THE USE OF THREE-DIMENSIONAL COMPUTER-GENERATED MODELS
FOR DESIGN PRESENTATIONS :
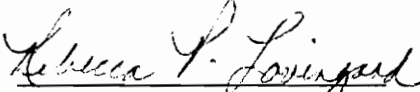## IMPLICATIONS FOR KITCHEN SHOWROOM DISPLAYS

by

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USE OF THREE DIMENSIONAL COMPUTER GENERATED MODELS FOR DESIGN PRESENTATIONS: IMPLICATIONS FOR KITCHEN SHOWROOM DISPLAYS

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(ABSTRACT)

Computers are being used in interior design for space planning, drafting, and modeling. Advances in technology have made it possible to create graphic renderings and animations which enable designers and clients to "walk through" the designed space long before its construction. In kitchen showrooms this technology can be used as a marketing device to generate numerous three-dimensional computer models of complete kitchen setups, each capable of displaying all the possible combinations of styles and finishes available.

The purpose of this study was to test the communication effectiveness of three-dimensional computer-generated models in presenting design ideas and alternatives to a client. Three forms of kitchen design presentations were compared: Line Drawings, an actual Showroom Display, and three-dimensional Computer Model. A sample of 32 residents from the town of Blacksburg, Virginia were shown the three presentations and scored each one for its efficiency of communication of specific design concepts. Their reactions to the use of

computer models as presentation media were also obtained. ANOVAs and Chi Square tests were used to analyze the data.

The Showroom Display was the best communicator of space and design ideas and the Computer Model was most effective in presenting color and finish alternatives. In conclusion, the Computer Models were found to be an effective and acceptable means of kitchen design presentation. Although they cannot replace Showroom Displays, Computer Models can be used effectively and economically as an enhancement to showroom displays and can facilitate reduction of the number of displays required for effective marketing in a showroom.

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CHAPTER 1

INTRODUCTION

The concept of a kitchen was unknown to the primitive man and he obtained his sustenance by eating raw meat when and where he found it. With the discovery of fire, he actually started cooking his meals. Since then there has been considerable development and the modern day American kitchen is far different from the colonial and the 19th century kitchens. "Today the kitchen is a room reborn. Once solely used as a workplace, it is now a multi-purpose family area used also for entertaining guests" (Cheever, 1991, p. v).

The field of interior design has, over the last few decades, branched out into several specializations. In the 1970's, about 20 years ago, the kitchen first emerged as a major room to challenge the professional designer. With this recognition of being a prime room of a modern household came the rush of supplies and technology and of competition among manufacturers (Perchuk, 1988).

The kitchen and bath industry has developed considerably since, and over the last couple of decades has attained a highly professional status. Designers and manufacturers are focusing more on consumer needs and changing trends.

Also, consumers have become consciously aware of their needs and the vast choice of products available on the market. In this highly competitive market, marketing strategies can count as much as the quality of the product itself.

Designers, manufacturers, and dealers are constantly working with new trends and improving marketing strategies to best present their product to the consumer. The way designers work with their clients has evolved too. The clients are now involved as much in the design process as they have been in the decision-making. But, as in all design fields, it is difficult for the client to visualize the finished product by looking at a set of line drawings such as plans, elevations, and perspective views along with a set of sample finishes or specifications.

In the field of kitchen design, showrooms displaying a part of the kitchen setup have seemed to be the ideal solution. This form of display though, has drawbacks mainly due to space and resource limitations. The client is not able to view the complete room (kitchen) but only a part of it and has to visualize the rest. The number of models on display is restricted in terms of number, space arrangements, layout, color schemes, and finishes, thus creating an unclear or incomplete presentation of the complete line of products and the options available to a prospective buyer. Also, showroom displays are capable of representing only one space layout each and these may not represent the client's kitchen layout. Thus, the showroom displays are limited as marketing devices because communication of the final product is unclear.

prupass the communication (1)

Marketing, partially if not totally, depends upon the clarity of communication between the seller and the buyer, as implied by Hosken (1992). Without a clear means of communication, the product, although outstanding, may not have the

expected impact on the consumer. The newest trend in marketing innovation is the use of the computer; its versatility and varied applications offer a number of possibilities. Until the mid 60's the primary use of computers was for text and number oriented jobs such as word-processing, accounting, and records. Today, the possibilities for computer usage are many and range from word-processing, to ray tracing, radiosity, hologram, animation, and virtual reality.

The advances in Computer Aided Design (CAD) software over the last decade have provided designers with efficient means of drafting and documentation. CAD was first seen nearly 30 years ago in the 1960's. By 1988, 84% of the top 100 interior design firms had incorporated the use of CAD along with conventional drafting techniques (Lobelson, 1988). In a design firm, CAD includes the use of computers for assistance in the design process, project and office management, specification writing, and inventory control. New software, advanced graphics, rendering, and animation techniques are now beginning to contribute to the creative side of architecture and interior design. Advanced modeling and rendering algorithms allow designers and clients to walk through and experience the designed space long before its construction. The potential of these modeling techniques as pre-design evaluation tools is obvious (Greenberg, 1991). This technology was used creating animated video tours of a whole city by students at the University of Houston (The Chronicle of Higher Education, 1991). Thus, the applications of three-dimensional modeling are varied and innovative.

In kitchen showrooms, this technology can be used as a marketing device to generate numerous three-dimensional computer models of completed kitchen setups displaying the whole room as against conventional showrooms which have a limited number of models with only a part of a kitchen displayed in each. With these computer-generated models one could have the option of creating combinations of all available layouts, styles, and finishes unlike the showroom displays which can effectively display only one space arrangement, style, and set of finishes per setup. Walk-through animations of these computer models can enable prospective clients to view and experience, at close quarters, a single kitchen setup in a variety of styles and finishes of their choice.

These computer-generated kitchen setups complete with lighting, finishes, appliances, and accessories could provide a possible alternative to the standard showroom setup. However, there is little research to suggest how computer modeling might work in this application and how it may be accepted by the client. This forms the basic purpose of this study.

Purpose of Sudy

The purpose of this study was to test the effectiveness of three-dimensional computer generated models in presenting design ideas and alternatives to a client. Three forms of kitchen design presentations: Line Drawings, an actual Showroom

Display, and three-dimensional Computer Models were compared for their effectiveness in presenting a kitchen design to a prospective client.

Research Objectives

The primary objective of this research was to test the communication effectiveness of a computer generated model of a kitchen showroom setup as a deisgn presentation medium. The research tested whether these models can be considered a possible alternative to an actual showroom displays and whether they are a better alternative to conventional line drawing presentations for the purpose of communicating kitchen design ideas.

The research also aimed to survey and examine consumers' attitudes toward use of computer modeling as a presentation device and obtain their views on its acceptability, their preferences, and its effect, if any, on their buying decisions.

Justification

Currently, the most popular method of displaying kitchen design and finishing options to consumers, is through showroom displays, vignettes, and sets of sample finishes. Due to their limited experience and visualization capability, the process of putting together a number of planning elements, design styles, colors, and other details, and imagining the completed kitchen, can be difficult if not impossible for a layperson. Computer generated modeling has the possibility of enhancing the

(3)

clarity of communication of the design idea and thus determining the success of the presentation (Hosken, 1992). Although the advantage of computer modeling has been tested and proven (Davis, 1986; Hosken, 1992), designers and showroom dealers need justification for the investment of time and resources that would be involved in incorporating such a presentation system into their businesses. The results of this study will indicate the degree of effectiveness of computer-generated models in presenting kitchen design ideas to buyers and the buyers' preferences of presentation devices in kitchen showrooms. These results may be applied to other fields of design and marketing where presentation of ideas to a client is involved, such as other furniture displays and showrooms. The findings will help determine if computer modeled setups are a possible alternative or added enhancement to showroom displays.

CHAPTER 2

LITERATURE REVIEW

The review of literature consists of three parts, beginning with a discussion of the development of the kitchen design industry. An overview of the research in kitchen design is provided and the trends in marketing techniques within that industry and the furniture industry are explored. The second part concentrates on innovations in computer usage and their applications in the design field. The third and concluding part discusses briefly the theory of communication which is the framework for this study.

Research in Kitchen Design

Research in kitchen design began primarily with the study of household work and work management principles within the home. In her writings dating back to the 19th century, Beecher (1873) discussed various aspects of successfully running a household and covered subjects ranging from recipes and general etiquette to care and decoration of the home. The aim of these publications was to propagate ideas for household work simplification, and the general awareness created by these writings, in a way, laid the basis for the field of home economics. The early 1900's saw home economists recognizing the kitchen as a workshop within the home and stressing the fact that functional organization of this space would result in better

home management. Matthews (1941) gave detailed descriptions for arranging an ideal kitchen and included suggestions for suitable finishes, heights for work surfaces, and dimensions for storage shelves.

The first kitchen planning guidelines were published in the 1920's by home economists and instructors at major universities (Cheever, 1991). These home management specialists acknowledged that standardized guidelines for well designed kitchens would save labor and result in increased efficiency.

Leading researchers Mary Koll Heiner and Helen McCullough published a booklet `Functional Kitchen Storage' in 1948, which was used by many other researchers. The basis of this booklet was a study that identified average food stuff and equipment used by typical families in the United States. The researchers then went on to identify the amount of space and equipment needed, which led to recommendations for a functional storage system. These included specific suggestions for the space allotted in each kitchen center of activity, the type of storage planned, and the recommended cabinet and countertop frontage dimensions. Kitchen specialists, until the early 1990s, used and followed the recommendations and guidelines which were predominantly based on this 1948 publication (Cheever, 1992).

The primary objective of home management studies was to be able to measure and thereby be able to minimize the human costs of household work. Steidl and Bratton (1967) summarized and defined the concept of the work, the

worker, and the workplace which provided the framework for these studies aimed at appraising the use of the human resource.
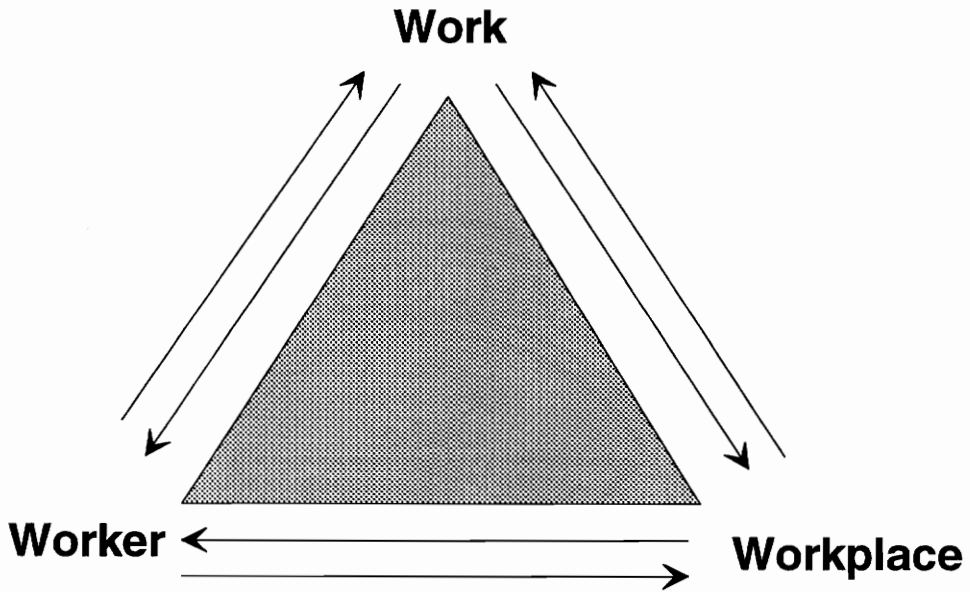
Work

Figure 1. The Concept of Work, Worker, and Workplace (Steidl & Bratton, 1967)

These three components of household work were determined to be interrelated and each capable of affecting the other two to some extent. Therefore, the measurement of the personal costs of work required not only a broad concept of these costs, but the use of knowledge about the other two dimensions of work - the work itself and the place of the work. Within this context, the workplace itself was studied to determine the conditions that expedite the activity, that exert the minimum

of strain on the worker, and that require minimum effort. And, the terms "strain" and "effort" were broadly interpreted to include not only the physical but also the affective, cognitive, and temporal costs of work. Aspects such as the location in vertical and horizontal space, the spatial arrangement of parts, the amount of space for work and storage, and specific features were examined (Steidl & Bratton, 1967).

A significant amount of the research in work-energy relationships and motion-activity measurements was conducted by the Small Homes Council at the University of Illinois. The outcome of these studies in workplace design was the formulation of principles for functional design of kitchens and other workplaces. These guidelines were published through booklets and circulars such as Cabinet Space for the Kitchen (McCullough, 1949) and Kitchen Planning Standards (Kapple, 1965) and were widely used by professionals and consumers. In kitchens, work surface heights, widths, and depths for specific tasks such as food storage, preparation, and cleaning were determined. The concepts of the work triangle and work center, although existing since the 1930's, were explored fully and incorporated into the workplace design process in order to facilitate the flow of work during a particular task.

In the 1950s and 1960s, the quest for better arranged kitchens was taken up by major manufacturers. Appliance and cabinet manufacturers began publishing brochures that presented proper kitchen planning.

In 1965, a major kitchen planning resource, the first edition of the Kitchen Industry Technical Manuals, was published by the American Institute of Kitchen Dealers (AIKD), which later became the National Kitchen and Bath Association (NKBA), and the Small Homes Council at the University of Illinois. Developed under the support of the AIKD, the University, and a group of Certified Kitchen Designers (CKD), this set of five manuals became the basis for CKD certification. The manuals have been a practical guide and handbook for designers and have also been used by many consumers. Since then, progressive research conducted through the AIKD and later the NKBA, has aimed to identify strategies and to integrate new technologies and changing family roles into the kitchen planning process.

Yust and Olson (1991) of the University of Minnesota, in conjunction with the NKBA, surveyed 101 families who had recently completed a kitchen remodeling or had developed a plan for new construction. The objective was to study the relationships that have emerged as contemporary kitchen technologies which integrate with family roles, preferences and management styles. Questionnaires were mailed to subjects who were previously identified by Certified Kitchen Designers as "typical" American families.

The households were mostly two to four person families with only 4% single persons. The respondents were mainly female heads of household, 60% of whom, along with their spouses, had completed at least a four year degree and many had studied beyond. About one-third were homemakers, a third professionally

employed, and a quarter were employed in services or trades. One-half of the spouses were professionally employed and about a third were employed in services or trades. The study assessed the space arrangements, facilities, activities, and characteristics of the household. The owners of these kitchens were happy as shown by the fact that 98% were satisfied with the amount and type of storage and 97% were satisfied with the kitchen arrangement for meal preparation, as well as being satisfied with the amount and location of counter space for meal preparation.

The findings of Yust and Olson identified the need for kitchen designers to provide a workable efficient kitchen for extensive food preparation with space for additional helpers. The results strongly suggested that the use of the kitchen has expanded beyond being a place for food preparation and storage to include more non-food related activities, including social, leisure, and entertainment. The expansive function and multi-faceted use of the kitchen demands a comprehensive design with equal attention to the efficiency as well as the aesthetics of the space. However, when scored, 46% of these survey participant's kitchens scored poorly on one or more of the scoring criteria published in the first edition of the Kitchen Industry Technical Manuals which was based on the 1948 publication, Functional Kitchen Storage, (Heiner & McCullough, 1948). Therefore, the results of this survey also proved that planning standards developed in 1948 were not appropriate for today.

In the NKBA Design Competition Survey (Cheever, 1991), a statistical poll of 60 kitchens from three different size categories was conducted. Each of the 60 kitchens was measured to determine the average lineal footage of cabinetry, number of drawers, and lineal footage of countertop. Each center of activity was then compared regarding equipment included within the center and the relationship of the centers to one another. The researchers also cataloged which kitchen arrangements were most often specified, what percentage of kitchens were open to adjacent living spaces, and what percentage of kitchens had some sort of eating center or other specialized area within the work space. Lastly, they measured the work triangle of each space. The overall results from this survey paralleled the information reported by Yust and Olson (1991).

The NKBA Utensil/Food Stuff Survey was conducted to develop a new list of equipment typically found in a North American kitchen, and to identify the appropriate storage space essential to accommodate these items, in order to develop new industry standards for acceptable kitchens in two size categories (Cheever, 1991). The original list of equipment and foodstuff developed by McCullough was used as a basis and was augmented by additional items typically found today.

Surveys were sent to 40 families asking them to identify what they kept in their kitchen and how often they used it. Secondly, they were asked where they used the item and where the item was stored. Lastly, they were asked how many of

these specific items were kept in the kitchen. Tabulations revealed that the number of items kept in kitchens was between 50% to 100% greater in number than in the original 1948 survey. Based on these findings, recommendations were made for base and wall storage frontage, number of drawers required, and countertop frontage for a large kitchen over 150 square feet and a small kitchen under 150 square feet. The results from these research projects were compiled to form a set of specific guidelines for kitchen designers in the "31 Rules for Kitchen Design" (Cheever, 1992).

The confirmation of the Americans with Disabilities Act-1990 added a new dimension to research in kitchen design. The principles of barrier-free design were developed to meet the demands of the growing percentage of aged and disabled population. The concept of adaptability and universal design resulted from the need to provide spaces and facilities which can be used as efficiently by people with limited capabilities such as young children, elderly, and others with physical or mental limitations. Some of the practical implications of these principles in kitchen design include controls that are easy to operate, sufficient lighting, and a place to be seated when one works (Guetzko & White, 1991).

Kitchen standards, as we can recognize from the review of their history, developed mainly through home economics research and were not a direct outgrowth of the furniture industry. However, both the kitchen design industry and the furniture industry have similar products and common target markets. The

display and sale techniques used in both today, are also similar and so are their advantages and drawbacks. A brief review of marketing trends in the furniture industry can provide a better understanding of the kitchen retail sector.

Marketing in the Furniture Industry

The furniture industry has evolved from being a product oriented industry to becoming a consumer oriented industry (Bennington, 1985). The furniture markets are in transition and this transition reflects basic changes in the attitudes and attributes of the consumer (Bullard, 1989). The old-fashioned customers based their needs on whims and fancies and, accordingly, the furniture stores catered to these needs (Slom, 1967). Slom observed that in the early 1900s there was great demand for heavy furniture as this was considered as "more furniture" for the money spent and this furniture was sold by the pound. Today's educated consumer responds positively to news and facts and will see through a deceptive discount off inflated price lists.

The early part of the 20th century saw new marketing trends such as chain-selling operations and mail-order catalogs. There was also an increase in specialty furniture houses in the mid-thirties. Furniture marketing strategies are now evolving to suit consumers' values and new tastes. Bennington (1985) stressed that a consumer-oriented approach to marketing recognizes the consumer as the final decision maker in the marketplace.

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The purchase of furniture is very personal because furniture is such a conspicuous product perceived by many people to be a reflection of their individual tastes and personalities (Bennington, 1985). Because of the intensely personal nature of the purchase and the vast number of options available in the marketplace, the consumer may have a difficult time making a buying decision. The seller's marketing strategy plays a vital role in helping the customer make their buying decision. The Popcorn Report on consumer trends and market research, cited by Peterson (January, 1993), states that consumers in the 1990s will demand truth in advertising. Today they are well educated and tend to know what they want (Bullard, 1989). Based on the Popcorn Report, Peterson suggested some advanced furniture marketing techniques for the 1990s as "advertorials", radio commentaries, consumer booklets, mobile showrooms, and video tapes all aimed toward factual and real presentation of the product to the consumer.

The emphasis in marketing strategies has always been on customer satisfaction before and after the sale. Efficient sales assistance ensures that customers get what best suits their needs and therefore eventually results in customer satisfaction.

In the past, despite the amount of research on furniture marketing, many criticisms directed at the furniture industry were focussed at the marketing methods (Davis, 1957). One of the fallacies cited has been the expense of the multiple furniture exhibits displayed. The concept of showrooms displaying mockups or

actual exhibits of their product must have come out of wanting to communicate to the buyer what exactly they were going to get for their money. However, as Davis concluded, space and resource limitations make it impossible to exhibit in real all materials and finishes available to the consumer. Similarly, in kitchen showrooms, despite the large line of products avaliable, only a limited number can be displayed in the vignettes. This is a drawback in the consumer-oriented marketing strategy.

Marketing in the Kitchen Design, Display, and Sale Industry

The kitchen first emerged as a major room to challenge the professional architect and designer about 25 years ago. And with this recognition of the kitchen as a prime room of a modern household came the rush of suppliers to fulfill the requirements of this market (Perchuk, 1988). The number of choices in appliances, materials, and components was numerous and confusing. But, as Perchuk predicted, this was just the beginning and in the near future, computerization, remote control, and retrieval systems would become available as manufacturers refine and implement their inventions.

Hart and Pell's (1993) report on the kitchen remodelling market suggested that close to 5 million kitchens would be installed in the year 1993 alone. Three-fourths of these would be remodelling jobs while the remaining one-fourth would represent new construction. Remodeling is done to alter the function or the aesthetics,or both, the two main aspects to the design of a space. Depending on

the kind of space being designed, each plays a proportionate role in the design of that space. As the primary workplace in the home, the functional aspect of the design of the kitchen typically takes precedence over the aesthetic aspect. The functional aspects of kitchen design include space allocations, work triangle, storage, surfaces, lighting, and ventilation. The aesthetic aspect concerns itself with colors, textures, lighting, and basic appeal to the homeowner. More homeowners remodel their kitchens primarily for increasing functional efficiency than for aesthetic change.

The modern kitchen consists of a series of components ranging from furniture and cabinetry to appliances and accessories. In order to ease the shopping process for the consumer, kitchen dealerships offer not only furniture, i.e. cabinetry in a multitude of styles, but also surface finishes such as flooring and wall-paper, window treatments, and even appliances. These products, as observed by practicing designers (Bowman, Robertson, & Hendricks, personal communication, November 1993), are displayed in the showrooms as vignettes along with samples of all other available options and finishes. Although the options available to the client are numerous and in infinite combinations, not all of them can be displayed in the showroom. To assist clients in planning their kitchens and selecting the appropriate products, many dealers offer in-house design services of professionals such as Certified Kitchen Designers or interior designers. Based on the client's requirements, style preferences, and budget, the designer prepares a set of

drawings which include two-dimensional plans and elevations and sometimes a three-dimensional perspective view. The designer then, with the aid of the drawings and options of sample finishes, presents the complete kitchen design to the client. The client, usually untrained in interpreting technical drawings and possessing limited visualization skills, tries to assimilate the design idea for the new kitchen. The vignettes and model displays are of limited help as references since they cannot provide a complete representation of the design idea and the exact style and combination of finishes suggested by the designer may not be displayed in the showroom vignettes. Also, the space arrangement of the showroom vignettes may not represent the client's kitchen layout. Thus communication between the designer and the client remains obscure.

Use of Computers in Design and Presentations

Computers have automated many businesses and made working environments more efficient and productive. The implementation of CAD (computer aided design) software has done the same in the design fields. Recent research indicates that the use of CAD in Interior Design will increase considerably. By 1988, 84% of the top 100 interior design firms had incorporated the use of CAD along with conventional drafting techniques (Lobelson,1988). Although some of these are mere drafting aids, most commonly available CAD packages assist in such design

functions as space planning, drafting, specifications, and three-dimensional modelling (Haworth, 1984; Planck, 1979; Steelcase, 1983).

A number of CAD packages created specially for kitchen design, such as Cabinet Vision, CADKIT, Planit, and 20-20, are now available (Markussen, 1992). The features and capabilities of these software programs were compared and evaluated by Markussen based on three documents from the National Kitchen and Bath Association: "Graphic and Presentation Standards," "31 Rules for Kitchen Design" and, "Generic Nomenclature." In addition to enabling designers to design kitchens and produce plans, elevations and perspective views, these programs also facilitate preparation of complete project documents including estimates and production drawings. The output from these software programs is mainly production documents and two-dimensional drawings and perspectives which have limited use as design presentation material.

Davis (1986) used computers to investigate solar studies and presentation graphics depicting static views of an architectural exterior form. In addition, Davis and Bernecker (1984) researched the use of computer graphics to predict people's subjective responses to various lighting alternatives. Their work indicates the computer to be an accurate predictor of impressions of spaciousness, visual clarity, and overall preference.

The results of Cleveley's study (1987) substantiated the usefulness of computer stimulation in recording end users' ability to relate to the built environment.

The end user was able to appreciate the qualitative aspects of the proposed built environment in the conceptual design phase when shown, through a computer stimulation, the movement of a wheelchair bound person negotiating a double-door vestibule.

Computer Animation and its Applications

The ability to communicate graphically is imperative to all designers (Hoffman, 1983; Meyers, 1982). In the kitchen retail business it is equally essential for the designers to communicate to and sell their ideas and kitchens to the client. According to kitchen designers (Bowman, Robertson, & Hendricks personal communication, November 1993), drawings and samples are often inadequate presentation materials and the client needs to visually see the image the designer is trying to portray.

One of the most modern means of communication is computer animation. Its applications in the field of design are still being explored. Some of the comprehensive three-dimensional design software packages have advanced graphic rendering and animation features which enable designers and clients to walk through the designed space long before its construction (Greenberg, 1991). Architecture design students at the University of Houston created an animation of the whole city via computer-generated video tours (The Chronicle of Higher Education, 1991).

Hosken (1992) compared the use of computer animation versus still-frames as presentation techniques for interior designers. The two forms of presentation were shown to the participants and their interpretation of the designed space was compared to the designer's interpretation of the same space. The results showed that the participants' interpretation of the space, viewed in the animated presentation, ranked more closely to the designer's interpretation, as against their interpretation in the still presentation. This indicates that the use of animation as a presentation technique is a powerful communication tool for designers to use with clients. This medium, animation, establishes realistic views of an interior space from a variety of perspectives, offering the client a greater level of understanding while also reducing their anxiety about the proposed design.

One of the more versatile three-dimensional animation software packages on the market is AutoDesk 3D Studio (Loveria, 1991; Simone, 1991). Its true-to-life rendering capability makes it possible to create life-like scenes and animations. McLain-Kark, Brandon, and Dhuru (1994) used this software to create the interior of a proposed health-care unit and also tested the same as a presentation technique. A group of gerontologists, businesspeople, and health professionals, forming the task force who gave feedback to the architect on the proposed design for the Alzheimer's Center, were the sample for this study. Still-frame renderings of the computer model of the proposed design were presented to this task force on the computer. It was evident that previously the task force members had not understood

the design from viewing the two-dimensional drawings. By viewing the computer generated model, they were able to provide specific suggestions to improve the interior design to accommodate the Alzheimer's patient. The results of this informal study indicated the enhanced clarity of communication of the designer's ideas when presented in a three-dimensional rendering on 3-D Studio as compared to the earlier presentation of two-dimensional drawings. The animation capabilities of this software, 3D Studio, in interior design presentation applications are yet to be tested.

Theoretical Framework

The theoretical framework for the study is based on a theory of communication. The most basic form of communication is the uni-directional communicative method of the Sender-Message-Receiver (Figure 2), as defined by Havelock (1971). This simple diagram represents communication as an interpersonal process, yet it does not represent the process in reality as there is no feedback from the receiver.

sender)   **Message** ▷   (**receiver**
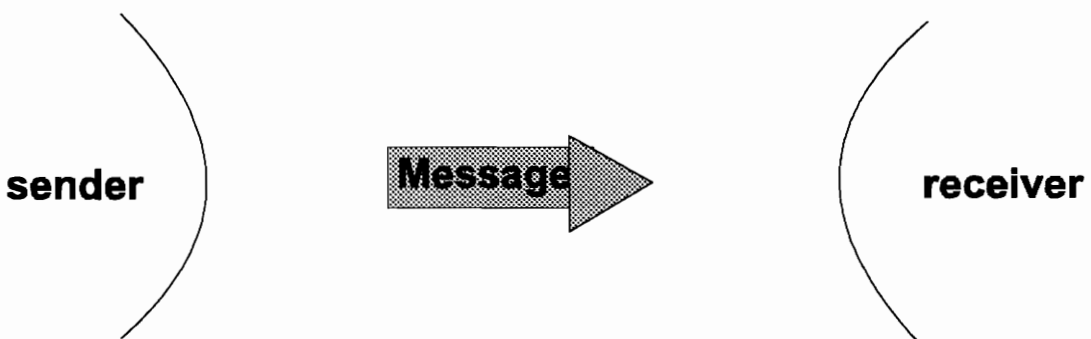
Figure 2   A One-Way Communicative Act (Havelock, 1971)

Communication is a back and forth process, between the client and the designer, where the flow of information is in both directions but the flow of knowledge/solution in only one direction. The designer is approached by the client with a specific problem/task to solve. The designer interprets the client's problem, researches it, and uses his or her professional knowledge to formulate a suitable solution. The solution is then packaged and presented to the client through communicative media such as sketches and drawings. The client assimilates the solution and may or may not be fully satisfied, and subsequently provides the designer with feedback regarding the solution. The designer then resolves the client's doubts and presents the revised solution back to the client. It is a successive process which continues until the client is fully satisfied with the solution provided by the designer. This multi-directional communicative method utilized in the design process can be compared to the model of a Two-Person Knowledge Utilization System (Figure 3) by Havelock (1971).
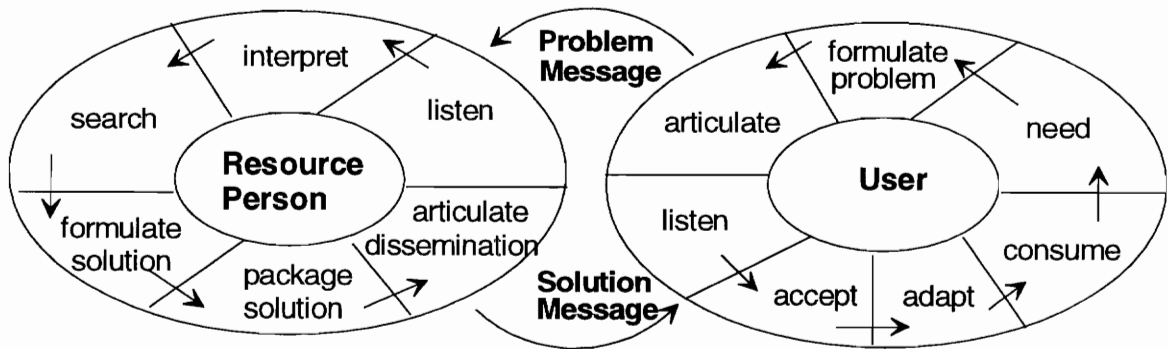
Figure 3   A Two-Person Knowledge Utilization System (Havelock, 1971)

The thought process of the "resource person" is comparable to that of the designer and similarly that of the "user" to the client/consumer. The designer makes use of his or her professional knowledge, in this case kitchen planning skills, to solve the problem and communicative skills to present the solution/design to the client. The presentation of the design is an important step in the communication between the "resource person" and the "user". There exist various methods of presentation which have been discussed earlier and the search for better and more communicative methods and media is endless. This study aimed to evaluate three methods of solution packaging and presentation.

Based on the above model, the variables of research in this study were the packaging of the solution, articulation of dissemination of the solution, and its perception and acceptance by the user.

To achieve the level of communication demonstrated in Figure 3, the barriers existing within and between either person must be reduced or eliminated. These barriers, defined by Havelock (1971) as interpersonal and intrapsychic barriers, are qualities that differentiate people of different levels. Havelock further described communication between two people of different levels as a process of overcoming intrapsychic and interpersonal barriers. Language, demographic discrepancies, and discrepancies in perception of situation, role, values, and self image are some interpersonal barriers in the communication model (Figure 4).

Interpersonal Barriers
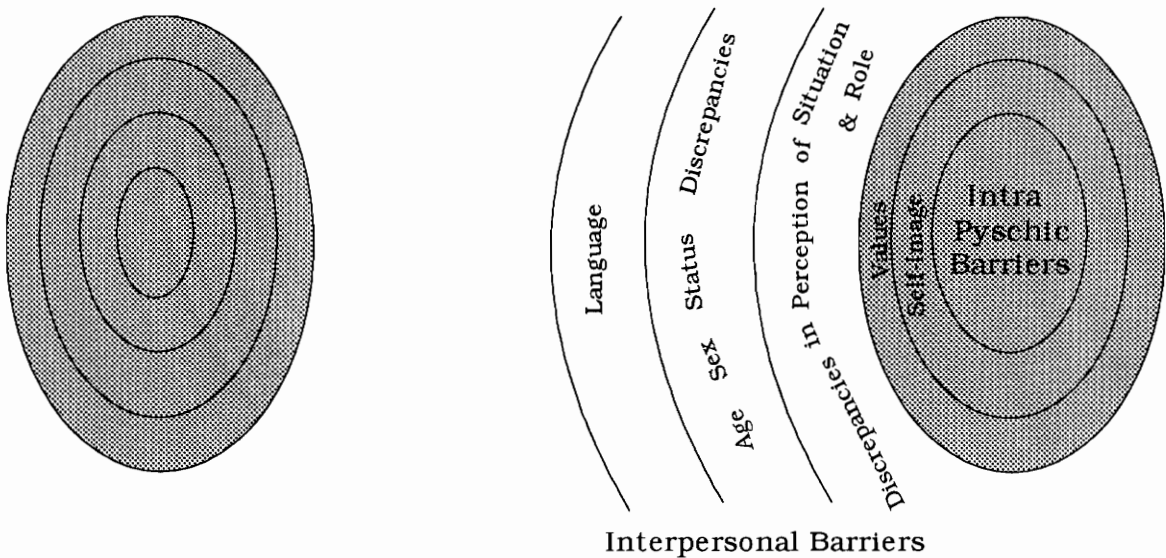
Figure 4   Interpersonal and Intra Psychic Barriers (Havelock, 1971)

The language and perception barriers, from the above diagram, can be said to be responsible for the lack of clarity of communication between a designer and a client. The client is unable to understand and comprehend the visual language (of

the drawing) which, however, for the designer is the best available means to present his or her ideas. The effect of these barriers on the clarity of communication is obvious. The degree to which these barriers of language and perception affect the communication process will vary depending on the method or type of communication device used. The other barriers due to discrepancies in age, sex, and status were controlled in this study by purposively selecting the sample.

The process of presenting a kitchen design idea, through a certain medium, to a prospective client, is comparable to that of solution packaging and dissemination (Figure 2), while simultaneously overcoming inter-personal barriers (Figure 3). This study tested three different methods of solution dissemination and their individual degrees of effectiveness in communicating to the user.

Summary

A review of literature revealed information on research in computers and animation methods used as design and presentation techniques by designers. The primary use of animation by computer-aided designers has been shown to be as a principal medium for design presentations to clients and as a pre-design evaluation tool. Animation has also been used as an advertising device in marketing, however, not as a direct user-interactive tool in selling different design options to a client. The literature suggests that because there is a strong relationship between three-dimensional and animated presentations and the clarity of communication of design

ideas, computer animation could be a valuable tool for helping the client visualize the designer's ideas.

Given this background, the study was designed to investigate the effectiveness of three methods of design presentation; Line Drawings, Showroom Display, and three dimensional Computer Model as communication tools for kitchen designers in presenting various design and style/finish options to a client.

CHAPTER 3

METHOD

The purpose of this study was to compare the effectiveness of communication of three-dimensional computer-generated models in presenting design ideas to a propective client. Three forms of kitchen design presentation: Line Drawings, an actual Showroom Display and a Computer Model were compared. The presentation techniques included in the study here are the three methods of communication used by designers/sellers to convey design ideas to clients/buyers.

This chapter is a report of the methodology used in this study. Included are the criteria used in selecting the sample, a description of the instrument used for data collection, and a detailed account of the procedure used to collect data. The chapter concludes with report of the method of data analysis.

Sample

The participants for this study were purposively selected from the population of the town of Blacksburg, Virginia. The selection criteria for the participants were based on the characteristics of typical clientele visiting a kitchen showroom which have been identified earlier (Yust & Olson, 1991). These criteria include factors such as socio-economic status, and familiarity with kitchen facts and/or home remodeling. The total number of participants in the sample was restricted to 32.

The Building Permit Office of the town of Blacksburg was contacted to obtain names of people who had submitted applications for building permits in the past six months. The sample was selected from among applications for new single family residences in the cost range of over $125,000 and for single family residential remodeling in the cost range of over $5,000. This range of building costs was determined to be one within which people are likely to install a custom-built kitchen. On collecting this information, these applicants were contacted to obtain their consent for participation. Introductory letters (Appendix A) were mailed to them to describe the study and indicate the reason for their selection as prospective participants for this study. Each prospective participant was then contacted over the telephone in order to inquire regarding their interest in participating in the study, until the required sample was obtained. Appointments for the data collection interviews were also scheduled at this time.

The final sample was composed of 75% remodeling applicants and 25% new construction applicants. This breakdown represents the actual figures for the type of kitchen construction work that is currently done (Hart & Pell, 1993). There were 20 females and 12 males in the sample. The selection criteria which ensured the participants' familiarity with kitchen facts and/or home remodeling eliminated the interpersonal barriers (Figure 4) and eased the flow of communication between the researcher and the participant.

Instrument

Questionnaires were prepared for data collection (Appendix B). The questionnaire was in five parts and consisted of close-ended and open-ended questions.

Each of the first three parts included the same two close-ended questions which aimed to record a participant's perception of the kitchen design displayed in each of the three presentations: Line Drawings, Showroom Display, and Computer Model. In the first question the participant was asked to visualize performing a specific task in the kitchen design presented. The second question asked the participant to imagine altering the finishes on the presented kitchen and visualize this new kitchen in the new finishes. For both these questions, the participants were requested to score each presentation on the ease of visualization they offered. A seven point scale was used to record the scores with 1= very difficult and 7=very easy. This method of scoring allowed the participants to indicate the degree of ease of visualization offered by each presentation.

The fourth section of the questionnaire consisted of general questions on the communication of space and design concepts. The participants were asked to compare and score the three presentations for their ability to communicate information about the space and the design. Five specific design concepts were evaluated: "the total kitchen," "horizontal spatial relationships," "vertical spatial relationships," "storage space," and "functional aspects." The presentations were

again scored on a seven point scale with 1= very difficult and 7=very easy. These questions were geared toward estimating whether there is a difference in the communication ability of the three presentations in terms of specific space and design concepts. In the last question in this section, the participants were asked to choose which of the three presentations would help them most in making a "buying decision" in the absence of an appropriate showroom display.

The open-ended questions in the concluding part of the questionnaire were designed to estimate the participants' overall impression about the three presentations and their preferences and attitude toward computer presentations. The first six among these questions asked the participant to name the most and least liked aspect about each of the three presentations. The next two questions asked about how close they felt the computer model appeared to the actual showroom display and about how they might change the computer presentation if it were possible. The final question was one of their personal attitude toward computer presentations in general. Here, the participants had to choose one of four comments on how they would feel about viewing a computer presentation of their own kitchen remodeling project. Last, the participants were asked if they would be willing to participate in a follow-up study of this project.

Procedure

The total scope of this project included preparing and setting up the three forms of presentation to be evaluated: line drawings of the kitchen display, the computer-generated model of the kitchen, and the actual showroom display, scheduling and conducting the data collection interviews, and finally analyzing and interpreting the data.

Presentations

Showroom display The three presentations were prepared and set up as follows. A kitchen cabinet manufacturer was located who was willing to lend an actual showroom display (Figure 5) for use in this study. This showroom display built in the traditional style was comprised of an L-shaped configuration with an island located in the center. It included in addition to wall and base cabinets along both walls, a cooktop on one wall and a double-bowl sink on the other. A ventilating hood was also present above the cooktop. The back-splash material on the portion of the wall between the wall cabinets and the counter was a ceramic tile with a hand-painted trim. When set up, the display occupied an area of approximately 10'-0" X 10'-0" and was about 8'-6" high. The showroom display was assembled and set up for data collection in the Housing Research Laboratory, Department of Housing, Interior Design, and Resource Management in Wallace Hall. This university site was easily accessible to the participants. The showroom presentation consisted of

Figure 5   Photograph of Showroom Display of Kitchen

the display model and a catalog and sample showing the alternative finishes for the kitchen.

Line drawings The Line Drawings of the same showroom display (Figure 6) were prepared. There were two drawings, one included a dimensioned plan, two wall elevations, and a legend of specifications for the cabinetry and finishes, while the other was a black and white perspective view of the kitchen. The drawing presentation included samples of the cabinet door and countertop material showing the original finishes and additionally a catalog and another sample of countertop material showing the alternative finishes (Figure 8).

Computer model The Computer Model (Figure 7) was simultaneously created, using the software program 3D Studio, to represent an exact duplication of the actual showroom display. The computer hardware used for generating the model consisted of a 486 DX2, 33 Mhz processor with 4 mb of RAM and 250 mb hard drive storage. It also utilized a video graphics card and a math co-processor. The output was through a high resolution monitor. The computer presentation consisted of two parts, the first one being a still-frame image of the showroom display followed by an animation and the second one being another animation. The first animation depicted the viewpoint of a person attempting to perform the task in the kitchen (refer to Appendix C: Questionnaire, Part III A). The second animation showed the change in finishes fading from the original ones to the proposed new ones (refer to Appendix C: Questionnaire, Part III B).
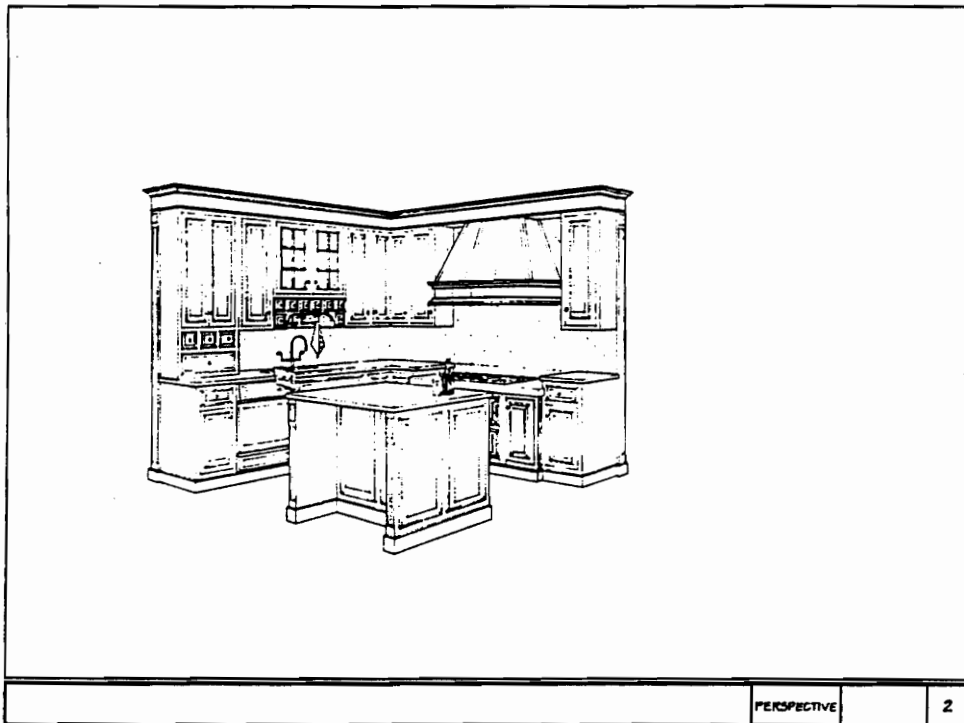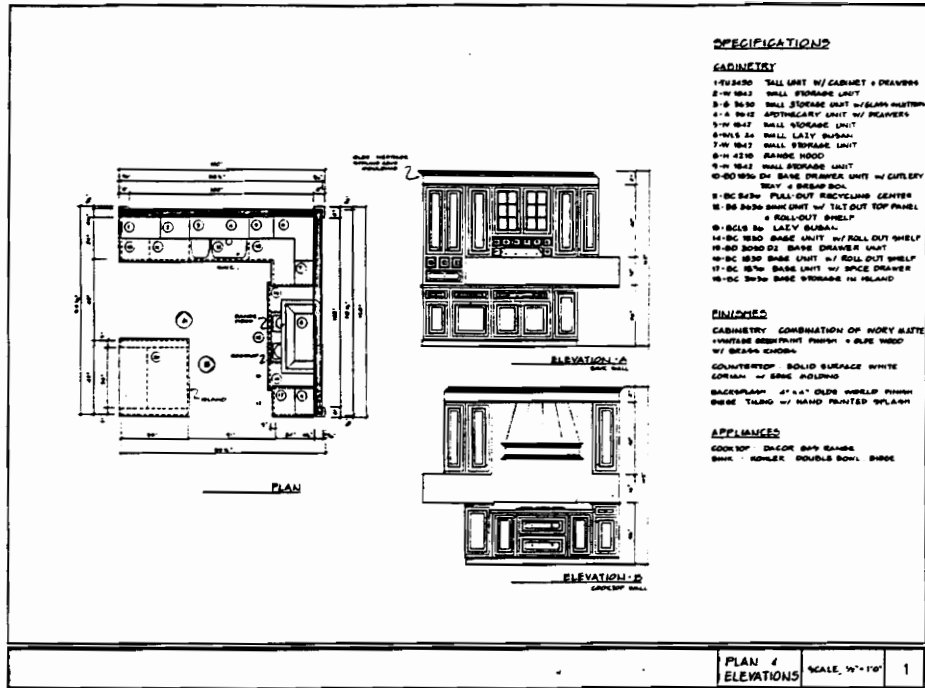
Figure 6. Line Drawings of the Kitchen

Figure 7   Computer Model of the Kitchen

The computer presentation was set up in the CAD Lab, a couple doors down the hall from the Housing Research Lab where the Showroom display was located.

<u>Data Collection</u>

Data collection interviews were scheduled individually for most participants except some married couples who preferred to participate simultaneously. Upon arrival the participants were given a brief presentation (Appendix B) describing the nature of the study and the procedure that would follow. They were also asked to sign a formal consent confirming their willingness to participate in the study.

The participant was shown the first presentation, the Line Drawings, along with the door samples and sample of countertop material representing the original set of finishes (Figure 8). The participant was then asked to complete the first question in part one of the questionnaire. Next, the participant was shown the alternative sample finishes for the same kitchen design (Figure 8) and then asked to write a response to the second question in part one of the questionnaire.

The participant was then walked over to the Showroom Display (Figure 5) and was given a chance to walk around the display and examine it. Following this, each participant was asked to fill in their response to the first question in part two of the questionnaire. The samples of alternative finishes were then shown and subsequently the second question in this part of the questionnaire was answered by the participant. The Computer Model was then shown (Figure 7).

Figure 8   Drawing Presentation with Original and Alternative Set of Finishes.

As described earlier, this was in two parts and each was shown for the corresponding question that was to be answered on part three of the questionnaire. First the animation with the simulated movement of the performance of the task was shown and the participant filled out the response to the first question in part three of the questionnaire. Secondly, the animation with the changing finishes (Figure 9) was shown and similarly the participants filled out the response to the second question.

The participants then answered the last two sections of the questionnaire. Finally each person was presented with a small gift as a token of appreciation for their participation in the study.

Methods of Data Analysis

The data collected through the questionnaires answered by the sample were analyzed on the Number Cruncher Statistical System. Several different tests were used to analyze the data. Descriptive statistics were used to acquire basic statistical data employed in the analysis of the primary research objectives. One Way Analysis of Variance (ANOVA) was used to determine if there were any significant differences in the communication ability of the three design presentations. An ANOVA was used because the data were considered to be continuous for the purpose of this study. The alpha level for significance was $p=.05$.

Figure 9. **Still-Frame Images of the Computer Model with Original and Alternative Finishes.**

A Duncan's New Multiple Range Test was used as a post-hoc test on ANOVAs to check for statistical differences among presentation preferences and to isolate the presentation that was the most preferred and therefore the most effective. Single sample Chi Square tests were used to determine whether the frequency of the responses differed among the three presentations and to analyze the responses to the question on the closeness in appearance between the computer model and the showroom display. Chi Square tests were used because these data were categorical in nature.

CHAPTER 4

RESULTS

The primary objective of this research was to test the effectiveness of three-dimensional computer-generated modeling in presenting design ideas and alternatives to a client. Three forms of kitchen design presentations, Line Drawings, an actual Showroom Display, and three-dimensional Computer Model, were compared for their effectiveness in presenting a kitchen design to a prospective client. The null hypothesis tested in the analyses was: "There is no significant difference among the three presentations in their communication effectiveness ."

$$H_o : \mu_{drawings} = \mu_{Showroom\ Display} = \mu_{Computer\ Model}$$

The research also aimed to survey and examine consumers' attitudes toward use of Computer Modeling as a presentation device and obtain their views on its acceptability. A sample of 32 individuals involved in home building or remodeling activity compared the three presentations for their effectiveness and ranked the acceptability of computer-generated models.

This chapter is a report of the findings from the study and the statistical tests used to analyze the data collected through the questionnaires filled out by the sample. The data for each research objective were analyzed and the findings are reported. The chapter concludes with a discussion of the results and some possible explanations for the outcomes.

Visualization of Task

The three presentations were compared for their ability to allow easy visualization of an activity in the kitchen design presented. The participants were shown the three presentations and were asked to visualize themselves performing a specific task in the kitchen presented. They were then asked to score each presentation for ease of visualization of the task. Participants assigned scores on a seven-point scale with 1 = very difficult and 7 = very easy. The null hypothesis tested in the analysis was: "There is no significant difference among the three presentations in ease of visualization of a task."

The Showroom Display scored the highest followed by the Computer Model and lastly the Line Drawings (Table 1). One Way Analysis of Variance revealed a significant difference in the three presentations (F=9.07; df=2, 95; p<.05). Subsequently the null hypothesis was rejected and the alternate hypothesis was accepted.

$$H_a : \mu_{drawings} \neq \mu_{Showroom\ Display} \neq \mu_{Computer\ Model}$$

By using the results of the Duncan's New Multiple Range Test and the means for the scores (Table 1), it was determined that the Showroom Display was significantly better than the Line Drawings and the Computer Model in allowing easy visualization of the task.

Table 1

<u>Means for Ease of Visualization of Task for the Three Presentations</u>

PRESENTATIONS	MEANS *	S.D.
Line Drawings	5.87 [a]	1.00
Showroom Display	6.81 [b]	0.00
Computer Model	6.22 [a]	1.22

<u>Note</u>

* Responses were coded where: 1= Very Difficult, 2= Difficult, 3= Fairly Difficult, 4= Easy nor Difficult, 5= Fairly Easy, 6= Easy, 7= Very Easy

[a, b] Means with different letters are significantly different ($p<.05$) using Duncan's New Multiple Range Test.

$F=9.07$; df=2, 95; $p<.05$

Visualization of Change in Finishes

The three presentations were compared for their ability to allow easy visualization of change in finishes in the kitchen design presented. The participants were shown each presentation and asked to visualize a change in the finishes used for each kitchen design. They were then asked to score each presentation based on a seven-point scale with 1 = very difficult and 7 = very easy. The null hypothesis tested in the analysis was: "There is no significant difference among the presentations in ease of visualization of change in finishes."

The Computer Model scored the highest followed by the Showroom Display and lastly the Line Drawings (Table 2). One Way Analysis of Variance revealed a significant difference in the three presentations (F=10.37,df=2, 95; p<.05). Subsequently the null hypothesis was rejected and the alternate hypothesis was accepted.

$$H_a : \mu_{drawings} \neq \mu_{Showroom\ Display} \neq \mu_{Computer\ Model}$$

By using the results of the Duncan's New Multiple Range Test and the means for the scores (Table 2), it was determined that the Computer Model was significantly better than the Line Drawings and Showroom Display. However, there was no significant difference between the Line Drawings and the Showroom Display in ease of visualization of change in finishes

Table 2

Means for Ease of Visualization of Change in Finishes for the Three

Presentations

PRESENTATIONS	MEANS*	S.D.
Line Drawings	4.56 [a]	1.78
Showroom Display	5.19 [a]	0.59
Computer Model	6.31 [b]	1.01

Note

* Responses were coded where: 1= Very Difficult, 2= Difficult, 3= Fairly Difficult, 4= Easy nor Difficult, 5= Fairly Easy, 6= Easy, 7= Very Easy

[a, b] Means with different letters are significantly different ($p<.05$) using Duncan's New Multiple Range Test.

F=10.37; df=2, 95; $p<.05$

Communication of Design and Space

The presentations were compared for their ability to communicate the overall design and specific space concepts regarding the kitchen. Each presentation was scored on five different spatial and design concept questions which included, "the total kitchen," "horizontal spatial relationships," "vertical spatial relationships," "storage space," and "functional aspects." Participants assigned scores based on a seven-point scale with 1 = very difficult and 7 = very easy. The null hypothesis tested in the analyses was: "There is no significant difference among the presentations in their communication ability of space and design."

The means for the responses (Table 3) show that the Showroom Display scored the highest on all questions. The Computer Model scored higher than the drawings on all but one question. One Way Analysis of Variance was done separately on the scores for each individual question and revealed a significant difference in the three presentations (F=21.15, df=2, 95; p <.05). Subsequently, the null hypothesis was rejected and the alternate hypothesis was accepted.

$$H_a : \mu_{drawings} \neq \mu_{Showroom\ Display} \neq \mu_{Computer\ Model}$$

By using the results of the Duncan's New Multiple Range Test and the means for the scores (Table 3), it was determined that the Showroom Display was significantly better than the Line Drawings and Computer Model on all the questions. Also, the Computer Model was significantly better than the Line Drawings on the communication ability of the "total kitchen". However, there was no significant

Table 3

Means for Communication Ability of Space and Design for the Three

Presentations

SPACE/DESIGN CONCEPT	LINE DRAWINGS *		SHOWROOM DISPLAY *		COMPUTER MODEL *	
	MEANS*	S.D.	MEANS*	S.D.	MEANS*	S.D.
Total Kitchen	4.84^a	1.61	6.78^b	1.71	5.56^c	1.09
Horizontal Spatial Relationships	5.21^a	1.54	6.71^b	1.24	5.12^b	0.49
Vertical Spatial Relationships	4.78^a	1.83	6.65^b	1.81	5.03^b	0.58
Storage Space	4.81^a	1.75	6.84^b	1.23	4.90^b	0.65
Functional Aspects	4.9^a	1.65	6.84^b	1.28	5.43^b	0.36
Total Average	**4.91**		**6.76**		**5.20**	

Note

* Responses were coded where: 1= Very Difficult, 2= Difficult, 3= Fairly Difficult, 4= Easy nor Difficult, 5= Fairly Easy, 6= Easy, 7= Very Easy

[a, b] Means with different letters are significantly different ($p<.05$) using Duncan's New Multiple Range Test.

$F=21.15$; df=2, 95; $p<.05$

difference between the Line Drawings and the Computer Model in the communication ability of "spatial relationships," "storage space," and "functional aspects."

Presentation Preference

The three presentations were evaluated for overall preference and the participants were asked to choose one presentation which would be most helpful to them in making a "buying decision." A single sample Chi Square test was performed on the data to determine whether the frequency of the responses differed among the three presentations. The null hypothesis tested in the analysis was: "There is no significant difference in the preference for presentations."

The results (χ^2=15.25, df = 2, p<.05) were significant (Table 4) and subsequently, the null hypothesis was rejected and the alternate hypothesis accepted.

$$H_a : \mu_{\text{drawings}} \neq \mu_{\text{Showroom Display}} \neq \mu_{\text{Computer Model}}$$

The frequency count on the observed responses (Figure 10) indicates that the Computer Model was most preferred, followed by the Showroom Display, while the Line Drawing presentation was the least preferred.

Table 4

Expected and Observed Frequency and Chi Square for Presentation

Preference

PRESENTATION TECHNIQUE	TOTAL EXPECTED n	TOTAL OBSERVED n (%) *	CHI SQUARE χ^2
Line Drawings	10.66	2(6)	7.03
Computer Model	10.66	20(63)	8.18
Showroom Display	10.66	10(31)	0.04
Total	32	32(100)	15.25

Note :

$p < .05$

*   Percentages rounded to the nearest whole number
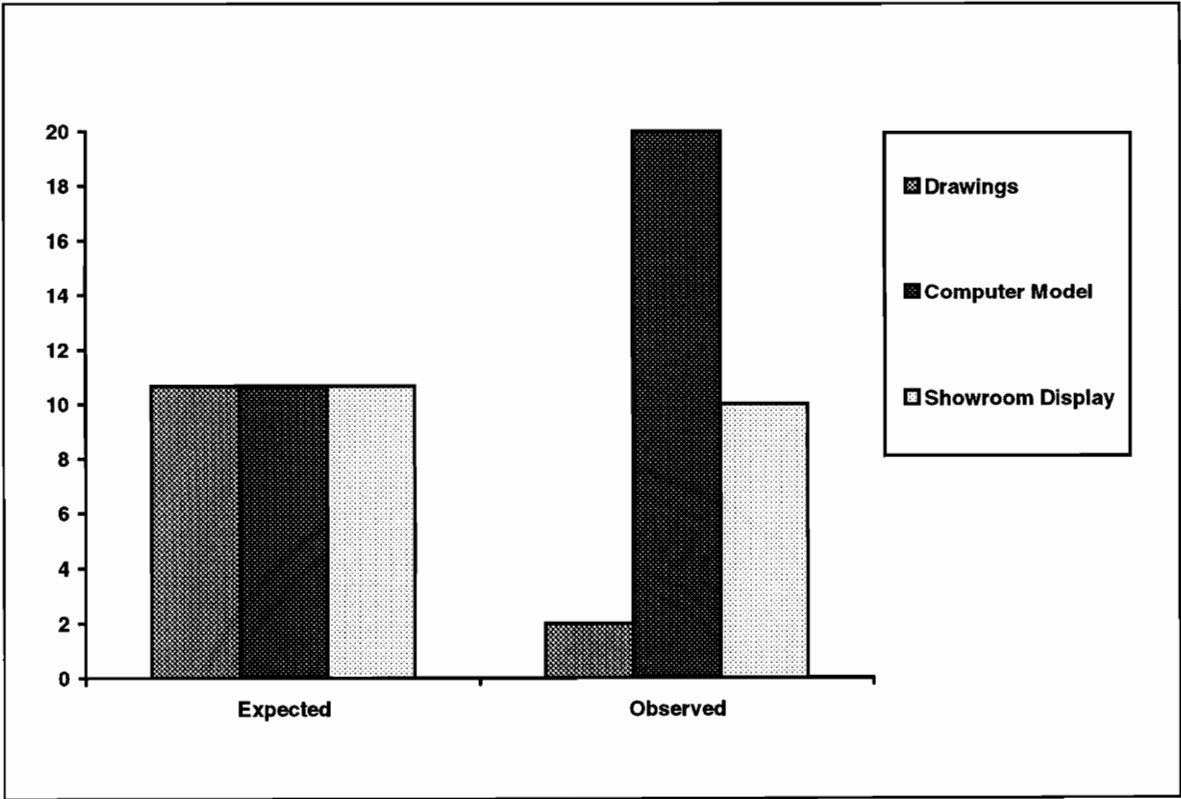
Figure 10

Expected and Observed Responses for Presentation Preference

Closeness in Appearance between Computer Model and Showroom Display

The Computer Model was compared to the Showroom Display to determine how close the two presentations appeared. The participants were asked to choose between four responses which described the closeness in appearance between the Computer Model and the Showroom Display. The four possible responses describing the closeness in appearance were "almost exactly alike," "close to," "not much like," and "totally unlike." A single sample Chi Square test was performed on the data to determine whether the frequency of the responses differed among the four levels of closeness. The null hypothesis tested in the analysis was: "There is no significant difference in the frequency of responses on the closeness of appearance between the two presentations.

The obtained results (χ^2=35,75, df = 3, p<.05) were significant (see Table 5) and subsequently the null hypothesis was rejected and the alternate hypothesis accepted.

$$H_a : \mu_{\text{exactly like}} \neq \mu_{\text{close to}} \neq \mu_{\text{not much like}} \neq \mu_{\text{totally unlike}}$$

The frequency count on the observed responses (Figure 11) indicates that a majority of the respondents felt that the Computer Model appeared close to the Showroom Display. Less than a third felt that the two presentations were exactly alike while less than a tenth felt that the Computer Model was not much like the Showroom Display. None of the participants felt that the Computer Model appeared totally unlike the Showroom Display.

Table 5

Expected and Observed Frequency and Chi Square for Closeness in Appearance between Computer Model and Showroom Display

PRESENTATION TECHNIQUE	TOTAL EXPECTED n	TOTAL OBSERVED n (%) *	CHI SQUARE χ^2
Almost exactly like	8	7 (22)	0.12
Close to	8	22 (69)	24.5
Not much like	8	3 (9)	3.12
Totally unlike	8	0(0)	8
TOTAL	32	32(100)	35.75

Note :

$p < .05$

*   Percentages rounded to the nearest whole number
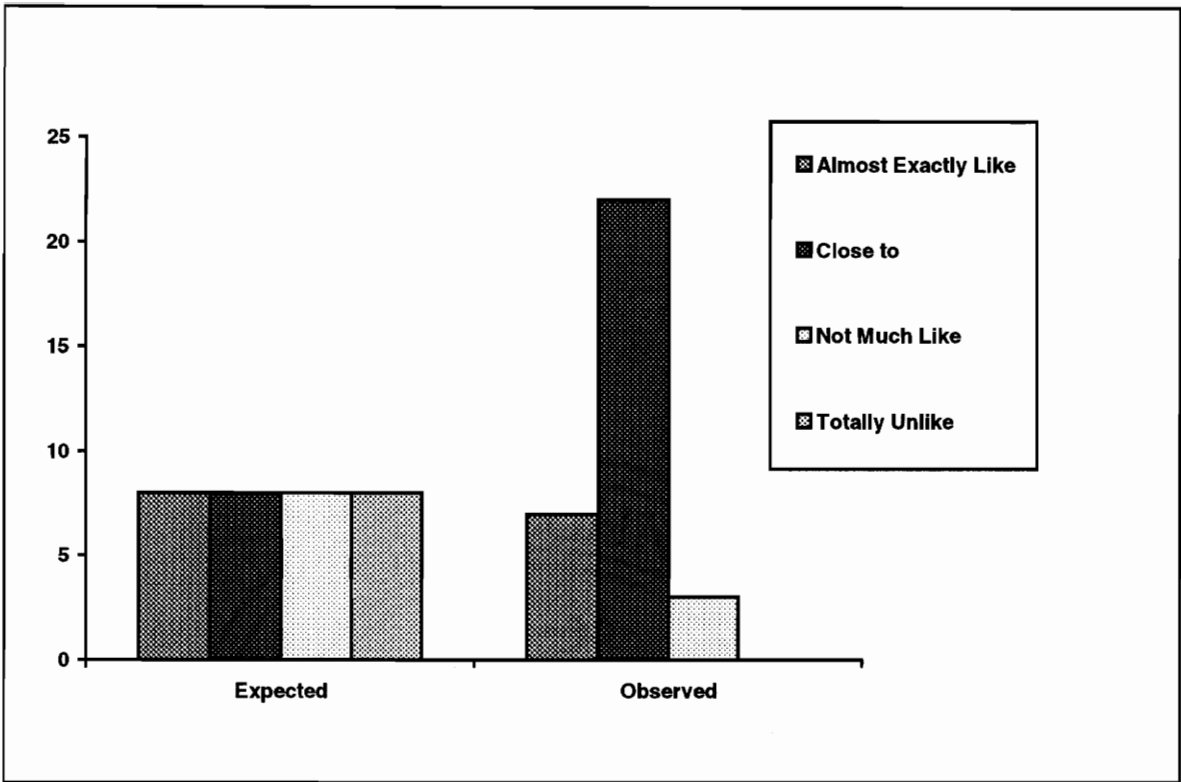
Figure 11

Expected and Observed Responses on Closeness in Appearance between Computer Model and Showroom Display

Acceptability of Computer Model as Presentation Medium

The Computer Model was tested for its acceptability as a means of presentation. The participants were asked how they would feel about viewing through a computer presentation a renovation proposal for their own kitchen. The responses were a choice between four which were: "computer presentation would be helpful," "samples and catalogs would be as helpful," "would be difficult to visualize through a computer presentation," and "would not like to look at computer presentations." Thirty of the 32 participants responded that the computer display would be helpful to them in visualizing their proposed kitchen. Only one person objected to looking at the computer presentation, while one person did not answer the question.

Presentation Attributes

The qualitative questions in the concluding part of the questionnaire sought responses to open ended questions regarding what the participants liked most and least about each of the three presentations. It also solicited suggestions for improvements in the Computer Model presentation. A summary of the responses received on these questions is given.

The most liked features about the Line Drawing presentation were the technical details such as dimensions and the legend of cabinetry and finishes that they included. A few participants felt that their mobility and facility to make instant

changes through sketches was important. The least liked aspect about the Line Drawings was their inability to offer easy visualization of three-dimensional spatial relationships. The lack of color was viewed as another disadvantage of this presentation.

The presentation of the Showroom Display was most liked by the participants for the fact that it was real; they could move within the space, touch, and feel, and therefore it gave a better idea of the color, texture, spatial relationships, and functional aspects of the design. The major disadvantage experienced in this presentation was that it could be viewed in only the finish that was displayed. Almost everybody said that the hardest thing about this presentation was its restriction in viewing alternative finishes.

Almost every participant indicated that the Computer Model presentation was very helpful in visualizing the change in colors and finishes for the kitchen. Some also felt that it was helpful to them in getting a better idea about the three-dimensional space. The least liked aspects of the Computer Model were the jerky motion of the animation and the unreal colors displayed. Some of the other disadvantages mentioned were the lack of technical information such as dimensions and specifications of cabinetry and finishes. A few participants also said that they could not judge the scale of the model because of the absence of something to compare it to.

The suggestions for improving the presentation with the Computer Model included the addition of a human figure for scale, more realistic color, smoother motion in the animation, and additional views from various angles. A number of participants suggested the addition of a "bird's eye perspective" to get a better view of the kitchen plan.

Discussion

The data analysis indicated that there was a significant difference in the communication effectiveness of the three presentations. The Computer Model was the easiest in visualizing changes in colors and finishes. The Showroom Display was a better communicator of the space and design than the Computer Model and the Line Drawings. Although almost all the participants preferred the Computer Model over the Line Drawings in communicating space and design concepts, the analysis showed no significant difference between the two. A majority of the participants felt that the Computer Model appeared close to the Showroom Display. The Computer Model presentation was preferred by over 90% of the participants as being helpful in making a "buying decision." The results and implications of the analyses are briefly discussed below.

Visualization of Task and Change in Finishes

The Showroom Display was found to be significantly better than the Line Drawings and the Computer Model in allowing easy visualization of the task. In the Showroom Display, the participant was able to actually move around in the kitchen and actually perform the required task and therefore found it very easy to visualize. Although the Computer Model was easier than the Line Drawings in visualization of task (Table 1), there was no significant difference between the two. The jerkiness of motion in the computer animation could be the reason for this insignificant difference. This drawback of the animation was due to the limitations in the computer hardware that was used.

The Computer Model was found to be significantly better than both the Line Drawings and the Showroom Display in allowing easy visualization of change in finishes. In the Line Drawings and Showroom Display, the participants had to actually try to imagine the kitchen in new finishes by looking at the samples and the presentations. However, in the Computer Model they could view the kitchen in both finishes very easily on the screen.

Space and Design Communication

The Showroom Display was significantly better than both the Computer Model and the Line Drawings on all the space and design communication questions,. The Computer Model was better than the Line Drawings only in the

communication ability of the "total kitchen." However, on the "spatial relationships,"

"storage space," and the "functional aspects" questions there was no significant

difference between the Computer Model and the Line Drawings. The "real

presence" of the Showroom Display made it better a communicator of all space and

design concepts.

Closeness in Appearance

The responses on the closeness of appearance between the Computer

Model and the Showroom Display indicated that over two-thirds of the sample (68%)

felt the Computer Model appeared "close to the Showroom Display." A fifth of the

sample (21%) felt that it appeared "almost exactly like the Showroom Display," while

the rest (11%) felt that it was "not much like the Showroom Display". The limitation

of low resolution images displayed in the computer presentation could be the reason

that the majority of participants chose to respond that the Computer Model appeared

"close to" and "not much like" the Showroom Display.

Presentation Attributes

The open ended questions regarding the most and least preferred attributes

of each presentation elicited a variety of replies. The general responses indicated

that the Line Drawings were liked for their ability to communicate technical details

and were disliked for the difficulty of visualizing the three dimensional aspects of the

space. The Showroom Display was disliked only for the difficulty it posed in visualizing changes in finishes and its restriction in being able to represent only one configuration of spatial arrangement. The most favorable aspect about the Computer Model was its ability to effectively present changes in colors and finishes. Some participants also felt that they could visualize the three-dimensional space and appreciate the overall design easily through the computer presentation. This agrees with the results of Hosken's research (1992) and the McLain-Kark et al. study (1994).

Presentation Preference

The Computer Model was preferred by 62% of the sample for selecting alternative finishes in the absence of a showroom vignette displaying their choice of finishes. Thirty people out of the 32 felt that the Computer Model would be very helpful in making a decision were they to renovate their own kitchen. Only one person felt that they would not like to look at computer presentations. This single participant had a personal dislike for computers in general.

The results of this study indicate that the computer presentation was most helpful in visualizing changes in finishes. The responses also indicate that a computer-generated model is an acceptable means of presentation. These findings support the studies from the review of literature that found computers to be accurate communicators of space and design concepts.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

Marketing, partially if not totally, depends upon the clarity of communication between the seller and the buyer (Hosken, 1992). Without a clear means of communication, the product, although outstanding, may not have the expected impact on the buyer.

In the field of kitchen design and sales, vignettes displaying a part of the kitchen setup seem to be the ideal form of marketing. This form of display, though, has drawbacks mainly due to space and resource limitations. The client is not able to view the complete room (kitchen) but only a part of it and has to visualize the rest. Also, the number of vignettes on display is restricted in terms of number, space arrangements, layout, color schemes, and finishes, thus creating an unclear or incomplete presentation of the complete line of products and the options available to a prospective buyer. Thus, the Showroom Displays are limited as marketing devices because communication of the final product is unclear.

The newest trend in marketing innovation is the use of the computer, the possibilities for its usage ranging from word-processing to animation and virtual reality. Advanced modeling and rendering algorithms allow designers and clients to walk through and experience the designed space long before its construction

(Greenberg, 1991). Earlier studies (Davis & Bernecker, 1984; Cleveley, 1987; Hosken, 1992; McLain-Kark et al., 1994) have shown computer-generated models to be accurate predictors of spaciousness, visual clarity, and overall preference.

In kitchen showrooms, this technology can be used as a marketing device to generate numerous three-dimensional computer-generated models of completed kitchen setups displaying the whole room as against conventional showrooms which have a limited number of models with only a part of the kitchen displayed in each. With these computer-generated models one could have the option of creating combinations of all available styles and finishes unlike the Showroom Displays which can effectively display only one style and set of finishes per setup.

The purpose of this study was to test the effectiveness of three-dimensional computer-generated modeling in presenting design ideas and alternatives to a client. The study also aimed to evaluate the acceptability of computer-generated models as means of design presentations. Three forms of kitchen design presentations: Line Drawings, an actual Showroom Display, and three-dimensional Computer Models, were compared for their effectiveness in presenting a kitchen design to a prospective client. These presentation techniques are the three methods of communication used by designers/sellers to convey design ideas to clients.

The three forms of presentation for this kitchen design were prepared and set up as follows. A kitchen cabinet manufacturer was located who was willing to lend

the actual Showroom Display for use in this study. The Line Drawings of the same Showroom Display which included a plan, elevations, and a perspective view were drafted. The Computer Model was simultaneously created, using the software program 3D Studio, and represented a duplication of the actual Showroom Display. The three forms of kitchen design presentation were set up separately.

The sample for this study was selected from among the building permit applicants in the town of Blacksburg, Virginia. The 32 participants had to have had some experience with home building or remodeling work. The selection criteria based on the characteristics of typical clientele visiting a kitchen showroom had been identified earlier by Yust and Olson (1991).

Data collection was done through interviews in which each participant was shown the three presentations and then asked to fill out a questionnaire. The participants compared the three presentations on several items and then assigned scores to each based on a seven-point scale. Open-ended and multiple choice questions were also included within the questionnaire which aimed to gauge general preferences and acceptability.

Data were analyzed using One Way Analysis of Variance (ANOVA) on the scores. Chi Square tests were used to analyze the multiple choice questions to check for variations in the frequency of responses. The responses on the open-ended questions were summarized and evaluated for trends and tendencies.

The results indicated that there was a significant difference in the communication effectiveness of the three presentations. The Computer Model was the easiest in visualizing changes in colors and finishes. The Showroom Display was a better communicator of the space and design than the Computer Model and the Line Drawings. Almost all the participants preferred the Computer Model over the Line Drawings in communicating space and design concepts yet, the analysis showed no significant difference between the two presentations. A majority of the participants felt that the Computer Model appeared close to the Showroom Display. The presentation with the Computer Model was preferred by over 90% of the participants as being helpful in making a "buying decision"

Conclusions

There is a significant difference in the communication effectiveness of Line Drawings, Showroom Displays, and Computer Models. A Showroom Display is an ideal communicator of its spatial and functional design concepts and its finishes, mainly because of its "real" existence. It cannot, however, present alternative designs and finishes effectively and thus the designer has to rely on the use of another presentation medium. While Line Drawings are capable of conveying technical information, they are poor communicators of three-dimensional spatial relationships and finishes.

Computer Models are capable of effectively communicating various design, color, and finish alternatives. Their communication ability of finer details such as texture of materials and true color is limited. But this is possibly due to limitations in computer hardware in this study.

Based on the results, computer-generated models can be effectively used in kitchen design showrooms as a means of displaying color, finish, and design alternatives. These models cannot replace showroom displays but can function as added enhancements with their ability to display various displays in all possible permutations of colors and finishes. Computer generated models and displays can also be recognized as acceptable means of design presentations.

Effective communication of a proposed design to a client can result in increased post-occupancy satisfaction. And, as a high percentage of the business in the kitchen and bath design industry is based on referrals, customer satisfaction is an important issue.

Implications

The potential for using computer-generated models, such as those used in this study, to present design ideas, holds implications for all designers, decorators, furniture showrooms, or any profession involved in presenting and marketing design ideas and options to consumers.

Kitchen and bath showrooms currently can effectively exhibit only a finite number of designs and styles despite the wide range they actually offer. The limitations of space and resources restrict the number of vignettes that can be displayed. Computer-generated models used in these showrooms can display effectively all the available styles and designs in all possible combinations. These models displayed through a computer monitor would occupy less space than a single showroom vignette and yet be able to present the complete line of products offered. Being simulated presentations, the computer models cannot actually replace the vignettes but can reduce their numbers, thus conserving space and assets. Furniture dealers, wall and window treatment stores, and other stores can use these computer-generated models similarly to display their complete range of products economically in terms of space and resources.

For designers, this could be an ideal way of presenting design ideas and alternatives to their clients thus helping them visualize the designer's proposed ideas while reducing the client's anxiety. Computer presentations can give the client a better idea of what they are going to get and will result in fewer complaints later on and more satisfied customers.

Computer terminals displaying the available products could be installed in showrooms to be used interactively by the clients themselves to view their choices and thereby aid them in their decisions. These apparatuses would allow

customers to work on their own design projects by allowing them to select and view their choice of products, styles, colors, and finishes.

Although such a presentation system would require a substantial investment initially, it would prove economical in the long run. The flexibility of a computer model to change styles and designs in keeping with the rapidly changing trends of today's market would make the investment feasible.

Recommendations for Further Study

The following recommendations for further research are made based on the results of this study:

1. Because of the limitations of the computer hardware used in this study, the capability of computer models could not be extended to effectively present spatial relationships and functional aspects of the design. With the use of upgraded hardware, the same study could be repeated to test whether use of high resolution animations and advanced graphics improves the perception of spatial and functional design concepts.

2. Select a kitchen design showroom and test the application of these computer-generated models as presentation media with actual customers. A computer-generated model of the proposed project should be used to

present the design to the client and assess their perception and understanding of this proposed design. On completion of the project, a post-occupancy evaluation should be conducted to assess the client's comprehension of the space and design after using it. The two tests should be compared to appraise the effectiveness of these Computer Models as a primary means of presentation.

3. A study similar to the one above can be conducted with the aim of assessing customer satisfaction. Two groups of clients, a control group which should be presented the proposed design through the conventional method and a second group which should be presented the design through computer-generated models, should be compared to measure their satisfaction with the design. This study would determine whether Computer Models can present proposed designs more accurately, thereby resulting in more satisfied customers

4. This research did not measure the effect, if any, of age, sex, and prior experience with computers on the acceptability of computer presentations. A study designed to measure the effect of these variables on the acceptability of presentation techniques could be conducted.

5. To make the results more generalizable, studies should be repeated with different types of products and with a larger sample. If the results are consistent over this changing range of products and clients, then the results could be generalized and applied to a much wider base of retailers.

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APPENDIX A

Letter of Introduction to Sample

Participant
Blacksburg, VA 24060

September 19th, 1994

Dear Participant,

As you may be aware, computer simulations are now being used in many fields as a means of conveying and presenting new designs and ideas. We are researching and testing the use of this technology in presenting interior design ideas to clients. The study involves comparing a person's perception of a kitchen setup in three different methods of presentation: 2-dimensional drawings, an actual kitchen showroom display and a 3-dimensional computer generated animation.

As a prospective participant for this study, your name was selected form the Building Permits applications file from the Planning Office of the town of Blacksburg. Your recent experience with home remodeling/building has made you a valuable source of information for this study and we sincerely hope that you will agree to participate.

We would like to arrange an appointment, at your convenience (weekends and evenings possible), for you to come to Wallace Hall, Virginia Tech Campus. The study will take approximately 1 hour. You will participate in three forms of design presentations for a kitchen as described above. You will then fill out a questionnaire giving your opinions about the three presentations. A short interview with the researcher will follow.

A small souvenir from India (the researcher's home) will be presented as a token of appreciation. Your participation and contribution in this study is extremely valuable and will be highly appreciated. You will be contacted in the next week to know your decision regarding participation in this project and to answer any questions you may have. We look forward to working with you.

Sincerely,

Shilpa Dhuru   Joan McLain-Kark
Graduate Student   AssociateProfessor

APPENDIX B

Brief Description of Study and Consent Form

The Use of 3-Dimensional Computer Generated Models for Design Presentations:

Implications for Kitchen Showroom Displays

Shilpa Dhuru   Joan McLain-Kark

Department of Housing, Interior Design and Resource Management, Virginia Tech

You are invited to participate in a study to compare the efficiency of communication of three forms of design presentations: 2-dimensional drawings, an actual kitchen model and a 3-dimensional computer generated model. The study involves experimentation for the purpose of research for the principal investigator's Master's Thesis. The study involves 29 subjects in addition to yourself.

You are requested to read the adjoining questionnaire and follow the instructions carefully and then fill in your responses to each question accordingly. The questions are designed to obtain your opinion regarding the three design presentations you will view. The questionnaire consists three parts and it will take you approximately 30 minutes to complete it. Your experience as a home builder/remodeler makes your participation in this project very valuable. The results of this project will be beneficial in evaluating the clarity of communication offered by computer generated models and will further help determine whether these computer generated models can replace actual showroom models. You may receive a synopsis of this research when completed. Please indicate this to the investigator.

The results of this study will be kept strictly confidential. At no time will the researchers release the results of the study to anyone other than the individuals working on the project without your written consent. The information you provide will have your name removed and only a subject number will identify you during analyses and any written reports of the research.

As a token of appreciation for your participation in the project you will receive a small souvenir.

You are free to withdraw from this study at any time without obligation. If you chose to withdraw, you will still receive the token.

This research has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University and by the Department of Housing, Interior Design and Resource Management.

I know of no reason I cannot participate in this study.

Signature

I have read and understood the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without obligation. I agree to abide by the rules of this project.

Should I have any questions about this research or its conduct, I will contact:

Shilpa Dhuru	231-6832	Ernest R. Stout	231-9359
Investigator		Chair, IRB	
		Research Division	
Joan McLain-Kark	231-7415		
Faculty Advisor			

APPENDIX C

Questionnaire

QUESTIONNAIRE

LOOK CAREFULLY AT THE KITCHEN DESIGN PRESENTED IN THE **DRAWINGS** AND ANSWER THE FOLLOWING QUESTIONS

A)   You have been asked to perform the following task: **Remove a pot from the base cabinet in the island, fill it with water from the sink, and put it to boil on the cooktop.** Imagine performing this task in the kitchen presented in the Drawings.

Was it easy to visualize yourself performing the above task in the kitchen represented in the Drawings? Circle the word which most closely represents the degree of ease/difficulty of visualization of the task)

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

B)   The designer wishes to propose a new look for this same kitchen by altering the finishes. Now look at the alternative finishes for countertop material and cabinet door and **try to visualize this "new" kitchen with the alternative set of finishes**

Was it easy to visualize the kitchen with the alternative finishes? Circle the word which most closely represents the ease/difficulty of visualization of the "new" kitchen.

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

End of Part I
Please do not turn page untill requested

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LOOK CAREFULLY AT THE KITCHEN DESIGN PRESENTED IN THE **SHOWROOM DISPLAY** AND ANSWER THE FOLLOWING QUESTIONS

A)   You have been asked to perform the following task: **Remove a pot from the base cabinet in the island, fill it with water from the sink, and put it to boil on the cooktop.** Imagine performing this task in the kitchen presented in the Showroom Display (You may actually try doing it).

Was it easy to visualize yourself performing the above task in the kitchen represented in the Showroom Display? Circle the word which most closely represents the degree of ease/difficulty of visualization of the task.

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

B)   The designer wishes to propose a new look for this same kitchen by altering the finishes. Now look at the alternative finishes for countertop material and cabinet door and **try to visualize this "new" kitchen with the alternative set of finishes.**

Was it easy to visualize the kitchen with the alternative finishes? Circle the word which most closely represents the ease/difficulty of visualization of the "new" kitchen.

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

End of Part II
Please do not turn page untill requested

LOOK CAREFULLY AT THE KITCHEN DESIGN PRESENTED IN THE **COMPUTER MODEL** AND ANSWER THE FOLLOWING QUESTIONS

A)   You have been asked to perform the following task: **Remove a pot from the base cabinet in the island, fill it with water from the sink, and put it to boil on the cook top.** Look at the animation on the Computer screen and imagine performing this task in the kitchen presented in the Computer Model .

Was it easy to visualize yourself performing the above task in the kitchen represented in the Computer Model? Circle the word which most closely represents the degree of ease/difficulty of visualization of the task.

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

B)   The designer wishes to propose a new look for this same kitchen by altering the finishes. Now look at the **Computer Model** and **try to visualize this "new" kitchen with the alternative set of finishes.**

Was it easy to visualize the kitchen with the alternative finishes? Circle the word which most closely represents the ease/difficulty of visualization of the "new" kitchen.

Very Difficult	Difficult	Fairly Difficult	Neither Easy nor Difficult	Fairly Easy	Easy	Very Easy

End of Part III
Please do not turn page untill requested

PART IV

Please compare the three forms of Kitchen Design Presentation: **Two-Dimensional Drawings, Showroom Display and Computer Model and answer the following questions.**

Score each presentation in its **ability to communicate information about the space and the design** to you. Assign scores from 1 - 7 in the following order.

1	2	3	4	5	6	7
VERY DIFFICULT	DIFFICULT	FAIRLY DIFFICULT	EASY NOR DIFFICULT	FAIRLY EASY	EASY	VERY EASY

1)   The total kitchen :

Drawings	1	2	3	4	5	6	7
Computer Model	1	2	3	4	5	6	7
Showroom Display	1	2	3	4	5	6	7

2)   Distance between cook top counter and island (i.e. the horizontal spatial relationships) :

Drawings	1	2	3	4	5	6	7
Computer Model	1	2	3	4	5	6	7
Showroom Display	1	2	3	4	5	6	7

3)   Distance between wall cabinets and counter (i.e. the vertical spatial relationships) :

Drawings	1	2	3	4	5	6	7
Computer Model	1	2	3	4	5	6	7
Showroom Display	1	2	3	4	5	6	7

4)   The amount of storage space available in the kitchen :

Drawings	1	2	3	4	5	6	7
Computer Model	1	2	3	4	5	6	7
Showroom Display	1	2	3	4	5	6	7

5)   Functional aspects of the kitchen (e.g., work space between sink and cook top) :

Drawings	1	2	3	4	5	6	7
Computer Model	1	2	3	4	5	6	7
Showroom Display	1	2	3	4	5	6	7

6)   If you were considering buying a kitchen **in colors and finishes other than those displayed in the Showroom Display**, which presentation would be the most helpful to you in making a `buying decision'? (Mark only one)

    Drawings   _____
    Computer Model   _____
    Showroom Display   _____

    Why?_____

PART V

1. What did you like most about the Drawing presentation?

    ----

2. What did you like least about the Drawing presentation?

    ----

3. What did you like most about the Showroom presentation?

    ----

4. What did you like least about the Showroom presentation?

    ----

5. What did you like most about the Computer presentation?

    ----

6. What did you like least about the Computer presentation?

    ----

7. How close do you think the computer presentation appeared to the showroom display?

    Almost exactly like the showroom display   _____
    Close to the showroom display   _____
    Not much like the showroom display   _____
    Totally unlike the showroom display   _____

8. If it were possible, how would you change the computer presentation?

                                                                                        Over Please

9. Suppose you were planning to renovate your own kitchen and **a showroom display was not available**, how would you feel about viewing a computer presentation of your proposed kitchen? (Mark only one response)

The computer presentation would be very helpful in making a decision   _____
I would just as well look at samples and catalogs as a computer presentation _____
I would find it difficult to visualize my kitchen through a computer presentation _____
I would not like to look at computer presenatations   _____

Comments: --

----

10. Would you be willing to participate in a follow -up study of this project   YES   /   NO

THANK YOU VERY MUCH FOR YOUR PARTICIPATION !!

VITA

Shilpa H. Dhuru was born on December 18th, 1968 in Bombay, India. She received her Government Diploma in Architecture from Academy of Architecture, Bombay in January, 1992. During the course of her undergraduate studies she worked part-time in her parents' architecture and interior design practice. In May 1990, Shilpa founded, in partnership, a kitchen design firm which was among the first of its kind in India. Upon completion of her undergraduate studies she also started working as an architect for an architecture, planning, and interior design firm specializing in residential and commercial design. She is currently a licensed architect of the Council of Indian Architects and a member of the Indian Institute of Architects. In August, 1992, Shilpa began her graduate studies when she was accepted to the master's program in the Department of Housing, Interior Design, and Resource Management. During her graduate studies she was a graduate teaching assistant for House Planning and 3D CAD Modeling and Rendering. She also received third place in the NKBA sponsored, national kitchen design competition in 1994. A paper she co-authored was accepted by IDEC and presented at their annual meeting in April 1994. Her future endeavors include kitchen and bath design and 3D CAD applications.