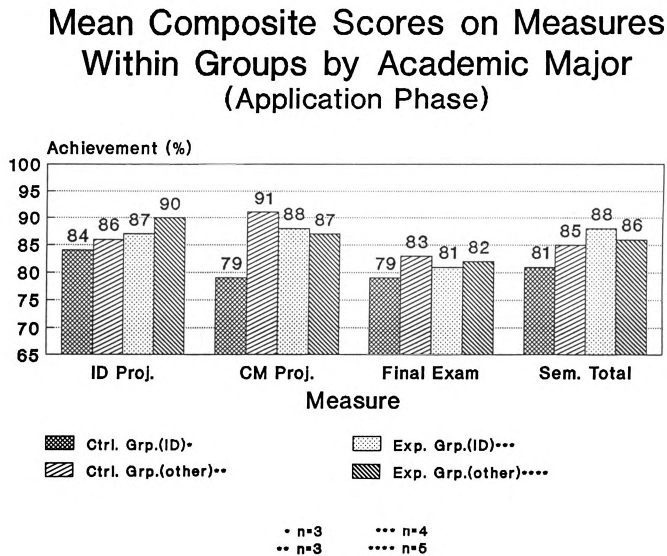


Figure 8. Mean Composite Scores on Application Phase Measures within Group by Major

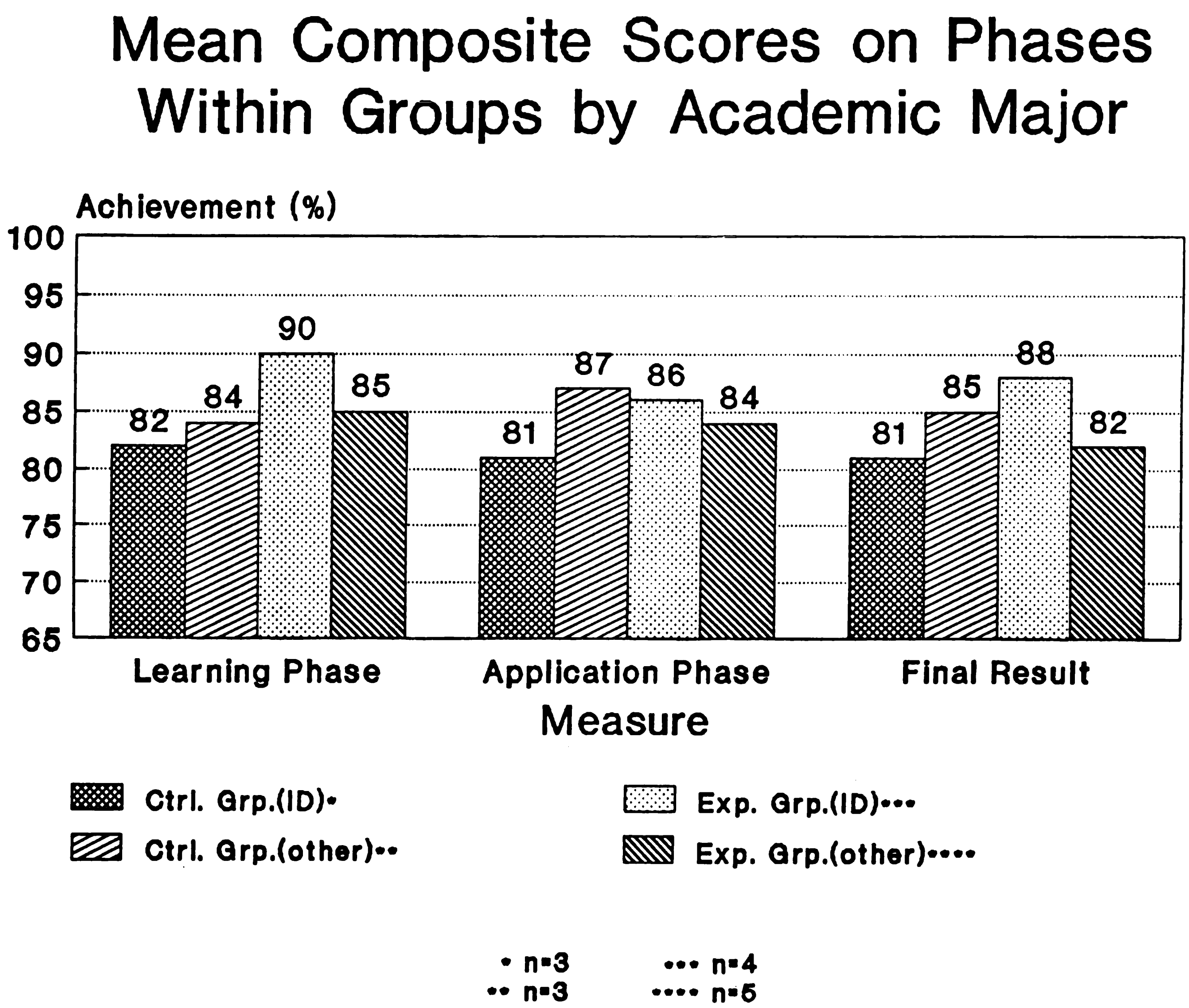


Figure 9. Comparison of Learning and Application Phase Scores

experimental discipline-specific materials is important in achieving better performance. Values for the non-majors did not show important differences, and on three measures (mechanical project, written final exam, and composite application phase) indicated by a negative value that the use of such materials may be detrimental. Values for non-majors ranged from -0.77 to 0.71.

Although determining E.S. values for each major within groups provided different conclusions as to whether discipline-specific materials are beneficial, the conclusion was made that such materials do produce important differences. This conclusion is based on E.S. values obtained for each group without taking into account the academic major of subjects within the groups. E.S. values ranged from .157 to 3.33. The 3.33 value was found on the weighted final grade measure.

On each of the measures, the experimental group is seen to achieve higher scores than the control group with the exception of an identical score on the final exam (see Table 5, p. 81, and Figures 6-9). Differences between Mann-Whitney values and the group averages shown in the figures on the performance test arise since Mann-Whitney values are affected by the rank and position of the scores within the entire sample rather than by their numerical values. The group averages reported are not dependent on the ranking of the individual scores within the entire sample.

The greatest difference (5%) between groups is seen on the performance test scores, with a control group average of 79% as opposed to the experimental group's 84% average. The least difference (2%) is seen on the construction management project with the control group averaging being 86% and an experimental group average of 88%. The differential in scores on the performance tests is of further interest since the percentages reported span the value (80%) associated with the border between a "B" and a "C" letter grade. In situations where a measure of this nature is heavily weighted, the use of materials which could provide better scores becomes critical.

Analyzing Figures 7 and 8 reveals the most marked differences between interior design (ID) majors and non-majors (other) within each group. These differences are seen on the composite quiz scores during the learning phase and in the construction management project during the application phase. On quiz scores, the experimental group interior design majors achieved a score nine percent higher (80%) than experimental group non-majors (71%). Score differences within the control group students on the construction management project are even greater; ID majors were found to score 11% lower (79%) than non-majors (91%). This was explained by student and instructor comments on the post-course survey which stated the construction management project had more difficult content then the interior design project, and proved to be too difficult for the majority of the interior design students in the class.

The final grade achievement level and rank of each student is shown in Figure 10. This figure clearly shows the experimental group students did better overall than control group students. It should be noted, however, that all students except for the one who ranked fifteenth achieved a final achievement level of greater than 80 percent. Students were assigned course grades of "A", "B", "C", or "D" based on the attainment of 90%, 80%, 70%, and 60% achievement levels, respectively. This final grade ranking is even more persuasive in arguing for the use of discipline-specific materials if a comparison

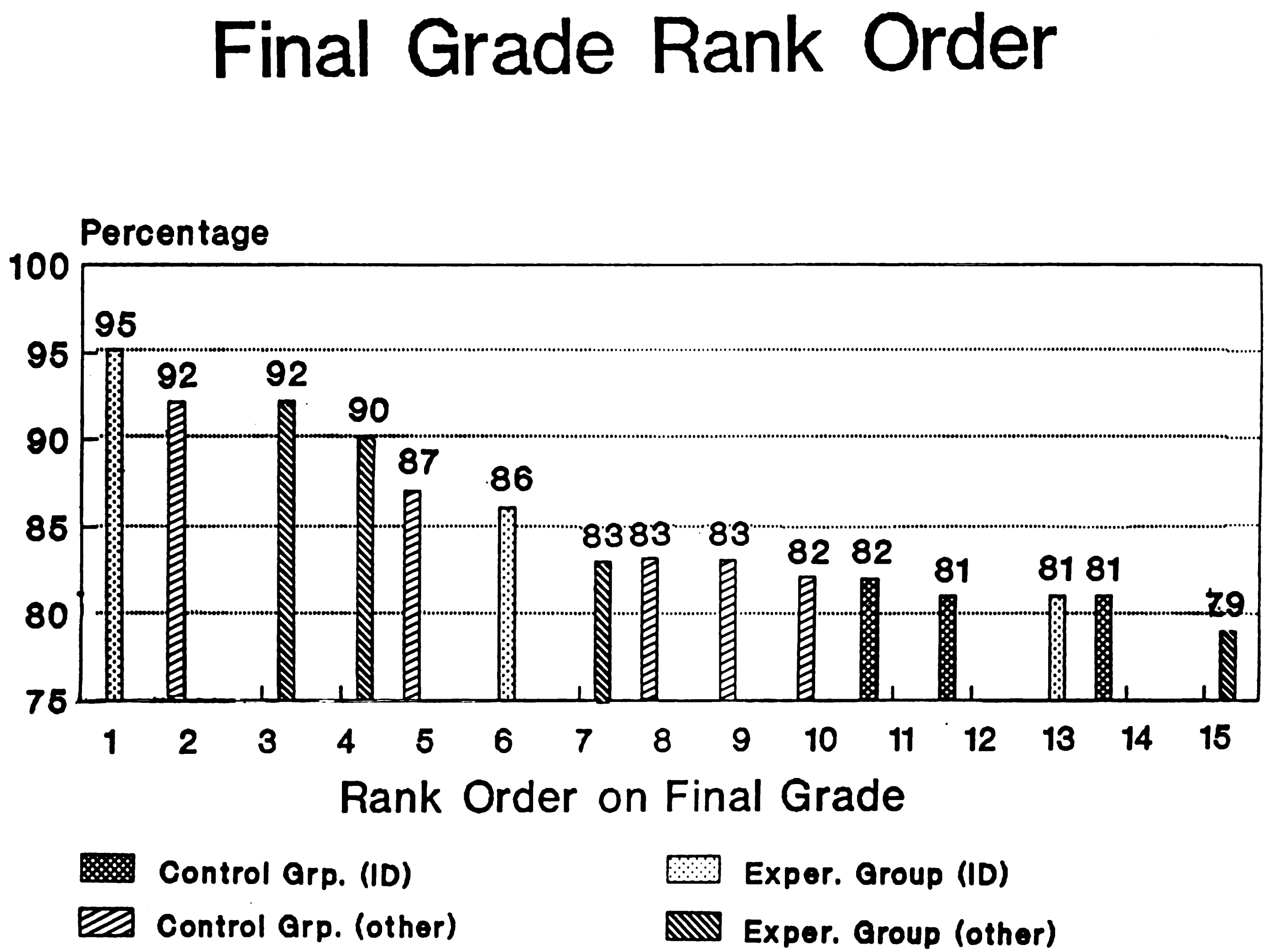


Figure 10. Rank Order on Weighted Final Grade by Group and Major

of the students' final grade rank order is compared to their self-reported GPA category as shown in Figure 11. Viewing these two figures shows that experimental group students generally have a lower average GPA, yet 71% (5/7) were able to rank in the top half of the sample as compared to only 25% (2/8) of the control group students.

Evaluating student achievement using criterion referenced versus norm referenced methods indicate that ID majors assigned to the control group did the poorest, with a group average of 81.38% (see Table 5, p. 81). The best students, the experimental group ID majors, attained a final grade mean percentage of 87.6%. The experimental group non-majors closely followed the experimental ID majors by achieving a composite final average of 86.01%; control group non-majors obtained a mean composite score of 85.47%. It is evident the use of the experimental group discipline-specific materials provided at least as an effective, and possibly better means of learning than did the control group's use of generic materials.

These conclusions are further validated by computing Kendall's Concordance (W), a value which determines significance based on the degree of consistency observed among several sets of measures (Siegal, 1956). Achievement on all composite measures was rank ordered by group classification and stratification. Computation of W yielded a value of .7166, which was found to be significant at the 0.01 alpha level. This value indicates that the degree of consistency of achievement exhibited by each group was high. By using W in a formula analogous to the one used to determine the Spearman-Brown correlation coefficient, it is possible to determine the average correlation coefficient over all possible pairs of rankings (Siegal, 1956). This value was computed

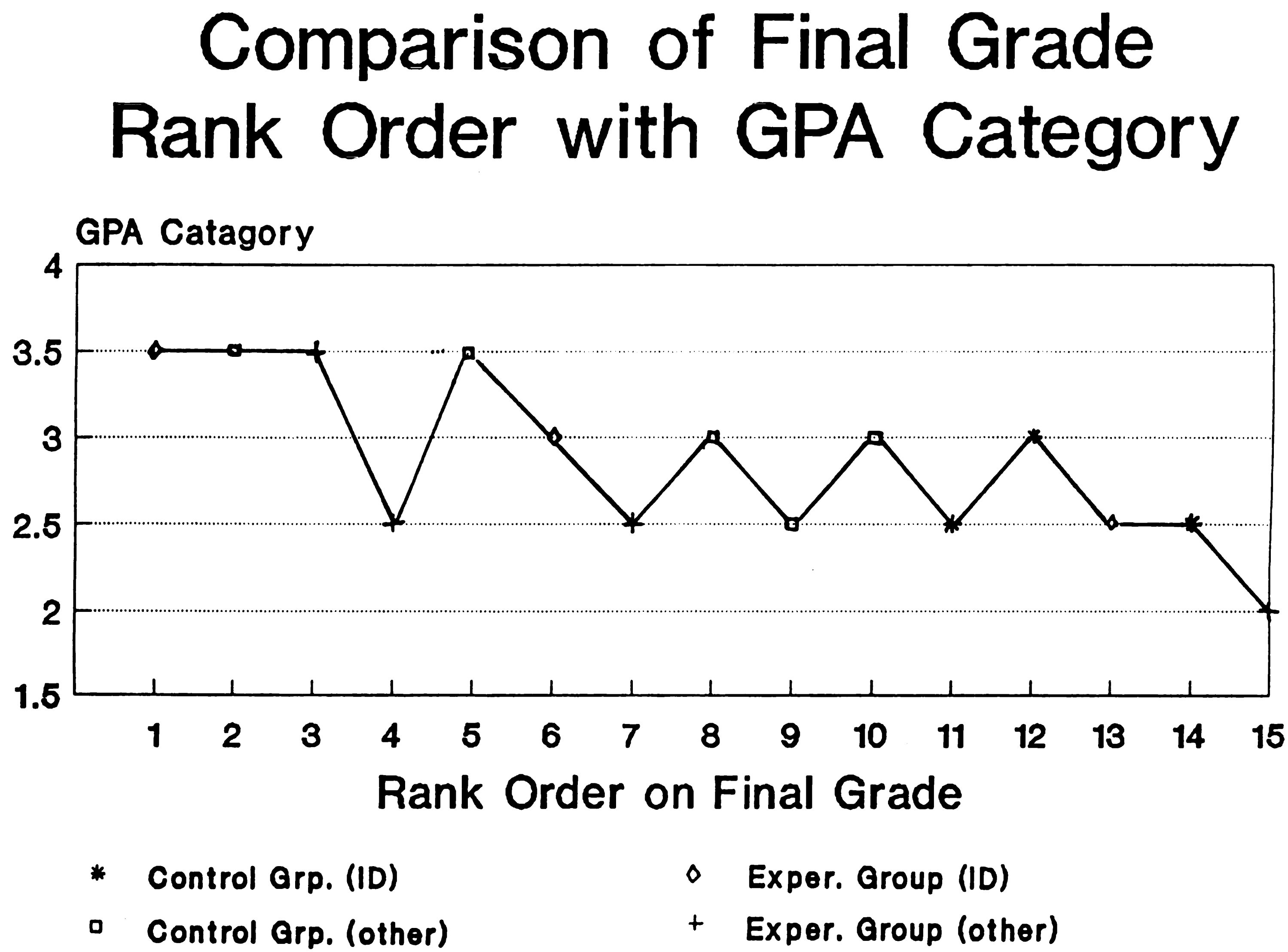


Figure 11. Comparison of Final Grade Rank Order with GPA

and found to be .66; this indicates a high degree of correlation between achievement and the materials used by each group of students. It indicates that the Concordance value obtained is not only reliable, but valid as well.

1. When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:

B) learn more quickly as measured by comparing weekly scores to assess whether better scores are obtained at an earlier point in the term?

The rate at which experimental versus control group students learned did not appear to vary to any great degree with the exception of scores at the beginning of the semester (see Figure 12). Scores on the first quiz showed an experimental group mean of 73% compared to the control group mean of 62%. Scores remained this far apart (11%) on the computer performance skills test number two, with the experimental group attaining an average of 81% as compared to that of 69% for the control group. After that point in time, difference in group averages ranged from one to five percent, with both groups achieving the same score (81%) on the course's written final exam.

The low scores of both groups on quiz one was attributed by the instructor to a poorly written quiz. Nevertheless, the scores show the higher achievement by experimental group students. The better experimental group scores (81%) on test two are a more valid indicator of the effectiveness of the experimental materials; the performance tests were drawing skill tests as opposed to the comprehension of concepts evaluated by the written quizzes. The degree of consistency in scores was higher during the application (project) phase of the

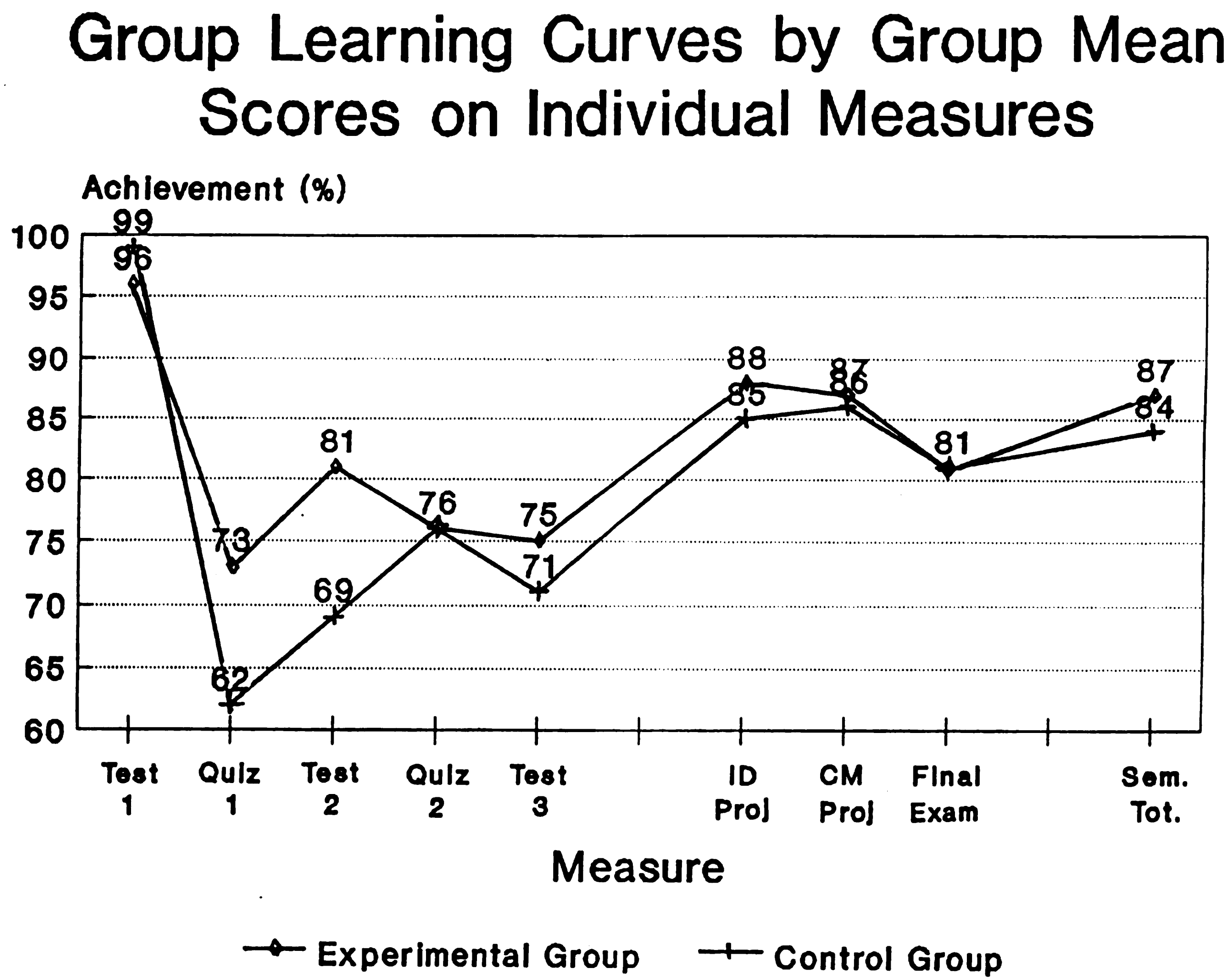


Figure 12. Comparison of Group Achievement on Common Measures

course than during the learning phase, and more closely paralleled the final grade scores.

1. **When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:**

   C) indicate a preference for discipline-specific texts or learning exercises as measured by:

      1) the percentage of students who choose to use the discipline-specific supplemental text in addition to the one assigned;

      2) the percentage of students which indicate on the post-course survey the desire for the utilization of such materials?

Students assigned to use control group references generally did not choose to use the experimental group materials available in the lab. Two of the eight students did evaluate the experimental group materials on the post course survey; one student who did not rate the experimental materials expressed extreme dissatisfaction with the control group text. Students in both groups (86.7%) overwhelmingly expressed the desire to use materials (both text and exercises) taken from their own academic disciplines. The remaining 13.3% indicated no preference for the type of materials used.

2. **What effect, if any, does a student's computer background appear to have on his/her ability and desire to learn AutoCAD as measured by:**

      1) the amount of time spent in the lab versus the scores obtained on assignments;

      2) by students' responses on both the pre- and post-course surveys?

It has been mentioned in the section on covariates of the study that students generally did not exhibit significant differences in the amount of CAD experience they had. Analysis of student post-course surveys showed that the use of discipline-specific materials resulted in 57% of the experimental group responding that the course required more than their usual amount of effort, as opposed to 62.5% of the control group indicating the same response. None of the students in either group indicated the course required less than their usual effort, while the remaining percentage of students stated the course required their usual amount of effort.

The experimental group students which indicated normal effort levels (n = 6) attained an average achievement level on their final course grade of 93% for interior design students (n = 1) and 98.75% (n = 2) for non-majors as compared to respective control group values of 92.5% (n = 2) for interior design students and 95.8% (n = 1) for non-majors. Those achievement levels of students indicating the course required more than their normal efforts (n = 9) were higher for students classified into the experimental group. Experimental group interior design students responding with this effort level averaged 97.5% (n = 2) on their final grade, while experimental group non-majors attained 87% (n = 2). Control group interior design students indicating this effort level (n = 1) achieved a final course grade of 90.83%, while control group non-majors (n = 4) averaged 90% achievement for their final course grade.

The type of future courses students would like to see offered and number of students interested in each type is as follows: DOS programming (n = 6), interior design/architecturally oriented project course (n = 10), 3D AutoCAD (n = 13), 2D VersaCad (n = 2), 3D VersaCad (n = 2), and dimensioning (n = 1). A course in 3D AutoCAD was taught Spring semester, 1991. The instructor reported several students which took the course used in this study chose to take the course in 3D AutoCAD as well.

Students in general found their experience with AutoCAD a pleasant one. When asked whether they would use CAD or traditional drafting methods if given the option in a professional work setting, 69% responded they would prefer to use CAD, while 31% indicated that it depended on the specific nature of the project. Reasons given for the preference of CAD included it's more professional appearance, the time which can be saved when making changes and in producing a hard copy of the drawings, the accuracy which can be achieved, and the fact that it was more fun to use. One student even commented that traditional methods of drafting were more likely to "drive him nuts" than any of the frustrations encountered with using a computer to draft. Students further responded that they felt CAD gave them an "edge" when applying for a design position, although they did not feel CAD skills were necessarily a mandatory skill.

Although the use of discipline-specific materials resulted in generally higher scores, the instructor indicated a preference for the general text utilized by all students as opposed to the discipline-specific one. The principle reasons for this preference were attributed to the greater depth of explanation, quantity of exercises, and presence of an index which allowed easy reference to the commands and concepts. The instructor did indicate, however, that he was not pleased with the general text, <u>Using AutoCAD</u>, and that he planned to use a different text the next time he taught the course. He indicated that he would recommend <u>Designer's AutoCAD Tutor</u> to others.

CHAPTER V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Conclusions to Research Questions

Discussion of the study's results within the context of the educational setting is provided to help educators assess appropriateness of using discipline-specific materials for their own classroom settings. Inferential statistical analysis and trend analysis of the descriptive statistics reported revealed useful, consistent patterns in levels of student achievement. The practical, though not necessarily statistical, consistency of the results make them useful as indicators of student achievement ability through the use of discipline-specific materials.

Although consistent patterns of achievement have been shown, the investigator suggests that the reader may wish to interpret these results in a conservative fashion due to the study's inability to obtain information regarding statistical reliability coefficients for the course materials. Such an interpretation would indicate that while discipline-specific materials appear to be more effective, they are at least as effective, and no worse than the use of generic instructional materials.

Due to the number of uncontrollable variables which can affect educational research, practical as well as statistical significance is considered to be important in assessing results. A significance level of 0.10 was chosen in accordance with the type of educational research being conducted and the preliminary nature of materials utilized by this study's experimental group.

Effectiveness of Discipline-Specific Materials on Final Achievement

1. When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:

A) learn more effectively as measured by the students' scores on individual assignments, quizzes, tests and projects as well as the composite grades obtained for the course?

Students assigned to the experimental group consistently achieved higher composite scores on each of the items evaluated for a grade. The scores of the experimental group students differed from those of the control group by two to five percent, with the exception of an equivalent score (81%) on the final exam. The greatest difference in achievement was shown by scores for each group on the in-class performance tests. The experimental group achieved a composite score of 84%, while the control group scored only 79%. Final weighted grade scores for each group showed the experimental group to have achieved an average overall higher weighted score (85%) as compared to the control group's weighted average of 83%.

When these results are evaluated with respect to the average GPA level of each group, it is evident that the experimental group materials are at least as effective, and perhaps more effective, than control group materials. This conclusion is based on the fact that the experimental group had an average GPA which was lower (X = 2.79) than that of the control group (X = 2.94), and had less CAD familiarity (26% versus 37% respectively) as well. The graduate student's scores (experimental group) were counterbalanced by equivalently high scores of an undergraduate student in the control group, negating a possible skewing of the experimental group's averages due to potentially different levels of motivation between the graduate student and the other undergraduate students. It appears the discipline-specific materials are more relevant to students, motivating them to achieve a higher level of knowledge. It could equally suggest that the discipline-specific materials were more easily comprehended. Regardless, the final result of their use in this study is an overall student achievement level which is greater than that of students using the more general learning materials. This indicates a greater degree of mastery of skills, and as such, may be expected to make the student a more desirable job applicant.

Effect of Discipline-Specific Materials on Group Learning Curves

1. **When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:**

    B) learn more quickly as measured by comparing weekly scores to assess whether better scores are obtained at an earlier point in the term?

Analysis of composite scores on each of the grade items reveals no particular divergence in the rate of achievement between the groups. Both groups' scores were usually within three percent of each other for any given item. An exception to this difference was found on the first written quiz and on the second computer skills performance test. Experimental group students achieved a composite score 11% higher than control group students on both of these items. It appears that the specific content of the learning materials does not necessarily affect how quickly the material is learned.

Student Preference for Discipline-Specific Materials

1. **When learning AutoCAD using discipline-specific instead of generically oriented learning exercises and texts, do students:**

    C) indicate a preference for discipline-specific texts or learning exercises as measured by:

1) the percentage of students who choose to use the discipline-specific supplemental text in addition to the one assigned;

2) the percentage of students which indicate on the post-course survey the desire for the utilization of such materials?

Students assigned to the control group did not appear to use the supplemental discipline-specific text reference. Of the eight students assigned to the control group, only two evaluated the experimental group discipline-specific text on the post-course survey. One control group student did, however, indicate extreme dissatisfaction with the control group text. Students in both the experimental and control groups indicated overwhelmingly (87%) they would prefer to use materials from their own professional discipline for learning CAD. The remaining two students indicated no preference for either set of materials.

Effect of Prior Computer Experience on Achievement

2. What effect, if any, does a student's computer background appear to have on his/her ability and desire to learn AutoCAD as measured by:

1) the amount of time spent in the lab versus the scores obtained on assignments;

2) by students' responses on both the pre- and post-course surveys?

Computer background did not appear to play a role in student ability to obtain better grades. The student with the lowest overall course grade was one more experienced in the use of computers. However, students having a very limited amount of computer experience were found to rank at both the low and high levels of achievement on their final grade. The effect of prior CAD experience could not be evaluated effectively since only one student reported using a CAD program of similar power and complexity (VersaCad) to its fullest extent. It is the researcher's belief that the this student's GPA (4.0) and greater degree of familiarity with a similar computer program were more likely to be affecting achievement rather than the use of a particular set of instructional materials. It is important to remember that student GPA in this study has been empirically shown to have a strong relationship with the level of academic achievement obtained ($X^2 = 8.36$; d.f. = 3; $.025 < p < .05$; C = .6).

There was no correlation between the amount of effort expended by control group and experimental group subjects in obtaining the grade each desired. In both the experimental and control groups the majority of students indicated the effort required was greater than their normal amount (57% and 62.5% respectively). Students having a lower GPA generally indicated the course required more effort more frequently than did students with higher GPA's. Both the students and the instructor reported no or very limited text use once the application phase was reached. At that point, students were utilizing references for design aspects of the projects rather than learning which CAD commands executed what actions and the most efficient way to accomplish a specific drawing task.

It is interesting to note that although students assigned to use the discipline-specific materials consistently achieved better results and survey results indicated their preference to use such materials, the course instructor rated the generic text as the one to be preferred from a teaching standpoint. The principle reasons indicated for this preference were the thoroughness of explanations and quantity of exercises provided by the more general text, in conjunction with the presence of an index which allowed easy access and cross referencing of information.

All students indicated a desire to take additional CAD courses. The specific types of courses they would like to see offered and the percentage of students desiring each type of course are as follows: 3-Dimensional AutoCAD (86.6%), courses with content specifically directed to interior design/architecture project applications rather than learning-oriented exercises (59.9%), and DOS programming techniques (40%).

The factor cited by students as having the most positive effect on their grade and attitude was the instructor's teaching style. The instructor's willingness to be flexible regarding assignment grading criteria and ability to understand the operational problems of producing CAD drawings provided students the motivation for learning. Students identified with the instructor and were aware the instructor understood the difficulties with the software since he was concurrently learning the program with them and experiencing similar problems. This helped alleviate student anxiety about the potential for receiving a lower grade due not to a lack of comprehension of CAD operations, but rather the unexpected problems created by the computer itself, and the lack of time available to use the computer at the end of the semester. The lack of access to computers/computers outside of class time was the principal reason for any negative attitude towards class or the final grade.

Implications of Findings

The levels of achievement seen in both groups, in conjunction with student computer and academic background, tend to support the tenets of instructional design. Motivation, leading to the level of achievement attained, apparently can be increased by the use of discipline-specific materials. While the amount of difference seen in achievement is statistically minimal, it has practical significance as shown by effect size values, particularly when assessed within the context of an academic grade evaluation.

A three percent difference in a grade may define the difference between an "A" and a "B", or a "B" and a "C". If enough borderline grades can be raised by the use of discipline-specific materials in a variety of courses, learning will be enhanced by improving student motivation. An added extrinsic benefit to the student is that an improved cumulative GPA may result in greater opportunities being made available than might have been without the use of such materials. Therefore, it is the researcher's belief that the use of discipline-specific materials should be encouraged whenever it is possible to do so.

Recommendations for Future Studies

This study has found study trends that suggest the type of instructional materials used in learning these skills is a factor in how well the skills are mastered. It appears that the use of materials that are as close in application as possible to the actual type of work experiences which will be encountered will produce better comprehension of the material being learned. It is the belief of the investigator that the use of such materials in both academè and the professional sector of design should be encouraged.

The principle limitations of this study, created by the physical conditions encountered, are the source for recommendations for future studies. As the principle purpose of this study was the field testing of a new educational product, it was deemed control of the instructional setting was more important than breadth of sample and sample size.

With the baseline data now available from this study, it is recommended that future studies broaden the sample size and composition, set the significance level for results at a more stringent level ($p = .05$), determine reliability of Designer's AutoCAD Tutor course materials, and control for differences in instructors' teaching effectiveness through statistical analysis. This latter factor is critical to assess since all students in this study commented favorably on the instructor as having a very positive influence on their ability and desire to learn the material.

Future studies might be designed to evaluate the use of the experimental group supplemental text Designer's AutoCAD Tutor within a university setting utilizing the quarter system and a semester time frame. It would be desirable to pursue research using students operationally knowledgeable with CAD software in general and other CAD programs similar to AutoCAD, such as VersaCad, in particular.

Studies of this nature could evaluate the effect of other CAD experience on the time required for the learning process to take place in students with varying CAD backgrounds and provide guidance to CAD instructors for course structure and sequencing of topics. Knowledge gained from such studies could help provide the corporate/professional design sector with estimates on how soon employees required to learn CAD may be expected to become proficient with the software. This could indirectly and positively affect the profitability of a firm by increasing its employees' productivity level through decreasing the total amount of time necessary to devote to CAD training, thus allowing the financial return on investment of CAD use to be achieved more quickly.

Summary and Conclusions

This study has identified Designer's AutoCAD Tutor as a reference which, when used in conjunction with a more complete but general reference, accomplishes effective learning of AutoCAD. The utilization of materials which reduces the technical and motivational problems associated with learning CAD, and AutoCAD in particular, is desirable. With the large number of top ranked firms (95%) now using CAD, the ability to learn and use this skill is becoming increasingly important.

Analyzing the current state of the design industry with regard to recent trends in down-sizing the number of personnel in a firm and making employees more productive, concurrent with the diversification of such firms into a variety of specialty design areas and services, leads to the clear conclusion that it is definitely advantageous to have CAD skills. To benefit the CAD learner and corporate management, it is imperative for research to address the identification, testing, and utilization of materials which provide such skills in the most effective and time efficient fashion possible. The increase in the number of colleges offering CAD courses in interior design curricula and the apparent concern of CAD instructors at the lack of appropriate materials further support this need. CAD skills are now perceived as not only desirable, but almost mandatory in providing students with the ability to obtain, retain, and advance within a professional design position in today's highly competitive job market.

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APPENDICES

APPENDIX A

UNIVERSITY CONSENT TO USE HUMAN SUBJECTS

MICHIGAN STATE UNIVERSITY

UNIVERSITY COMMITTEE ON RESEARCH INVOLVING
HUMAN SUBJECTS (UCRIHS)
206 BERKEY HALL
(517) 353-9738

EAST LANSING • MICHIGAN • 48824-1111

August 3, 1990

IRB# 90-342

Tami Lyn Schultz
5340 N. Montezuma Trail
Tucson, AZ 85715

Dear Ms. Schultz:

RE: "A COMPARATIVE ANALYSIS OF GENERIC VERSUS DISCIPLINE-SPECIFIC INSTRUCTIONAL MATERIALS FOR AUTOCAD USE IN INTERIOR DESIGN IRB# 90-342"

The above project is exempt from full UCRIHS review. The proposed research protocol has been reviewed by another committee member. The rights and welfare of human subjects appear to be protected and you have approval to conduct the research.

You are reminded that UCRIHS approval is valid for one calendar year. If you plan to continue this project beyond one year, please make provisions for obtaining appropriate UCRIHS approval one month prior to August 3, 1991.

Any changes in procedures involving human subjects must be reviewed by UCRIHS prior to initiation of the change. UCRIHS must also be notified promptly of any problems (unexpected side effects, complaints, etc.) involving human subjects during the course of the work.

Thank you for bringing this project to my attention. If I can be of any future help, please do not hesitate to let me know.

Sincerely,

John K. Hudzik, Ph.D.
Chair, UCRIHS

JKH/sar

cc: R. Kilty-Padgett

NORTHERN ARIZONA UNIVERSITY

OFFICE OF SPONSORED RESEARCH ADMINISTRATION
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS COMMITTEE
MEMORANDUM

TO: Ms. Tami Lyn Schultz

FROM: Carey L. Conover, Human Subjects Officer

DATE: July 23, 1990

SUBJECT: Exempt Review of the Use of Human Subjects in Research

Your study, "A COMPARATIVE ANALYSIS OF GENERIC VERSUS DISCIPLINE-SPECIFIC INSTRUCTIONAL MATERIALS FOR AutoCAD USE IN INTERIOR DESIGN" has been found by the Human Subjects Committee to be exempt from formal Institutional Review Board review due to the fact that it appears to follow appropriate research procedures as it relates to requirements for the care and protection of physical, psychological, social and other human rights concerns.

Exemption from formal review includes research which involves one or more of the factors listed as follows:

1. Surveys, interviews, and observations if the subjects cannot be identified (directly or indirectly) through responses which may provide a link which would place them in a position of risk of criminal or civil liability; or provide a link exposing sensitive aspects of the subject's behavior, e.g., use of drugs, alcohol, sexual behavior or illegal conduct.

2. Educational tests of a cognitive, diagnostic, aptitude or achievement nature when information is recorded so that subjects cannot be identified directly or through identifier links.

3. Research in established settings, e.g., comparisons of instructional strategies, techniques, curricula or classroom management methods.

4. Research involving the study of existing data documents, records or specimens if subjects cannot be directly or indirectly identified.

5. Other comments, if applicable: ______________________

Please inform the Institutional Review Board if any irregularities arise as a result of this research project.

CLC/am

APPENDIX B

CONSENT TO USE MATERIALS IN PRESS

COLLEGE OF HUMAN RESOURCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061-0424

DEPARTMENT OF HOUSING, INTERIOR DESIGN AND RESOURCE MANAGEMENT DEPT. (703) 231-6163
OFFICE (703) 231-

May 10, 1990

Tami Schultz
E231 Owen Graduate Hall
Michigan State University
East Lansing, Michigan 48825

Dear Tami:

Enclosed you will find a copy of a letter sent to Amanda Miller, Interior Design Editor at VNR. She gave permission over the phone today and will be sending you written confirmation to use the packet for Fall 1990.

I will send you a original set of loose pages of The Designer's AutoCAD Tutor (after June 8) so that Kinko's can make the copies. You will need to give Kinko's a copy of the permission letter. I will include the full manuscript so that it will be similar to the final publication. The copy you have now is missing Part 5 and part of Part 1. However, the final book will be better presented (i.e. better quality drawings, headings) so that you may want to mention this limitation in your methods chapter. That is, you will be comparing a Kinko's packet with a book, Inside AutoCAD.

Good luck with your thesis.

Sincerely,

Joan McLain-Kark

Joan McLain-Kark
Assoicate Professor

P.S. I have enclosed information on the Ph.D program--we are in the process of revising materials so I will keep you informed on developments.

VNR VAN NOSTRAND REINHOLD
115 FIFTH AVENUE, NEW YORK, NEW YORK 10003 (212) 254-3232

May 18, 1990

Tami Schultz
E231 Owen Graduate Hall
Michigan State Univ.
East Lansing, MI. 48825

Re McLain-Kark: AUTO CAD

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Sincerely,

Carl Maddalone

Carl Maddalone
Manager,
Editorial Services

Date: May 19, 1990

Permissions Applicant: Tami Schultz

VNR Author/Publication: McLain-Kark: DESIGNER'S AUTOCAD TUTOR

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APPENDIX C

PROJECT COVER LETTER AND CONSENT FORM

MICHIGAN STATE UNIVERSITY

COLLEGE OF HUMAN ECOLOGY
DEPARTMENT OF HUMAN ENVIRONMENT AND DESIGN

EAST LANSING • MICHIGAN • 48824-1030

Dear Student:

The Fall 1990 **semester of this** introductory Computer Aided Design (CAD) class has been chosen as a highly select but representative group of students invited to participate in this research study. The choice to include this particular course in the study was based on its prior enrollment records which show unique blends of students from a variety of academic interests. This study is directed toward analyzing and offering suggestions for improving CAD instructional textbooks which are either presently available or are in the final stages of the publication process and will be available shortly. Your valued opinions are urgently requested.

As a student, you invest a great deal of time and money to acquire professional skills and knowledge. You are entitled to receive the best education it is possible for the university to provide. Your education is affected by your instructors and the quality of the teaching materials they choose to use. As a college student you make informed choices about which courses you take and the instructors from which you elect to take them. Rarely do you have the opportunity of helping select textbooks and modifying their content for use by future students. The opportunity to do so now is unique. You will have a responsible role in helping future users of these textbooks by offering suggestions for improving the quality of these materials, as well as providing useful comments for your instructor's use in future sections of this course.

Textbooks are written for you, the student consumer. Authors wish to communicate clearly to make the process of learning as easy as possible. Hopefully, you will enjoy it as well! It is only possible to incorporate your suggestions if you provide feedback when given the opportunity to do so. You will be asked to indicate your likes and dislikes, to identify which features work and don't work for you, and to tell what you would add or how you would change existing features to improve the texts chosen for your use.

CONDITIONS OF THIS RESEARCH STUDY

Some of you will be asked to use and critique one textbook; others of you will be asked to use and critique this same textbook and an additional textbook and compare them to each other. If you are assigned to use the additional text and aren't able to afford it (±$10-$15) a copy may be checked out for a limited time from your instructor. You are asked to use only the text(s) which you are assigned to use as much as possible; however, if you find it necessary to use other sources, the researchers are interested in knowing what you used. **No one will be penalized for using additional sources, but it is asked that you keep their use to a minimum.** A space has been provided on each assignment cover sheet for you to indicate this information.

In order for this study to present meaningful recommendations, it is necessary for as many students as possible to consent to participate and respond with specific suggestions rather than vague or unclear comments. You will be asked to fill out a short cover sheet for each of your assignments. On it you will respond to questions by checking the response which is closest to your opinion. On the reverse side of the sheet, you will have the chance to write down any strengths and weaknesses you note in the texts. Each text's set of assignments has approximately the same level of difficulty and covers the same content. To give the researchers an idea of whether your opinions change as you proceed through the course, you'll also fill out a short survey at both the beginning and end of the course. That's all there is to it!

All scores and survey responses will be kept completely confidential by the researchers. Scores and opinion responses will be pre-coded and reported in terms of group statistics in the research report. No individual scores or responses will be attributed to any specific student by name or code number. Researchers will know you only by code number. Use of this number will be limited to the initial stages of research. The number will consist of your major and part of your social security number. Your instructor will not know who has or hasn't elected to participate. Access to your participation consent status will be restricted exclusively to the researchers. All information will be used solely by the study's researchers for the purposes of this study only. This is a completely voluntary effort on your part. You are free to end your participation at any time without penalty. It is hoped you will take advantage of this opportunity to help fellow students by allowing your thoughtful input to be included in this study.

REGARDLESS OF YOUR DECISION ON PARTICIPATION, YOUR INSTRUCTOR WILL ASK YOU TO COMPLETE THE SAME ASSIGNMENTS AND FILL OUT THE COVER SHEETS AND SURVEYS TO AID HIM/HER IN TEACHING THIS COURSE IN THE FUTURE.

YOUR INDICATION TO PARTICIPATE ON THE CONSENT FORM IS YOUR AUTHORIZATION TO THE RESEARCHERS FOR INCLUSION OF YOUR RESPONSES IN THE STUDY. THIS FORM WILL BE COLLECTED BY UNIVERSITY PERSONNEL OTHER THAN YOUR INSTRUCTOR AND WILL BE SEALED AND MAILED DIRECTLY TO THE RESEARCHERS AT MICHIGAN STATE UNIVERSITY.

If you have any questions or concerns regarding your participation in this study, please feel free to contact Ms. Carey Conover, Institutional Review Board Chairman, NAU Office of Sponsored Research at 523-4889 or the researchers indicated on your copy of the consent form at the following telephone numbers: (517) 353-6947 or (517) 355-3378. Please note: this location is on Eastern Daylight Time.

Results of this study will be made available to your instructor upon its completion. Please contact him/her if you have any questions regarding its conclusions and recommendations. Thank you for your consideration of this opportunity.

Yours truly,

Roberta Kilty-Padgett
Roberta Kilty-Padgett,
Project Director
Associate Professor
Human Environment & Design
(517) 355-3378

T. Lyn Schultz
T. Lyn Schultz,
Principal Researcher
Graduate Student
Human Environment & Design
(517) 353-6947

THIS PROJECT HAS BEEN REVIEWED BY THE NORTHERN ARIZONA UNIVERSITY BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH (602-523-4889) AND BY THE MICHIGAN STATE UNIVERSITY COMMITTEE ON RESEARCH INVOLVING HUMAN SUBJECTS (517-353-9738).

PARTICIPATION CONSENT FORM

Student Code Number: ____________________

[ ] I have read and understand the information contained in the cover letter and printed below. I choose to **participate** in this study and to abide by its research conditions.

[ ] I have read and understand the information contained in the cover letter and printed below. I choose **not to participate** in this study and understand I will not be penalized for this choice.

PLEASE DETACH AND KEEP THIS PORTION OF THE CONSENT FORM FOR YOUR OWN RECORDS.

I have read and understand the cover letter accompanying this consent form. I understand the purpose and agree to abide by conditions of this research which are as follows:

1) The purpose of this study is to evaluate instructional materials available for learning computer-aided design skills to determine whether any particular materials are more effective in presenting the information to the student.

2) Consent to participate only allows the **inclusion** of my **pre-coded scores and responses** in the study and in no way affects the number or type of class assignments or evaluations of material required of me in this course.

3) My choice to participate is completely **voluntary** and I may withdraw at any time without incurring any type of penalty. If I choose to withdraw, I will still be held responsible for completing any surveys but all my responses and scores will be used only by my instructor for class purposes.

4) Choosing to **not participate** in no way affects the number or type of class assignments or evaluations of material required of me in this course.

5) Choosing **not to participate** means that my scores and responses to surveys will **not be included in the study** but will be **used only by my instructor** for class purposes.

6) I have an equal chance of being assigned to use either 1) Using AutoCAD or 2) Using AutoCAD **and** Designer's AutoCAD Tutor for reference but that I will be assigned to complete only **one set** of learning exercises regardless of which text(s) I am asked to evaluate and that each set of assignments has an approximately equal level of difficulty and the same number of assignments.

Please feel free to direct any questions or concerns regarding participation in this study to either your instructor, the NAU Institutional Review Board Chairman or the researchers. Researchers' addresses and telephone numbers are listed on the reverse side of this form.

PLEASE CONTACT YOUR INSTRUCTOR; MS. CAREY CONOVER--NAU'S IRB CHAIRMAN; OR THE FOLLOWING INDIVIDUALS IF YOU HAVE ANY QUESTIONS OR CONCERNS REGARDING THIS STUDY.

T. LYN SCHULTZ, RESEARCHER
E231 OWEN HALL
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN 48825
(517) 353-6947

R. KILTY-PADGETT, PROJECT DIRECTOR
204 COLLEGE OF HUMAN ECOLOGY
DEPT. OF HUMAN ENVIRONMENT & DESIGN
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN 48824-1030
(517) 355-3378

NOTE: MICHIGAN STATE UNIVERSITY IS ON EASTERN DAYLIGHT TIME. PLEASE TAKE THE DIFFERENCE IN TIME ZONES INTO ACCOUNT IF YOU CHOOSE TO CONTACT THE RESEARCHERS BY TELEPHONE.

THIS PROJECT HAS BEEN REVIEWED BY THE NORTHERN ARIZONA UNIVERSITY BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH (602-523-4889) AND BY THE MICHIGAN STATE UNIVERSITY COMMITTEE ON RESEARCH INVOLVING HUMAN SUBJECTS (517-353-9738).

APPENDIX D

SURVEYS

STUDENT BACKGROUND PROFILE

RESPONSES ON ALL SURVEYS ARE FOR RESEARCH PURPOSES ONLY AND WILL NOT AFFECT YOUR GRADE IN ANY MANNER. ALL RESPONSES/SCORES WILL BE KEPT STRICTLY CONFIDENTIAL AND WILL BE REPORTED ONLY IN TERMS OF PRE-CODED STATISTICAL VALUES. NO INDIVIDUAL STUDENT WILL BE IDENTIFIED BY NAME OR STUDENT IDENTIFICATION CODE NUMBER.

Time of day class meets: ____________________
Student Identification Code Number: ____________________

PART A: PRIOR COMPUTER BACKGROUND

1. Is this the first computer course you've ever taken?

   [] YES [] NO

2. Indicate each type of computer software you are familiar with and the number of courses/seminars you have taken of each. Write in on the blanks provided below each area how many of these classes utilized hands on class experiences. If you are self-taught, indicate the number of different programs you have learned in this manner. Write in any additional types of software you know on the last "blank" category.

	courses	seminars	self-taught
[] WORD PROCESSING	0 1 2 3 4 5	0 1 2 3 4 5	YES NO
# OF "HANDS ON"	______	______	______
[] SPREADSHEET	0 1 2 3 4 5	0 1 2 3 4 5	YES NO
# OF "HANDS ON"	______	______	______
[] DESKTOP PUBLISH.	0 1 2 3 4 5	0 1 2 3 4 5	YES NO
# OF "HANDS ON"	______	______	______
[] DRAFTING (CAD)	0 1 2 3 4 5	0 1 2 3 4 5	YES NO
# OF "HANDS ON"	______	______	______
[] ______	0 1 2 3 4 5	0 1 2 3 4 5	YES NO
# OF "HANDS ON"	______	______	______

3. Have you ever observed anyone drafting with any software? (If no, go to question 5.)

   [] YES [] NO

4. Was this person using AutoCAD?

   [] YES [] NO [] UNKNOWN

5. Have you ever drafted using a computer before? (If no, answer NOT APPLICABLE to question 6a on the next page.)

   [] YES [] NO

6. Check the response in each category that best describes your own opinion of and/or prior encounter(s) with CAD:

a) User Attitude:	b) Functionality:	c) Applicability:
[] ENJOYABLE	[] USEFUL	[] DEFINITELY
[] MIXED REACTIONS	[] SOMEWHAT USEFUL	[] IN SOME SITUATIONS
[] NEGATIVE	[] NOT USEFUL	[] NOT AT ALL
[] NOT APPLICABLE	[] UNSURE	[] UNSURE

7. Rate your overall prior opinion of and/or encounter(s) with CAD:

   [] VERY POSITIVE
   [] POSITIVE
   [] NEUTRAL
   [] NEGATIVE
   [] VERY NEGATIVE

8. Have you ever read any "how to" AutoCAD reference manuals? (If no, go to question 10.)

   [] YES [] NO

9. For each manual you have read, rate its ability to give clear explanations and descriptions of the program based on the following scale:

   1=EXCELLENT 2=GOOD 3=FAIR 4=POOR 5=UNACCEPTABLE

title	rating
____________________	1 2 3 4 5
____________________	1 2 3 4 5
____________________	1 2 3 4 5
____________________	1 2 3 4 5

10. Have you ever used any version of AutoCAD software before? (If no, go to question 12.)

    [] YES [] NO

11. What version(s) of AutoCAD have you used?

    [] 2.1
    [] 2.5
    [] 9.0
    [] 10.0
    [] UNKNOWN
    [] OTHER(specify) ______

12. Have you ever used any drafting software other than AutoCAD? (If no, go to Part B of this survey.)

    [] YES [] NO

13. For each program you have used, indicate the difficulty of learning the program using the following scale:

1 = VERY DIFFICULT
2 = MODERATELY DIFFICULT
3 = AVERAGE DIFFICULTY
4 = MODERATELY EASY
5 = VERY EASY

a) AutoCAD	1	2	3	4	5
b) VersaCAD	1	2	3	4	5
c) CADVANCE	1	2	3	4	5
d) Point Line	1	2	3	4	5
e) DataCAD	1	2	3	4	5
f) ARRIS	1	2	3	4	5
g) Drawbase	1	2	3	4	5
h) FastCAD	1	2	3	4	5
i) CADKEY	1	2	3	4	5
j) Other (specify) ________	1	2	3	4	5
k) Other (specify) ________	1	2	3	4	5
l) Other (specify) ________	1	2	3	4	5

PLEASE GO ON TO PART B ON THE NEXT PAGE

PART B: STUDENT BACKGROUND

1. What is your gender? [] MALE [] FEMALE

2. What is your age? ________

3. What is your class level based on the <u>total</u> number of <u>credits completed</u>?

   []FRESHMAN []SOPHOMORE []JUNIOR []SENIOR []GRADUATE

4. What is your major? If it isn't listed, please write it in on the blank line.

   [] UNDECLARED [] INDUSTRIAL SUPERVISION [] GEOLOGY
   [] INTERIOR DESIGN [] FASHION MERCHANDISING [] ENGINEERING
   [] CONSTRUCTION [] TEXTILES & CLOTHING [] ________

5. How many <u>credits</u> are you <u>currently taking</u> in each of the following categories of courses?

   _____ COURSES NUMBERED 100-199 _____ COURSES NUMBERED 400-499
   _____ COURSES NUMBERED 200-299 _____ COURSES NUMBERED 500-699
   _____ COURSES NUMBERED 300-399

6. How many of these credits are studio or laboratory-based? ______

7. Do you have a job? (If no, go to question 10.)

   [] YES [] NO

8. On the <u>average</u>, how many hours do you work per <u>week</u>? ________

9. Are you a design professional or design faculty member? If so, indicate which in the blank.

   [] NO [] YES ____________________

10. Are you taking this class to <u>fulfill</u> university <u>general education requirements</u> (not included as part of fulfilling your major's requirements)? (If yes, go to question 12.)

    [] YES [] NO

11. Is this class required for your major?

    [] YES [] NO

2. Have you taken the course pre-requisite(s) or equivalent(s)? The pre-requisite is IS 150: **FUNDAMENTALS OF DRAFTING** or the instructor's permission.

   [] YES [] NO

PLEASE COMPLETE THE REVERSE SIDE OF THIS PAGE.

13. Why did you choose to take this particular course? Check all that apply.

    [] IT IS ONE OF SEVERAL COURSES WHICH SATISFIES A DEPARTMENTAL REQUIREMENT.
    [] IT IS PART OF MY MINOR STUDIES.
    [] IT IS A PRE-REQUISITE FOR A DIFFERENT COURSE I WANT TO TAKE.
    [] IT FILLS A CONTENT AREA DEFICIENCY IN MY MAJOR/MINOR STUDIES.
    [] IT IS A SUBSTITUTE FOR A DISCONTINUED COURSE.
    [] FRIENDS ARE TAKING/HAVE TAKEN IT AND RECOMMENDED IT.
    [] FACULTY MEMBER/ACADEMIC ADVISOR RECOMMENDED IT.
    [] I ENJOYED OTHER CLASSES TAUGHT BY THE SAME INSTRUCTOR.
    [] IT WAS AN OPEN COURSE WHICH FIT INTO MY SCHEDULE (A "FREE" ELECTIVE).
    [] I FEEL IT WILL HELP ME IN MY PROFESSIONAL CAREER.
    [] OTHER (specify)____________________

14. Indicate your grade point average within your major or your overall GPA if you are undeclared. (Estimate to the <u>best</u> of your ability.)

    [] 3.50 - 4.00 [] 2.00 - 2.49
    [] 3.00 - 3.49 [] LESS THAN 2.00
    [] 2.50 - 2.99 [] NOT YET DETERMINED (FIRST TERM IN COLLEGE)

15. Would you be interested in taking additional CAD courses if they were offered?

    [] YES [] NO

16. Would you prefer for the course to be offered at a different time of the day?

    [] YES [] NO [] DOESN'T MATTER

17. What hours of the day do you prefer to study/attend classes? Check all that apply.

    [] 8:00-9:00 [] 9:00-10:00 [] 10:00-11:00 [] 11:00-12:00
    [] 12:00-1:00 [] 1:00-2:00 [] 2:00-3:00 [] 3:00-4:00
    [] 4:00-5:00 [] EVENING

THANK YOU FOR YOUR RESPONSE ON THIS SURVEY.

SA-1

ASSIGNMENT COVER SHEET: STUDENT TEXT ASSESSMENT SURVEY

Drwg. Title:________________ Due Date:__________ ID #:__________

1. Indicate the amount of lab time you spent using AutoCAD this week. Be sure to total each day's time and add them together for the weekly total.

	MON	TUES	WED	THURS	FRI	SAT	SUN		research use only
TIME IN									TOT:
TIME OUT									
TIME IN									CUM:
TIME OUT									
TIME IN								WEEKLY	
TIME OUT								TOTAL	CUM. %:
DAILY TOTALS									

2. BEFORE COMING INTO LAB, how well did you understand the commands needed to complete the assignment?

[ ] COMPLETELY
[ ] FAIRLY WELL
[ ] SO - SO
[ ] POORLY
[ ] NOT AT ALL

Did you have problems on-screen?
[ ] YES
[ ] NO(go to 3.)

Difficulty was with:(check all that apply)
[ ] UNDERSTANDING PURPOSE OF COMMANDS USED
[ ] POSITIONING CURSOR/EQUIPMENT PROBLEMS
[ ] MAKING SOFTWARE DO WHAT YOU WANTED
[ ] OTHER(specify)

3. Were you able to complete the assignment to your satisfaction?

[ ] YES
[ ] NO

Did you spend time practicing the skills you have difficulty using, in addition to doing the assignment?
[ ] YES [ ] NO

4. Please rate each statement based on your overall opinion.

1=STRONGLY AGREE 2=AGREE 3=NEUTRAL 4=DISAGREE 5=STRONGLY DISAGREE

a) I am confident with my ability to effectively use commands required for this lesson on future work . . 1 2 3 4 5

b) I am confident with my ability to use CAD commands learned in previous assignments on future work 1 2 3 4 5

5. Rate each text you used on this assignment on its clarity of explanation and presentation of material.

1=EXCELLENT 2=GOOD 3= FAIR 4=POOR 5=UNACCEPTABLE

Using AutoCAD		Designer's AutoCAD Tutor
1 2 3 4 5	a) general CAD concepts	1 2 3 4 5
1 2 3 4 5	b) CAD commands	1 2 3 4 5
1 2 3 4 5	c) CAD command sequences	1 2 3 4 5
	d) information organized for	
1 2 3 4 5	easy reference	1 2 3 4 5
1 2 3 4 5	e) uses applicable exercises	1 2 3 4 5

PLEASE COMPLETE THE REVERSE SIDE OF THIS PAGE

SA-2

6. Indicate how heavily you relied on EACH reference you used to complete the assignment, REGARDLESS of whether it was the one(s) you were asked to use or not.

1=EXCLUSIVELY 2=HEAVILY 3=MODERATELY 4=SOMEWHAT 5=NOT AT ALL

a) Using AutoCAD. 1 2 3 4 5
b) Designer's AutoCAD Tutor 1 2 3 4 5
c) Other__________________ 1 2 3 4 5

7. Indicate your levels of interest, enjoyment, familiarity with the subject content of this application and the degree of appropriateness to your major of this assignment for applying the skills presented.

1=HIGH 2=MODERATE 3=SO-SO 4=SLIGHT 5=NONE

a) Degree of appropriateness for major. . . . 1 2 3 4 5
b) Degree of familiarity w/application. . . . 1 2 3 4 5
c) Level of interest. 1 2 3 4 5
d) Level of enjoyment 1 2 3 4 5

8. Rate the difficulty level of this assignment by circling your answer choice.

1=VERY DIFFICULT 2=MODERATELY DIFFICULT 3=AVERAGE DIFFICULTY
4=MODERATELY EASY 5=VERY EASY

9. Please note any particular STRENGTHS and WEAKNESSES you discovered for each text you are using. Consider the organizational format and writing style. Comments might be made on: number or type of examples given, clarity of explanations, depth of explanation, the use of underlining, italics or boldface type or spacing to identify and emphasize important terms and phrases, chapter sections, chapter summaries, etc. Remember, you are our best source of information, so please indicate your honest opinion. Thank you.

Using AutoCAD (blue softcover) Designer's AutoCAD Tutor (Kinko's)

STRENGTHS

WEAKNESSES

10. Indicate any additional comments you have regarding the text material or learning exercises. To help improve the material, please be as specific as possible.

IA-1

INSTRUCTOR TEXT ASSESSMENT SURVEY

Drwg. Title:____________________ Due Date:____________

Material dealt primarily with:
[] SETTING UP PARAMETERS
[] DRAWING (basic skills)
[] EDITING (basic skills)
[] PRECISION DRAWING/EDITING, ENHANCING
[] PLOTTING

Specific topics covered in this assignment:
____
____
____
____
____

1. Indicate the degree to which you relied on each reference for preparation of lecture materials according to the following scale:

   1=EXCLUSIVELY 2=HEAVILY 3=MODERATELY 4=SOMEWHAT 5=NOT AT ALL

a) Using AutoCAD	1	2	3	4	5
b) Designer's AutoCAD Tutor	1	2	3	4	5
c) Mastering AutoCAD	1	2	3	4	5
d) AutoCAD Instant Reference	1	2	3	4	5
e) Inside AutoCAD	1	2	3	4	5
f) AutoCAD Reference Manual	1	2	3	4	5
g) Other:(specify) ____________	1	2	3	4	5
h) Other:(specify) ____________	1	2	3	4	5

2. Rate each text's ability in addressing the following items according to the following scale:

   1=EXCELLENT 2=GOOD 3=FAIR 4=POOR 5=UNNACCEPTABLE

Using AutoCAD		Designer's AutoCAD Tutor
1 2 3 4 5	a) Present clear explanations of CAD concepts	1 2 3 4 5
1 2 3 4 5	b) Present clear explanations of CAD commands	1 2 3 4 5
1 2 3 4 5	c) Present clear explanations of frequently used command sequences	1 2 3 4 5
1 2 3 4 5	d) Present material in an organized manner	1 2 3 4 5
1 2 3 4 5	e) Use of applicable learning exercises	1 2 3 4 5

3. Did questions asked of you primarily address: (check one)

   [] SKILLS/INFORMATION COVERED IN PREVIOUS LECTURES/ASSIGNMENTS.
   [] NEW MATERIAL NECESSARY FOR SUCCESSFUL COMPLETION OF THE ASSIGNMENT.
   [] INFORMATION NEEDED FOR "FINE-TUNING" AND ENHANCING THE ASSIGNMENT.

IA-2

TOTAL POINTS POSSIBLE ON THIS ASSIGNMENT:________

Student Score Breakdown

Control group		Experimental group	
code #	score	code #	score

Number of students per group which obtained the following percentages:

Percentages	Control Group Majors	Control Group Non-Majors	Experimental Group Majors	Experimental Group Non-Majors
90-100				
80-89				
70-79				
60-69				
below 60				

Please indicate any comments you have regarding the text material or supplemental learning exercises. In order to help improve the material, please be as specific as possible. Thank you.

Using AutoCAD		Designer's AutoCAD Tutor
____________	Strengths:	____________
____________	Weaknesses:	____________

STUDENT EVALUATION OF PROJECTS ID #:____________

1. Rate the difficulty of each project using the following scale:

   1=VERY DIFFICULT 2=MODERATELY DIFFICULT 3=AVERAGE DIFFICULTY 4=MODERATELY EASY 5=VERY EASY

a) interior design project.	1	2	3	4	5
b) structural design project.	1	2	3	4	5

2. What were the most difficult and the easiest parts of each project for you and why?

   A. INTERIOR DESIGN PROJECT
   MOST DIFFICULT:

   EASIEST:

   B. STRUCTURAL DESIGN PROJECT
   MOST DIFFICULT:

   EASIEST:

3. Indicate how each of the following factors affected your ease in doing the second project compared to the first one using the following scale. List any other factors under other.

   1= #2 WAS EASIER 2= #2 WAS MORE DIFFICULT 3= NO DIFFERENCE

a) greater familiarity with using the program	1	2	3
b) understanding how to organize and work on a project to minimize "housekeeping commands" such as zoom, pan, window, layer, etc..	1	2	3
c) degree of familiarity with project content	1	2	3
d) other (specify)____________________	1	2	3
e) other (specify)____________________	1	2	3

4. Please indicate the degree to which you relied on each reference for doing each project, regardless of which text(s) you were originally assigned to use for learning the AutoCAD program.

   1=EXCLUSIVELY 2=HEAVILY 3=MODERATELY 4=SOMEWHAT 5=NOT AT ALL

   A. INTERIOR DESIGN PROJECT

a) Using AutoCAD.	1	2	3	4	5
b) Designer's AutoCAD Tutor	1	2	3	4	5

   B. STRUCTURAL DESIGN PROJECT

a) Using AutoCAD.	1	2	3	4	5
b) Designer's AutoCAD Tutor	1	2	3	4	5

5. Indicate any other sources you used in helping to complete each project and how heavily you relied on them.

   1=EXCLUSIVELY 2=HEAVILY 3=MODERATELY 4=SOMEWHAT 5=NOT AT ALL

   A. INTERIOR DESIGN PROJECT

a) your instructor.	1	2	3	4	5
b) your classmates.	1	2	3	4	5
c) friends that know AutoCAD.	1	2	3	4	5
d) other (specify)____________________	1	2	3	4	5
e) other (specify)____________________	1	2	3	4	5
f) other (specify)____________________	1	2	3	4	5

   B. STRUCTURAL DESIGN PROJECT

a) your instructor.	1	2	3	4	5
b) your classmates.	1	2	3	4	5
c) friends that know AutoCAD.	1	2	3	4	5
d) other (specify)____________________	1	2	3	4	5
e) other (specify)____________________	1	2	3	4	5
f) other (specify)____________________	1	2	3	4	5

6. Indicate your level of interest in doing each project using the following scale:

   1=HIGH 2=MODERATE 3=SO-SO 4=SLIGHT 5=NONE

a) interior design project.	1	2	3	4	5
b) structural design project.	1	2	3	4	5

7. Indicate your level of enjoyment of each project using the following scale:

   1=HIGH 2=MODERATE 3=SO-SO 4=SLIGHT 5=NONE

a) interior design project.	1	2	3	4	5
b) structural design project.	1	2	3	4	5

8. Indicate the degree of appropriateness of each project for demonstrating your ability to use AutoCAD in a professional work setting using the following scale:

   1—HIGHLY APPROPRIATE 2—MODERATELY APPROPRIATE 3—NEUTRAL
   4—MODERATELY INAPPROPRIATE 5—HIGHLY INAPPROPRIATE

   a) interior design project. 1 2 3 4 5
   b) structural design project. 1 2 3 4 5

9. Indicate whether each of these projects should be used as is, or if they need modification for future sections of this course.
   (If "AS IS", go to question 11.)

   a) interior design project. . . . .[ ] AS IS [ ] MODIFIED
   b) structural design project. . . . .[ ] AS IS [ ] MODIFIED

10. Please indicate how you would modify each project to make it more appropriate for your needs. Remember, the projects are geared for students from a <u>broad variety of academic majors</u>. Use the back side of this sheet if you need more room.

11. Please add any other comments you have regarding the projects. Use the back side of this sheet if you need more room.

THANK YOU FOR YOUR RESPONSE ON THIS SURVEY.

INSTRUCTOR EVALUATION OF PROJECTS

1. Rate each project's actual difficulty level in comparison to the difficulty level you perceived for them at the beginning of the term using the following scale:

   1—MUCH MORE DIFFICULT   2—SOMEWHAT MORE DIFFICULT   3—NO DIFFERENCE
   4—SOMEWHAT EASIER   5—MUCH EASIER

   a) interior design project. 1   2   3   4   5
   b) structural design project. 1   2   3   4   5

2. List any frequent or common difficulties each group of students had with each project.

   A. INTERIOR DESIGN PROJECT
   INTERIOR DESIGN MAJORS:

   ALL OTHER MAJORS:

   B. STRUCTURAL DESIGN PROJECT
   INTERIOR DESIGN MAJORS:

   ALL OTHER MAJORS:

3. Indicate the overall level of enjoyment each group of students (by major) appeared to exhibit for each of the two projects using the following scale:

   1—HIGH   2—MODERATE   3—SO-SO   4—SLIGHT   5—NONE

   A. INTERIOR DESIGN MAJORS

   a) interior design project. 1   2   3   4   5
   b) structural design project. 1   2   3   4   5

   B. ALL OTHER MAJORS

   a) interior design project. 1   2   3   4   5
   b) structural design project. 1   2   3   4   5

4. Indicate the degree of appropriateness of each project for demonstrating each group of students' ability to use AutoCAD in a professional work setting using the following scale:

   1—HIGHLY APPROPRIATE   2—MODERATELY APPROPRIATE   3—NEUTRAL
   4—MODERATELY INAPPROPRIATE   5—HIGHLY INAPPROPRIATE

   A. INTERIOR DESIGN MAJORS

   a) interior design project. 1   2   3   4   5
   b) structural design project. 1   2   3   4   5

   B. ALL OTHER MAJORS

   a) interior design project. 1   2   3   4   5
   b) structural design project. 1   2   3   4   5

5. Indicate whether each of these projects should be used as is, or if they need modification for future sections of this course.
   (If AS IS, go to question 7.)

   a) interior design project. . . . . [] AS IS   [] MODIFIED
   b) structural design project. . . . . [] AS IS   [] MODIFIED

6. Please indicate how each project would be modified to improve it for use in future sections of this course.

7. Please add any other comments you have regarding the projects.

THANK YOU FOR YOUR RESPONSE ON THIS SURVEY.

STUDENT POST-COURSE EVALUATION   ID #:________

1. Check the response that **best** describes **your** overall opinion toward CAD **in general** and it uses after having taken this course:

   a) User Attitude:
   - [] ENJOYABLE
   - [] MIXED REACTIONS
   - [] NEGATIVE

   b) Functionality:
   - [] USEFUL
   - [] SOMEWHAT USEFUL
   - [] NOT USEFUL

   c) Applicability:
   - [] DEFINITELY
   - [] IN SOME SITUATIONS
   - [] NOT AT ALL

2. Rate your **overall** opinion of CAD after taking this course?

   [] VERY POSITIVE [] POSITIVE [] NEUTRAL [] NEGATIVE [] VERY NEGATIVE

3. Please rate each statement based on your overall opinion.

   1=STRONGLY AGREE 2=AGREE 3=NEUTRAL 4=DISAGREE 5=STRONGLY DISAGREE

   a) CAD skills give me an edge in finding a job. .1 2 3 4 5
   b) CAD is an **essential** professional skill 1 2 3 4 5

4. If your future professional work environment offered you the choice of using CAD versus manual drafting methods on projects, which method would you choose to use for the **majority** of your work and why?

   [] CAD [] MANUAL DRAFTING [] DEPENDS

5. Did you feel you learned enough in this course to effectively use AutoCAD for your own purposes?

   [] YES [] NO

6. Would you be interested in taking additional CAD courses if they were offered?

   [] YES [] NO

7. Which of the following topics would you like to know more about? Check all that interest you.

   - [] DOS COMMANDS AND PROGRAM STRUCTURE
   - [] A PROJECT-ORIENTED COURSE DIRECTED PRIMARILY TOWARD EXTENDING THE MATERIAL COVERED IN THIS COURSE
   - [] 3D AUTOCAD
   - [] 2D VERSACAD
   - [] 3D VERSACAD
   - [] OTHER(describe)________
   - [] OTHER(describe)________

8. Indicate how your prior knowledge of a different CAD program(s) affected your ease of learning AutoCAD concepts and commands. (If you have no prior "hands on" CAD experience, go to question 9.)

   a) CAD concepts (layers, windows, color use, set up parameters, line-types, mirroring, array, symbol insertion, plot, etc.) . . .[] HELPED [] HINDERED

   b) CAD command execution (actually **doing** the drafting). . . . .[] HELPED [] HINDERED

9. What **specific tasks** were helped or hindered by your knowledge of other CAD programs and why?

10. In order to achieve the quality of work you desired, did you feel the course required:

    - [] LESS THAN YOUR USUAL AMOUNT OF EFFORT
    - [] YOUR USUAL AMOUNT OF EFFORT
    - [] MORE THAN YOUR USUAL AMOUNT OF EFFORT

11. Rate the difficulty of the course assignments, quizzes and projects and the overall course difficulty using the following scale:

    1=VERY DIFFICULT 2=MODERATELY DIFFICULT 3=AVERAGE DIFFICULTY 4=MODERATELY EASY 5=VERY EASY

    a) learning assignments 1 2 3 4 5
    b) quizzes. 1 2 3 4 5
    c) interior design project. 1 2 3 4 5
    d) structural design project. 1 2 3 4 5
    e) overall course difficulty. 1 2 3 4 5

12. Indicate your opinion on the pace of the class:

    [] TOO SLOW [] APPROPRIATE [] TOO FAST

13. Rate the ability of the instructor to clearly explain each of the general CAD topics listed below according to the following scale:

    1=EXCELLENT 2=GOOD 3=FAIR 4=POOR 5=UNACCEPTABLE

    a) general concepts 1 2 3 4 5
    b) drawing commands 1 2 3 4 5
    c) editing commands 1 2 3 4 5
    d) plotting commands. 1 2 3 4 5
    e) command sequences. 1 2 3 4 5

14. Rate the ability of each text you used to clearly explain each of the general CAD topics listed below according to the following scale:

1=EXCELLENT 2=GOOD 3=FAIR 4=POOR 5=UNACCEPTABLE

Using AutoCAD		Designer's AutoCAD Tutor
1 2 3 4 5	a) general concepts	1 2 3 4 5
1 2 3 4 5	b) drawing commands	1 2 3 4 5
1 2 3 4 5	c) editing commands	1 2 3 4 5
1 2 3 4 5	d) plotting commands	1 2 3 4 5
1 2 3 4 5	e) command sequences	1 2 3 4 5
1 2 3 4 5	f) overall adequacy	1 2 3 4 5

15. Comment on any particular commands or concepts you had difficulty learning. Is there anything that would have made it easier to learn them?

16. Indicate the level of your interest in learning the material covered:

[] HIGH [] MODERATE [] SLIGHT

17. For each of the factors listed below indicate, by placing a check mark or "X" on the appropriate blank, whether the factor had a positive, negative or no effect on your efforts to achieve the quality of work you desired. Indicate the 3 factors having the most effect on your work for each type of effect by placing a 1, 2, or 3 on the line instead of a check mark or X with "1" having the most effect of the top 3 factors.

factor	+ effect	- effect	no effect
a) text(s) assigned for use	____	____	____
b) subject matter of assignments	____	____	____
c) pace of the course	____	____	____
d) time of day course was taught	____	____	____
e) instructor's teaching style	____	____	____
f) access to computer lab	____	____	____
g) prior computer experience	____	____	____
h) #/type of credits taken this term	____	____	____
i) job	____	____	____
j) family/other outside committments	____	____	____
k) illness	____	____	____
l) absence(s) from class	____	____	____
m) other(list)________________	____	____	____

PLEASE COMPLETE THE REVERSE SIDE

18. If given the choice, would you prefer to learn AutoCAD using materials tailored to your own major?

[] YES [] NO [] DOESN'T MATTER

19. Please indicate any other comments you have about the course.

THANK YOU FOR YOUR RESPONSE ON THIS SURVEY.

INSTRUCTOR POST-COURSE EVALUATION

1. For each of the following sources, indicate which usage category you would recommend. If any of the sources are unfamiliar or inapplicable for either student or instructor use, indicate NA for not applicable. Please add in any additional sources you may be aware of and/or anticipate using in future similar AutoCAD courses. For each of the student and instructor required categories, rank the top 3 sources next to the box. Let number 1 indicate the best of the 3 choices.

REQ=REQUIRED TEXT   OPT=OPTIONAL SUPPLEMENTAL TEXT

	STUDENT USE			INSTRUCTOR USE		
	REQ	OPT	NA	REQ	OPT	NA
a) Using AutoCAD	[]___	[]	[]	[]___	[]	[]
b) Designer's AutoCAD Tutor	[]___	[]	[]	[]___	[]	[]
c) Mastering AutoCAD	[]___	[]	[]	[]___	[]	[]
d) AutoCAD Instant Reference	[]___	[]	[]	[]___	[]	[]
e) Inside AutoCAD	[]___	[]	[]	[]___	[]	[]
f) AutoCAD Reference Manual	[]___	[]	[]	[]___	[]	[]
g) Other:(specify) ______	[]___	[]	[]	[]___	[]	[]
h) Other:(specify) ______	[]___	[]	[]	[]___	[]	[]

2. Rate each text's overall instructional ability on the following issues according to the following scale:

1=EXCELLENT   2=GOOD   3=FAIR   4=POOR   5=UNACCEPTABLE

Using AutoCAD		Designer's AutoCAD Tutor
1 2 3 4 5	a) general concepts	1 2 3 4 5
1 2 3 4 5	b) drawing commands	1 2 3 4 5
1 2 3 4 5	c) editing commands	1 2 3 4 5
1 2 3 4 5	d) plotting commands	1 2 3 4 5
1 2 3 4 5	e) command sequences	1 2 3 4 5
1 2 3 4 5	f) overall adequacy	1 2 3 4 5

3. Did the pace of the coursework require modification from the initial course syllabus and calendar? (If no, go to question 6.)

[] YES   [] NO

4. Indicate any portions of the course which required a modification of pace; indicate the nature of the change and write in the change in duration on the blank.

[] LEARNING EXERCISES . [] MORE TIME NEEDED [] LESS TIME NEEDED ______
[] PROJECT #1 . . . . . [] MORE TIME NEEDED [] LESS TIME NEEDED ______
[] PROJECT #2 . . . . . [] MORE TIME NEEDED [] LESS TIME NEEDED ______

5. If a different amount of time was needed for the learning exercises, what particular assignment #'s and commands/concepts required time modification?

6. Do any assignments and/or projects warrant a modification of time allocation in future sections of this course? (If no, go to question 9.)

[] YES   [] NO

7. Indicate which portions of the coursework require a modification of pace and the nature and duration of each modification. Write in the change in duration on the blank.

[] LEARNING EXERCISES . [] MORE TIME NEEDED [] LESS TIME NEEDED ______
[] PROJECT #1 . . . . . [] MORE TIME NEEDED [] LESS TIME NEEDED ______
[] PROJECT #2 . . . . . [] MORE TIME NEEDED [] LESS TIME NEEDED ______

8. If a different amount of time is needed for the learning exercises, what particular assignment #'s and commands/concepts require time modification?

9. Is there anything which would have made covering the material easier (in terms of additional examples, more or different drawings, lists of key terms, self quizzes, etc.)?

[] NO   [] YES (please comment)

10. Overall, indicate which group of students, by major classification, seemed to be more interested or had an easier time completing one or the other of the two projects or sets of learning exercises.

	Int. Dsn. majors	Other majors
A. Interest level:		
1) general exercises	[]	[]
2) design exercises	[]	[]
3) interior design project	[]	[]
4) sturctural design project	[]	[]
B. Ease of accomplishment:		
1) general exercises	[]	[]
2) design exercises	[]	[]
3) interior design project	[]	[]
4) structural design project	[]	[]

11. Would you change the sequencing of the learning exercise units and/or projects for future sections of this course? If yes, indicate your new sequencing of material.

[] NO   [] YES

12. Do you expect to use either of these texts for future AutoCAD courses?

    a) Using AutoCAD . . . . [] YES [] NO [] POSSIBLY
    b) Designer's AutoCAD Tutor. . . . . . [] YES [] NO [] POSSIBLY

13. Would you recommend either of these texts to other instructors for similar types of courses?

    a) Using AutoCAD . . . . [] YES [] NO [] POSSIBLY
    b) Designer's AutoCAD Tutor. . . . . . [] YES [] NO [] POSSIBLY

14. Please state your overall evaluation of both Using AutoCAD (UA) and Designer's AutoCAD Tutor (DAT) as a primary, required student reference text. Please comment specifically on whether each are able to stand alone for purposes of this class. Please indicate which text you have a preference for based on the following factors. If not applicable, list 1, 2, or 3 under the N/A column using the following coding:

1=NOT APPLICABLE   2=HAVE NO PREFERENCE   3=LACK INFORMATION TO DECIDE

N/A	FACTOR	UA	DAT
	a) text availability from publisher		
	b) support material availability		
	c) cost of text		
	d) organization of subject content for ease of use within chapters/units through the use of:		
....	........1. chapter summaries..............................	....	.....
....	........2. list given of commands covered..............	....	.....
....	........3. italics/bold/underlining/spacing for emphasis	....	.....
....	........4. room for marginal notes........................	....	.....
....	........5. appropriate examples and exercises...........	....	.....
	6. self quizzes		
	e) sequencing of material in the text for ease of use		
	f) clarity and depth of explanations of material		
	g) student preference for one text over another		
	h) reputation of publishing company		
	i) OVERALL TEXT PREFERENCE		

COMMENTS:

Please comment on any other factors you deem pertinent to the selection and evaluation of these and other texts used for student and instructor reference. Use the back of this page or the attached pages if you need more room.

THANK YOU FOR YOUR RESPONSE ON THIS SURVEY